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"Ain't I a woman?": Black Women Negotiate and Resist Systemic Oppression in Undergraduate Engineering and Mathematics Disciplines

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“Ain’t I a woman?”: Black Women Negotiate and Resist Systemic Oppression in Undergraduate Engineering and Mathematics Disciplines

by

Jessica Alyce Wilson

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Curriculum and Instruction with an emphasis in Mathematics Education Department of Teaching and Learning College of Education University of South Florida

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Keywords: African American women, STEM education, Experiences, Persistence, Overall well-being, Sense of agency

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DEDICATION

Throughout my dissertation research I explored literature that helped me understand my study but also helped me to understand myself. Specifically, Patricia Hill-Collins (2000) is one author that stands out because she discussed Black women’s struggle against structures of domination, which empower interpretations of the world through norms Whiteness and masculinity. Hill-Collins (2000) emphasizes the importance of intersecting oppressions in shaping what counts as knowledge so that it is representative of Black women’s experiences. I highlight these points to draw attention to my identity development as a Black woman mathematician, mathematics educational researcher and critical educator for social justice because as I explored the research that would inform this study, I realized my perspective had been excluded from common knowledge in my field. Throughout my Ph.D. journey my knowledge base was often discredited, dismissed, and misunderstood, although I honored my perspective and lived experiences. Initially, I did not understand the depth of what I was experiencing as a doctoral student. In many ways I felt rejected and learned to be afraid of being myself, which triggered a lot of pain and uncertainty for me. What I did not know when I began my Ph.D. journey was those feelings of rejection would be a defying moment along my journey. I had to choose one of two options: 1) I would either try my best to align with controlling images, shrink in my identity to make others comfortable and suppress my own ideas, or 2) I would continue to advocate for my perspective and positionality and seek out conferences aligned with my interest area, find mentors in my field who were interested in the work I wanted to produce who would also be supportive throughout my journey, explore literature that aligned
with my perspective and positionality, and identify courses at my institution that would support
my understanding of such literature, even if it meant taking courses outside of my department or
college. I chose the second option and the more I searched for my truth, I was affirmed and
inspired in so many ways. Through this transformative process I became liberated in every
aspect of my identity, which helped me to accept that I was different. This research study is the
first glimpse of me being my authentic self through research but most importantly through this
study I seek to provide insight to an intersectional experience that will help shape the knowledge
base in my field to also be inclusive of the characterizations of Black women in undergraduate
engineering and mathematics disciplines.

I dedicate this dissertation to others like me who are struggling to find themselves and are
in need of inspiration. Remember that you are enough just as you are and know that your lived
experiences and interpretation of the world is valuable!! You are not alone, I see and hear you.
This process has taught me that my power is in my self-definition, so never feel guilty for
honoring your perspective and telling your story! It’s when you tap into your true self that you
are guided to everything in life you were created to be.
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To my dissertation committee thank you for your positivity, words of encouragement, and thought-provoking feedback to my work. I appreciate your time in seeing me through this process.

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Thank you for seeing something in me that would be beneficial to the field of education and encouraging me to remain focused on a greater goal of doing critical work to advance the mathematics education community. To all of the critical education scholars who I have engaged with or simply watched you discuss your research, at CRSEA, AERA, and ASEE I thank you for your presence in these spaces and your scholarship. On those days when I needed a pep talk and did not have someone around to reiterate to me that my positionality and perspective was valuable, your published research inspired me to be creative and allow my heart to guide me in the work I choose to do. So, thank you, thank you, and thank you!!! Just know the value to the work you all are doing has many layers. You continue to inspire me, with each message you send to check on me, each conversation at conferences we engage in, and even the research you develop and publish. I hope I can be to so many others who pursuing this journey, what you all have been to me.

To my fellow sista scholars who are doctoral students and early career scholars who have become friends. Thank you for the positive energy over the years. I have met the majority of you while traveling to conferences and I am always amazed to enter a discussion and discover someone’s passion for critical research matches my own. They ain’t ready!! Well I guess they will have to get ready! A special thank you to Monica Ridgeway for your feedback early on and your encouraging phone calls along the way.

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ABSTRACT

In this inquiry I used Black Feminist Thought as the interpretive lens to investigate the characterizations and experiences of high achieving Black women undergraduate engineering and mathematics majors at a predominantly white institution. The qualitative inquiry considered intersecting oppressions to evaluate the experiences of this population. In particular, Black women operate in the intersection of race and gender, thus for a thorough analysis of their engineering and mathematics experiences to occur, the historical context of the United States and its oppressive structures must be considered. Stereotypes and systemic oppression follow this socially constructed identity as the participants enter the fields of engineering and mathematics as Black women. In order to develop relevant suggestions to increase the participation of this population in the field, I assert that the social construction of this intersectional identity must be considered.

I evaluated the participants’ experiences to determine its influence on their academic persistence and overall well-being. I implemented sista circle methodology, an ethnographic method that embodies a gender specific research methodology. Sista circle methodology expands beyond traditional methodology to draw on social relations, the wisdom of Black women in U.S. context, and functions as a medium for mentorship as a Black feminist practice. The data I collected as part of this study included a demographic survey, pre-interview, two sista circles, vision board collage, post-sista circle electronic reflection, “sista circle” alternative interview, and member checking.
There were five participants in this study, and three of these participants engaged in the *sista circle* unity getaway and the remaining two participants completed the sista circle alternative interview. I analyzed the responses of all five participants in the interviews and *sista circles* to identify themes that emerged in this study. Eight themes emerged from the data: The first finding presented normalized policies and practices that reproduced an unwelcoming academic climate and specifically, 1) access to caring professors and the 2) competitive isolating environment. The academic climate forced the participants to negotiate self-doubt as they question if their program is the appropriate means to pursue their future career endeavors, in the second finding the participants experienced 3) variations in program expectations and reality, 4) a shift in academic self-concept, and 5) negotiated alternatives to persistence. In the third finding the participants responded to the conditions in the academic climate through forms of resistance, which include the construction of a 6) professional persona, 7) sense of community and peer bonds, and identifying 8) academic opportunities as motivational tools.
CHAPTER ONE:
INTRODUCTION

Discussions on students of color and women in the fields of science, technology, engineering and mathematics (STEM) are often representative of racial and gender discrimination, as these discussions often preserve the status quo (Castro, 2014; Martin, 2009). In the United States, race, gender and class have played significant roles in the discussion of educational access and opportunities, especially in a discussion of STEM educational opportunities and careers. Furthermore, authors have advocated for equal opportunity in STEM education for decades (Oakes, 1985, 1990; Malcolm, 1981, 1990), but it is essential that academic scholarship place emphasis on historical prejudice and injustice, unequal access to opportunities for competent students, and the isolating conditions for underrepresented students enrolled in STEM majors if progression and change will occur (Battey & Leyva, 2016; Berry, 2008; Leyva, 2017; Martin, 2009, 2006; Snipes & Waters, 2005; Stinson, 2006; Tate, 1997).

Social constructs that exist in STEM education have historically privileged the experiences of white, men (Battey & Leyva, 2016; Castro, 2014; Leyva, 2017; Martin, 2009), which has simultaneously placed students of color and women at a disadvantage. Furthermore, the experiences of students of color and women have often been considered as experiences that are marginal to the experiences of their White, men counterparts. As a result, students of color in particular have been traditionally defined as at-risk and underserved, which implements a deficit approach to their experiences in the STEM fields (Castro, 2014; Martin; 2009; Solórzano & Yosso, 2001). Although authors often take a deficit approach to understand the
underrepresentation of Black women in STEM education, in this study I explore high achieving Black women’s persistence in undergraduate engineering and mathematics disciplines so as a field we can learn from their experiences and identify methods to support these women. In order to challenge the status quo through increased participation among Black women in the STEM fields, it is imperative the reality and achievement level of Black Women in the U.S. is widely known.

One of the primary factors that influences low enrollment in STEM disciplines is the lack of interest in mathematics and sciences courses as they pursue their K-12 level education (NACME, 2008; National Science Board, 2006). This lack of interest negatively effects students’ interest in majoring in STEM disciplines upon entering college (NACME, 2008; National Science Board, 2006), which is reflected in the freshmen intentions data (National Science Foundation, 2015). Based on a report from the National Science Foundation and the National Center for Science and Engineering Statistics (NSF & NCSES, 2015) on freshmen students’ intentions for choosing majors, only 35.4% of Black women assessed intend to major in Science and Engineering (S&E) fields. Of these Black women interested in S&E, only 3.2% intended to major in engineering disciplines, 1.5% intended to major in physical sciences, and only 1.4% intended to major in mathematics, statistics and computer sciences (NSF & NCSES, 2015). However, 14.3% of the Black women interested in S&E fields intended to enter the social and behavioral sciences and 15% the biological and agricultural sciences (NSF & NCSES, 2015).

Furthermore, underrepresented minority women, Black women in particular earn more bachelor’s degrees in the social sciences and psychology than in any other science and engineering field (NSF & NCSES, 2015). Also, the field of mathematics and statistics remains fairly stable in the amount of bachelor’s degrees earned by Black women from 2002-2012 (NSF
In the case of Engineering, the amount of bachelor’s degrees earned by Black women also remains fairly stable but demonstrates modest decline over the 2002-2012 time-period (NSF & NCSES, 2015).

Similar trends exist in an evaluation of Black women in master’s and doctoral degrees. The National Science Foundation reports that in the U.S. in 2012, the field of Mathematics and Statistics (1,506) master’s degrees were awarded to women and (75) of those degrees were awarded to Black women (NSF & NCSES, 2015). Similarly, in 2012 the field of Engineering awarded (5,525) master’s degrees to women, and of those degrees (376) were awarded to Black women (NSF & NCSES, 2015). Comparatively, White women in the field of Mathematics and Statistics represent (966) and in Engineering represent (3,031) of the master’s degrees award in 2012 (NSF & NCSES, 2015). On the doctoral level, we see that of all Black women that earn Doctorates in 2012, the field of Mathematics and Statistics awarded .4% of these degrees, and the field of Engineering awarded 2.5% of these degrees (NSF & NCSES, 2015). However, 74.5% of all doctoral degrees awarded to black women were in non-science and -engineering disciplines, particularly 47.7% of these degrees were awarded in Education (NSF & NCSES, 2015). These trends are representative of retention concerns with respect to Black women that pursue and attain degrees in the fields of science and engineering, specifically mathematics and engineering. Furthermore, as Gregory (2015) highlights, “African American women represent the largest void in engineering degrees awarded; yet the relationship between their representation and persistence has received very little attention” (pp. 4-5). Therefore, research that explores both the supporting conditions that lead to Black women’s persistence in the engineering and mathematics fields, and the relationship between Black women’s retention in these fields and their persistence is necessary.
Retention and Attrition in Engineering and Mathematics

Faculty members in engineering and mathematics programs frequently attribute low-retention rates to students being underprepared or unmotivated (Borum & Walker, 2012), which is frequently referenced as the “weeding out” process (Geisinger & Raman, 2013; Perna et al., 2009). The “weeding out” process involves the perception that high attrition rates are unavoidable in engineering programs, and as a consequence to this way of thinking among faculty, they convince students who are often classified under deficit terms “underprepared and unmotivated” that it is a norm to leave engineering and mathematics disciplines ultimately convincing students to abandon their programs (Geisinger & Raman, 2013). However, students that leave engineering and mathematics programs often perform well and are in good academic standing (Seymour & Hewitt, 1997; Besterfield-Sacre, Atman & Shuman, 1997; Marra et al., 2009). Geisinger and Raman (2013) reviewed research literature on retention in STEM from 1949-2011 and identified a common set of factors contributing to low-retention rates in engineering programs. The factors include: “the unwelcoming academic climate found in many engineering programs, conceptual difficulties with core courses, a lack of self-efficacy or self-confidence, inadequate high school preparation, insufficient interest-in or commitment-to the field of engineering or a change in career goals, and racism and/or sexism” (Geisinger & Raman 2013, p. 917).

Experiences of Black women in Engineering and Mathematics

Similarly, negative race and gender stereotypes, microaggressions, and uncaring and discouraging professors have been identified as primary barriers faced by Black women in engineering disciplines (Borum & Walker, 2012; Frillman, 2011; Gregory, 2015; Somerville-Midgette, 2014). These experiences often negatively influence Black women’s academic
persistence and overall well-being as they navigate the field (Frillman, 2011; Gregory, 2015). Furthermore, researchers need to explore counterspaces for Black women that are conscious of students’ overall well-being and are culturally relevant and gender specific. These spaces have the potential to assist these students as they navigate challenges and barriers in their programs.

Researchers have conducted studies to explore the experiences and/or support systems of Black women as doctoral students (Shavers, 2010; West, 2011) and Black women as doctoral students, career and workforce professionals in engineering and mathematics fields (Borum, 2012; Borum & Walker, 2012; Bush, 2013; McGee & Bentley, 2017; Rice, 2016; Rice & Alfred, 2014; Simon, 2011; Somerville-Midgeette, 2014). This literature discusses Black women’s experiences and/or support systems as undergraduate students in STEM disciplines. However, since the participants presented their life experiences in retrospect, a limitation is potential recall error and bias in the data collected and their life histories could also be misremembered or forgotten. To address this limitation, researchers need to explore the experiences of Black women as undergraduate engineering and mathematics students as they pursue undergraduate degrees. Since the students were persistent in their undergraduate programs at the time of this study, their experiences were new and fresh in their minds, and provided a current perspective to this research as they pursed undergraduate engineering and mathematics degrees.

“Ain’t I a woman?”

In the historical quote “Ain’t I a woman?”, Sojourner Truth recognized her experiences as a Black woman were often viewed as marginal to men and white women. Although society dehumanizes this intersectional experience of Blackness and womanhood, Sojourner Truth boldly and unapologetically raised the question, “Aint I a woman?” to acknowledge her self-valuation of her experiences and identity. Similarly, in this research study, as I consider the
experiences of Black women navigating oppressive structures that permeate undergraduate engineering and mathematics disciplines, I acknowledge that Black women function outside of the dominant group in engineering and mathematics disciplines. As a result, I ask does the academic culture value these students as significant contributors to the engineering and mathematics community?

Reflection of Relevant Experiences

Personal Background

I begin this section with a brief introduction of my cultural identity. I continue with a discussion of my academic experiences that include my K-12 experiences, and as an undergraduate and graduate student that has shaped my identity as a mathematics education researcher.

Cultural identity. The term diaspora is defined as the inclusion of numerous concepts and ideas. These include but are not limited to migration, displacement, fragmentation, ethnic identity, marginalization, connection to homeland, etc. (Hill-Collins, 2000). My culture is defined as a woman a part of the African Diaspora. African Diaspora people in the U.S. are commonly defined as African American, and the inability to connect to the origins of our roots in Africa, stems from the disruptive outcomes of slavery in the U.S. (Hill-Collins, 2000). As a result, I self-identify as a Black American woman, which is a descriptor for the African Diaspora and represents my ethnicity. This identifier also represents my race and gender, which is notable in the United States since race and gender have been socially constructed in America. This ultimately connects me to so many others that are part of the African Diaspora that share similar stories and experiences as a result of our shared culture.
**Socioeconomic position.** I grew up in a working-class family in a Metropolitan Detroit Area suburb. Additionally, I would currently define myself as a member of the *new professional middle class*, discussed in the work of Springer (2005). Springer (2005) makes connections of economic privilege that is evident through skin color, family reputation and educational advantages. As a result, Springer (2005) defines this class as Black women with variations in skin color, who came from impoverished backgrounds but held a stronger sense of their value and commitment to black communities than the upper middle-class elite because of the ties the professional class had to the cultural values of everyday blacks (p. 122).

I am connected to this class because of my family background, and strong commitment and dedication to giving back to communities of color. Next, I transitioned to a narrative of my K-12 educational experience.

**Developing my mathematics identity.** As early as the 3rd or 4th grade I can recall being presumed a math whiz by my peers, teachers, school administrators and parents. My mother knew that one of my favorite childhood books was entitled *The Math Wiz* and she always reminded me that I was her math whiz. My love for math was rooted in my parents’ strong mathematics background. So, excitement and positivity surrounded mathematics in my household for my brother and me. I recognized patterns when doing mathematics, and this made the process of problem solving enjoyable since I could accurately solve problems by looking at an example and making the connections. I can recall being in 3rd grade and loving to take timed multiplication tests and earning a perfect score on nearly each test. At home for fun my parents would challenge me to take multiplication tests and try to beat my highest score and best time.
As a mathematics educator researcher for social justice I see where my mathematics skills were advantaged in the mathematics classroom. Particular ways of learning have traditionally dominated the norms of success and high achievement in mathematics reinforcing memorization skills and pattern recognition. Such normative traditions preserve the myth that only “special people…do mathematics”, which maintains and privileges the Eurocentric culture of mathematics (Snipes & Waters, 2005, p. 118).

One of the most memorable experiences occurred in the 5th grade, where I had my first experience teaching a mathematics course. My teacher noticed that I was different and advanced in how I conceptualized and understood the mathematics content. As a result, my 5th grade teacher decided to use my mathematics skills as an opportunity to get lower performing mathematics learners in the class, closer to the mathematics benchmark. During math time he divided the class into two large groups, which allowed my teacher to work with students that were behind on the course material while I taught the advanced students and lead the section reviews. This served as another opportunity that reaffirmed my mathematics abilities, but once again as a mathematics education researcher I wonder about my peers in this situation. Was this the best way for the teacher to handle this situation? How could the school better support the diverse learning environment that was evident in this classroom? In what ways did my peers benefit or suffer from this experience? Was this an equitable solution in the mathematics classroom through this experience? Did my peers view this experience as establishing hierarchy, suggesting that I was the “better” mathematics learner or the converse that they were the “bad” mathematics learners? How might this affect intrinsic motivation, students’ self-efficacy and perception of self, especially at the age of 10 years old?

**Experience as a Future Engineers Program Administrator**
Initially, the focus of my dissertation research was to understand the ways in which the experiences of being a mentor in an Engineering Outreach opportunity, namely the Future Engineers Program (FEP) (pseudonym), influence the mentors who are Black and/or Latino(a) undergraduate students enrolled in Engineering and Mathematics disciplines at a predominantly white institution (PWI). As a program administrator, one of my primary tasks was to develop and conduct the assessment for the FEP. Thus, I did extensive research on mentoring to determine methods to investigate the FEP and align these methods with my initial dissertation research. As a result, I began this process by carrying out a qualitative inquiry approach in which I conducted interviews with the undergraduate students as part of the FEP evaluation. The interviews allowed me to assess the FEP and simultaneously operated as a pilot study for my dissertation research. The FEP evaluation was instrumental in my decision to narrow the focus of my dissertation research, which led me to shift the scope of my initial dissertation research topic. As I provide a synopsis of the FEP evaluation, I only included details of the FEP that connected to my current dissertation research. My objective is for this explanation of the FEP evaluation to function as a relevant research experience. In other words, I did not spontaneously select my current research topic; instead it was influenced by my role as a FEP administrator and lead of program assessment.

**Context of the future engineers program.** The FEP was a 5-week program that occurred during the summer 2015 semester. During the operational time of the FEP, 12 undergraduate students enrolled in Engineering and Mathematics disciplines were hired to serve as mentors to 30 middle school youth (see Figure 1-1). The FEP focused on providing a culturally relevant Engineering program to students that have been historically underrepresented in science, technology, engineering, and mathematics (STEM) fields (Knight & Marciano, 2013).
As a result, the FEP focused on the recruitment of women and girls, Black and Latino(a) students, and socioeconomically disadvantaged students to serve in mentor (undergraduate students) and mentee (middle school youth) roles. When evaluating the population of mentors and mentees for the FEP, approximately 96% of the participants classified in one or more of the identified groups above, which have been historically underrepresented in the STEM fields.

![Diagram of FEP Participants]

**Figure 1-1.** Future Engineers Program Participants

*That's my fam.* On the first day of the FEP, I established that all FEP participants would reference each other as their “fam”, representative of the term family. The term fam is part of Black English Vernacular and was used in the FEP to represent familial capital, which extends the concept of family to be inclusive to a broader understanding of kinship (Yosso, 2005). Familial capital nurtures the concept of “extended family”, which is inclusive of friends who may be regarded as members of our familia (Yosso, 2005). Yosso (2005) describes familial capital as cultural understandings nurtured among familia (kin folk) to convey a sense of cultural intuition, cultural history and memory (see Delgado Bernal, 1998, 2002). This set the tone for the entire FEP, and upon the program completion all FEP participants referenced everyone affiliated with the program as their fam. For example, when I handled disciplinary concerns, I treated students as if they were siblings. In an incident with two 11-year-old girls, they were upset with each other because the boys were being nice to one of the girls and being rude to the other (which would shift from day-to-day). I reminded the girls that you don't let boys come in-
between you because you are sisters (a reminder of kinship that I shared with all students throughout the FEP). Disputes between students required conversations with both parties where they could engage in honest dialog to move past their issues, which more often than not, ended with a hug as a physical symbol of affection. Since my approach to resolve conflict, demonstrated effectiveness, I proposed that all disputes conclude with such a display of affection to reestablish the nature of family among us. As a result, on the rare occasion that a dispute occurred, students would handle the situation independently to avoid the hug process. It is amusing to me now, how quickly students engage in self-correction when they want to avoid the adult led process and displaying affection towards one another. There are many examples of how I fostered and reinforced this concept of family in the FEP.

Furthermore, this concept of family is important to my role as a program administrator because my relationship with mentors (undergraduate students) and mentees (middle school youth) was very different from a traditional program administrator. For example, I was with a close friend and I ran into one of the mentors (undergraduate students), we hugged and began to briefly catch up; I proceeded to introduce the undergraduate student to my friend and I stated, “she is one of the mentors in my program”. My friend was shocked and said, “I thought this was a family member of yours”. The undergraduate student reassured my friend stating, “that is right, we are family!” This dynamic of family is important to understanding my relationship with the FEP participants and is an example that ratifies the culturally relevant nature of the FEP.

**Program administrator as researcher.** I was a program administrator, developer, and managed the mentors’ (undergraduate students) throughout the summer FEP. As a result, the mentors knew me very well and family nature of the FEP contributed to positive interactions during the mentor interviews for the program evaluation. Participants were able to speak freely.
Furthermore, I realized that during the interviews, I extended the conversation style interview format by engaging the students in sincere conversation and challenging them to think deeper about their experiences (Gall, Gall & Borg, 2003). I was a mentor, role model to the undergraduate students during the interviews.

**Reflection of the interview process that inspired the focus of my dissertation study.**

During the interview process I noticed that the women had striking similarities in their observations and interactions with program members that gained my attention. One participant shared that she noticed that men that were FEP administrators would focus on the boy mentees (middle school youth) and witnessed them avoiding the girl mentees. The participant stated that the mentees (middle school youth) noticed this avoidance and inquired with her, as their mentor, and the girl mentee shared her perception that the man in the FEP administration must not like them. I recall this incident because the message got back to me, and I mentioned to the administrator the observation. The outcome of our conversation was positive as the man in the FEP administration began to spend more time with both girls and boys. However, he expressed discomfort to me because he was accustomed to working with boys in youth outreach programs. The girl mentees were pleased with the shift, however they mentioned to me that they could tell he was uncomfortable. Another mentor (undergraduate student) mentioned to me that she went to speak with one of the FEP administrators during her personal time, the FEP administrator concluded a conversation with a group of men and she mentioned there was a shift in his demeanor. She instantly felt like the FEP administrator was rushing her to conclude the conversation even though she had just arrived to speak with him. His body language and their conversation became very short and dismissive and she compared this shift to how he treated the men that were conversing with him prior to their interaction, which she characterized as a
positive and embracive dialogue. Similar to the girl (mentee), this second mentor (undergraduate student) stated that this member of the FEP administration must not like her.

Trends relative to gender were evident in the findings of the program evaluation. However, the women were quick to disregard their observations as ridiculous or something that was just in their head. Furthermore, multiple women mentioned that in sharing their characterizations with other mentors, that happened to be men, the men would reassure the women that they were over thinking these occurrences and their observations were a reflection of the FEP administrators’ personality, and they should not take it personally. As a result, my perception of this finding was that the women’s reality was being interpreted by their male counterparts and was devalued because it was not a shared experience, and it frequently left the women in disbelief of their own reality. However, as a program administrator, I witnessed the same occurrences, but my observation included discrimination relative to race, class and gender. As a program administrator and critical educator for social justice I found it necessary to constantly act on behalf of the mentors and mentees in the FEP because their success and well-being was most important to me. As a result, I found it necessary as a program administrator and researcher to affirm the women and let them know that I heard them and I did not devalue their observations and perspectives.

My take away as a researcher. I noticed that in interviewing the mentors (undergraduate students), the women shared similar lived experiences with mentor participants in the FEP, and as Engineering and Mathematics majors, especially among the women that identified as African American (Black women born in America). In a spirit of inquiry, I began to wonder: Why did the women feel this way? Why do they believe their characterizations are just illusions in their head? Why are their characterizations not being validated? Furthermore, why
are the experiences of these women not being considered as a truth that needs to be addressed? As a result, I found myself limited by the interview setting since the focus was on program evaluation. The findings of the program evaluation demonstrate distinction in the individual experiences the participants had, which yield barriers and systems of support. To improvise in the moment, I noticed I became a mentor in the interview by sharing my own experiences and critical understandings with the Black women, while helping them navigate their own characterizations. The Black women stressed that they wanted to continue our discussion and spend more time with me. The more I interviewed the women and talked with them, I realized that I needed to host an event in a location that would provide a nurturing setting outside of the university allowing participants to engage in dialogue with each other. This research experience influenced me inquisitively to analyze and study the stories of Black women as undergraduate students enrolled in Engineering and Mathematics disciplines since these women needed to be validated or their voice is lost, often misunderstood or misinterpreted. We must value the narratives of these women.

**The moment when everything came together.** During February 2016 I attended a conference at Teachers College, Columbia University. The purpose of the conference was to engage in workshops and paper presentations that were centered on the discussion of Black women and girls in education. Latoya Johnson’s (2016a) presentation captivated my attention because it focused on mentoring, a topic of my research and personal interest. The presenter discussed her research on *sista circle* methodology (Johnson, 2016a). Johnson (2016a) emphasized her data collection process where she gathered a group of Black women that were schoolteachers to have a Sunday dinner and enjoy a three-course meal as they sit around the dining room table at one of the participants homes, while responding to questions and engaging
in discussion about their experiences as schoolteachers. I was stunned, because in that moment I realized that she developed a methodology that operates as a counterspace for Black women. This idea resembled what I wanted to do with the undergraduate Engineering and Mathematics students I worked with. Although my initial idea was far more informal, since I would invite the women over to my home to enjoy a home cooked meal and engage in girl talk. Additionally, we could get to know each other collectively and develop unity among us as women in engineering and mathematics disciplines. However, this methodology would allow me to engage the women in peer mentorship and fellowship while allowing me to collect data and extend the fields understanding of their experiences as Black women undergraduate students enrolled in engineering and mathematics disciplines. This presentation provided a foundation and extensive research to validate why this culturally relevant and gender specific methodology was necessary when evaluating Black women. It was in that moment I realized the perfect methodology for my research had to be culturally relevant and gender specific, and therefore I implemented *sista circle methodology* in this dissertation research.

**Statement of the Problem**

Five major problems influenced the research of this study. To begin, current research that examines the experiences of students of color focused on their high achievement, and often times researchers explore students with GPA’s of 3.0 or higher, and their persistence to abstain in their engineering and mathematics disciplines despite challenges and barriers that are in opposition of their academic success or negatively influence their overall well-being (Musesus, Palmer, Davis & Maramba, 2011; Palmer, Maramba & Dancy, 2011; Strayhorn, 2013), and particularly for Black students (Ellington, 2006; Ellington & Frederick, 2010; Harris, 2009; Martin, 2000; McGee, 2013; McGee & Martin, 2011; McGee, 2015; Montgomery, 2009). However, there is an
increasing proliferation of literature that focuses on high achievement and the persistence of Black males in engineering and mathematics disciplines (Day, 2015; Hayes, 2013; Hrabowski, Maton & Greif, 1998; Jett, 2009; Noble, 2011; Moore, 2000; Palmer, Davis & Maramba, 2011), but few have begun to focus on women of color (e.g., Espinosa, 2011), Native American women, Latina American women (e.g., Robinson, 2012; Rodriguez, 2015), and particularly Black women (e.g., Borum, 2012; Borum & Walker, 2012; Bush, 2013; Frillman, 2011; Gibson & Espino, 2016; Gregory, 2015; Jackson, 2013; Rice, 2016; Rice & Alfred, 2014; Simon, 2011; Somerville-Midgette, 2014).

Next, the majority of this research on Black women, researchers explored their undergraduate experiences in engineering and mathematics through the perspectives of Ph.D. students, career professionals and/or researchers who have persisted in the field (e.g., Borum, 2012; Borum & Walker, 2012; Bush, 2013; Rice, 2016; Rice & Alfred, 2014; Simon, 2011; Somerville-Midgette, 2014). However, rarely does the researcher explore the experiences of high achieving Black women while they are persisting as undergraduate students in engineering (e.g., Gibson & Espino, 2016; Gregory, 2015; Jackson, 2013), science (e.g., Fries-Britt & Holmes, 2012; McPherson, 2012), and computing science (e.g., Charleston, George, Jackson, Berhanu & Amechi, 2014). Furthermore, research on the experiences of high achieving Black women while they persist as undergraduate students in mathematics is scant.

Additionally, existing literature in engineering and mathematics fields tends to consider Black women as members of one of four categories: (1) Women, (2) Minorities (3) Minority women (Geisinger & Raman, 2013), and (4) Black students rather than Black women. Since these categories are aggregated, it is common that the collective experiences and voice of Black women is often misplaced. In the field of engineering and mathematics, we must acknowledge
Black women’s experiences are at the intersection of multiple structures of domination including race and gender (Hill-Collins, 1896). Therefore, neglecting to explore the distinct experiences of Black women maintains the dominant perspective that positions Black women’s experience as marginal to the experiences of men and White women.

Further, in comparison to Black men in engineering and mathematics education, Black women’s experiences have been looked at as an aggregate because they outperform their men counterparts. Additionally, the literature presented in engineering and mathematics education, and higher education does not consider that the experiences of Black women may vary since they come from different family backgrounds, lineages of collegiate experiences, some are immigrant students, and variations in access to supportive opportunities as well as barriers. The descriptor Black women, is a term that represents a multitude of women with a wide range of lived experiences and historical backgrounds that connects them as members of the African Diaspora (Hill-Collins, 2000), and in itself is representative of a very diverse group of people.

Finally, Black women in engineering and mathematics disciplines continue to endure academic and personal challenges related to the campus climate at predominantly white institutions (PWIs) (McGee & Bentley, 2017). Yet existing research that addresses the experiences of Black women often neglects to make connections to their overall well-being and how they cope with negative experiences in PWIs, and their experience as members of populations marginalized and historically underrepresented in engineering and mathematics fields (McGee & Bentley, 2017; McGee & Spencer, 2013; McGee & Stovall, 2015). The dominant culture of the fields of engineering and mathematics is rooted in race and gender by its design since White men represent the majority in engineering and mathematics fields (Battey & Leyva, 2016; Bush, 2013; Martin, 2009; NSF, 2011). Race and gender have been socially
constructed and therefore engender stereotypes, particularly negative stereotypes that lead to isolating students of color and women who have been historically underrepresented in the fields of engineering and mathematics (Bush, 2013; Larnell, Boston & Bragelman, 2014; Martin, 2009; McGee & Bentley, 2017; Smith, Brown, Thoman & Deemer, 2015; Solorzano, Ceja & Yosso).

Carr and Steele (2010) suggest that gender differences might not be innate or stable factors. Instead, such gender differences often emerge because of negative stereotypes relative to women’s abilities (Carr & Steele, 2010; Leyva, 2017; Rhoton, 2011). Furthermore, as stereotypes impugn women’s abilities, men may be led to alter their decision-making in ways that increase their behavior to take risk and decrease their concern about loss, which makes them more likely to demonstrate their abilities (Carr & Steele, 2010), placing men at an advantage as opposed to their women counterparts. As a result, when stereotypes negatively affect students of color and women’s overall well-being, White men simultaneously benefit from existing in an environment that does not presume a threat to their being since their identity is kept safe (Battey & Leyva, 2016; Carr & Steele, 2010; Martin, 2009). As a method of coping with gendered experiences, women of all races and ethnicities are confronted with acculturation and take into consideration assimilation into the dominant culture of engineering and mathematics, a norm of White, male culture (Bush, 2013; Gibson & Espino, 2016). Similar research studies conducted on Black women suggest, success for these women, does not come without emotional and psychological consequences (Carr & Steele, 2010; Gregory, 2015; Gutiérrez y Muhs, Niemann, Gonzalez & Harris, 2012; McGee & Bentley, 2017; Shavers, 2010; West, 2011). Therefore, researchers need to explore high achieving Black women enrolled in undergraduate engineering and mathematics programs, to understand their experiences and how they emotionally navigate PWIs. If the experiences of high achieving Black women as undergraduate students in
engineering and mathematics disciplines is better understood, then it will inform strategies that lead to academic persistence, achievement, and positively aid their overall well-being.

**Purpose of this Inquiry**

The purpose of this inquiry was to (1) understand the experiences of Black women as undergraduate students in engineering and mathematics disciplines and (2) explore how these experiences shaped their academic persistence and overall well-being. As a result, selecting a methodological approach that was culturally relevant was necessary, but what was most important and valuable to me was *sista circle* methodology allowed these women to learn from each other and me (Johnson, 2015, 2016b). I personally enjoy engaging in the process of qualitative data collection because it yields in-depth conversations and produces rich information I learn about participants’ experiences and characterizations. However, given the nature of this research, I think it was crucial that I understood and did not ignore the opportunity for peer mentorship that would occur as a result of these Black women’s participation in the *sista circles*, and this research.

**Sista Circles**

Domination may be unavoidable because of social structures that permeate society (Hill-Collins, 2000). However, it is unlikely that this hegemonic worldview will persist in social spaces that are dedicated to Black women and their collective voice (Hill-Collins, 2000). As a result, social spaces exclusive to Black women are necessary because this is where they speak freely and construct independent self-definitions, which is a necessity to the development of Black women’s resistance (Hill-Collins, 2000). *Sista circles* provide a safe space for Black women’s consciousness to be nurtured and fosters a collective self-defined standpoint (Hill-Collins, 2000). As Black women “come to voice” in this inquiry (Hill-Collins, 2000), *sista*
circles provide mentorship to the participants as a Black feminist practice (Johnson, 2016b). Johnson (2016b) presents sista circle methodology as a culturally relevant, gender specific methodological approach.

**Research Questions**

This study was designed to address the following questions:

1. How do Black women in pursuit of engineering and mathematics degrees at PWIs characterize their experiences while enrolled in their respective undergraduate programs?
   a. How have those experiences shaped their academic persistence?
   b. How have those experiences shaped their overall well-being?

In the next section I provide the theoretical framework that was used to analyze this inquiry.

**Significance of the Inquiry**

This research contributes to existing literature on Black women as undergraduate students in engineering and mathematics disciplines because of its potential to reveal underlying barriers, challenges, and systems of support that shape their persistence and overall well-being. Also, since in this study I use sista circle methodology in an undergraduate engineering and mathematics context, this research can be used to make inferences about the implementation of this and other ethnographic methodological approaches to support and improve future research practices for Black women and other historically marginalized groups in undergraduate engineering and mathematics disciplines. Finally, understanding the relationship between high achievement, persistence, and the overall well-being of Black women as undergraduate students in engineering and mathematics disciplines supports the development of relevant implications for effective retention efforts. Furthermore, as I engage in discussions on sista circles it provides insight into the implementation of Black women’s social networks that are content specific,
which can also contribute to the implications relative to retention and interventions in undergraduate engineering and mathematics disciplines.

**Theoretical Framework: Black Feminist Thought**

Black feminist thought (BFT) undergirds the focus of this study (Hill-Collins, 1989, 1998, 2000, 2002). Black women scholars frequently use the BFT framework to examine the state of Black women in higher education (e.g., Borum & Walker, 2012; Gibson & Espino, 2016; Green, 2017; Howard-Hamilton, 2003; Johnson, 2015; Patton, 2009; Shavers, 2010; Wilson & King, 2016). Black feminist thought provides a model to conceptualize the experiences of Black women in engineering and mathematics undergraduate programs at a PWI. Furthermore, this theoretical model provided useful indications to make sense of the Black women’s experiences as members of a historically underrepresented group in STEM education, as well as understand the marginalization and isolation that often coexist with this. Additionally, BFT provides a theoretical framework to use as I explore *sista circle* methodology that was implemented in this research.

Black Feminist Thought speaks to the Black woman’s experience in the United States, with the understanding that the vast majority of African-American women were brought to this country to work as slaves in an oppressive situation (Hill-Collins, 2000). Patricia Hill-Collins (2000) describes oppression as

any unjust situation where, systematically and over a long period of time, one group denies another group access to the resources of society. Race, class, gender, sexuality, nation, age, and ethnicity among others constitute major forms of oppression in the United States (p. 4).
The context of U.S. slavery was characterized by the convergence of class, race, and gender oppression, which subsequently shaped all relationships women of African descent had as members of Black American families, communities, working class citizens, and among each other (Hill-Collins, 2000). Consequently, three interdependent dimensions surround African American women’s oppression characterized as the: economic (exploitation) dimension, political dimension and the ideological dimension (Hill Collins, 2000).

**Engineering and Mathematics**

I was led to BFT because it informed and guided my understanding of the literature I reviewed earlier in this chapter. In reading about oppressive experiences of Black women in engineering and mathematics fields, I found direct connections to the three interdependent dimensions of African American women’s oppression. A larger system of oppression works to preserve and protect the interest and worldview of elite, White men, and simultaneously works to suppress the beliefs (thoughts) of Black women (Hill-Collins, 2000). For example, Patricia Hill-Collins (2000) discusses how historically, African American women have been denied credentials to become literate in the U.S., which had a direct impact and currently limits their access to positions as poets, authors, teachers, scholars and critics. It is not until recent years that Black women have been granted access to leadership roles in professional settings (i.e. universities, publishing concerns, and other social institutions that validate knowledge) (Hill-Collins, 2000). Exclusion from positions of power in mainstream organizations elevates the interest of the dominant group, which corresponds with the suppression of the interest and ideas of Black women within traditional scholarship (Hill-Collins, 2000). I highlighted this issue earlier in this chapter, as I recognize the scholarship on Black women in engineering and mathematics is minimal. In addition, the research on Black women is traditionally addressed in
ways that suppress the voice of Black women because it is positioned from a majoritarian perspective. Due to this historical exclusion from mainstream organizations (particularly in the fields of engineering and mathematics), stereotypical images of Black women permeate and are further exploitable (Hill-Collins, 2000).

**Definition of Black Feminist Thought**

Social theories that emerge on behalf of and/or from U.S. Black women (and other historically marginalized groups), aim to identify ways to get away from, survive in, and/or oppose widespread economic and social injustice (Hill-Collins, 2000). Patricia Hill-Collins (1989, 1998, 2000, 2002) defines BFT as

>a critical social theory committed to justice for the collective population of Black women and other oppressed groups. The premise of BFT centers on the empowerment of Black women and the assertion of their voices as central to their experiences (Patton, 2009, p. 516).

In this dissertation research I collected data on the lived experiences of Black women that were undergraduate students enrolled in engineering and mathematics disciplines at PWIs. I developed this research agenda as I understood the collective voice of this population is often overlooked, and that similar to the definition I have provided of BFT, the lived experiences of this population are essential to Black women’s empowerment and the assertion of their voice within engineering and mathematics disciplines at PWIs. Therefore, BFT is the necessary framework for this inquiry because it was developed by and for the same population that I explored and sought to expand on current research in the field on this population. In this section I present the tenets of this theory:

1. Self-definition and self-valuation of Black women

2. Interlocking nature of oppression (dialectical relationships)
3. The importance of Afro-American women’s culture (Hill-Collins, 1986).

The first tenet projects the standpoint that the suppression of oppressed groups comes from self-definition standpoints, which can stimulate resistance. On a personal level, the oppressed need to develop their own opinion that is connected to being involved, since often times the oppressed find the oppressor’s point of view inadequate (Hill-Collins, 2000). The oppressed are able to make connections based on their lived experiences with past oppression when they are actively involved, which allows them to develop their own point of view that is representative of those lived experiences (Hill-Collins, 2000). Ultimately, the collective historical experiences of Black women’s oppression have the power to stimulate a self-defined standpoint that can also foster Black women’s activism (Hill-Collins, 2000).

In the second tenet I explore Black women’s “subordination within intersecting oppressions of race, class, gender, sexuality, and nation” (Hill-Collins, 2000, p. 22). As long as this subordination persists, the need for Black feminism as an activist response to oppression will be present. Further, Black feminism responds to the fundamental contradiction in U.S. history, which suggest democracy and promises of individual freedom to all American citizens, as well as, social justice and equality under the law. However, the reality of different group treatment based upon their status for race, class, gender, sexuality and citizenship continues. Institutionalized oppression remains visible and palpable (Hill-Collins, 2000). The alleged lack of political activism among oppressed groups often stems from flawed consciousness as a reflection of our own inferiority (Hill-Collins, 2000).

The third tenet involves endeavors to redefine and justify the importance of Black women’s culture. Through this process, Black feminists have identified previously unexplored domains of the Black woman’s experience (Hill-Collins, 1986). Black feminists have also
identified tangible domains of social relations where “Afro-American women create and pass on self-definitions and self-valuations essential to coping with the simultaneity of oppression they experience” (Hill-Collins, 1986, S21). The approach to culture taken by Black feminists can be typified by the definition presented by Mullings (1986), which states

the symbols and values that create the ideological frame of reference through which people attempt to deal with the circumstances in which they find themselves. Culture…is not composed of static, discrete traits moved from one locale to another. It is constantly changing and transformed, as new forms are created out of old ones. Thus culture…does not arise out of nothing: It is created and modified by material conditions (p. 13).

Black women’s culture helps provide an ideological frame to aid Black women to see the circumstances that shape race, gender and class oppression (Hill-Collins, 1986). Also, Mullings (1986) definition of culture suggests the values that accompany Black women’s self-valuation and self-definition will take on a tangible, material expression: presented in “social institutions like church and family, in creative expression of art, music and dance, and if unsuppressed, in patterns of economic and political activity” (Hill-Collins, 1986, p. S22). Lastly, Black women’s lives will be linked together. However, these themes that characterize their experiences will be experienced differently by Black women of different social groups (i.e. classes, ages, regions, sexual preferences, religions, etc.) and by those in different historical contexts (Hill-Collins, 1986). Black women’s culture is not monolithic; to be precise it is socially constructed.

Black Feminist Thought has helped me understand, provide clarity and continuity to the literature I have read and simultaneously provides a deeper understanding of the experiences of Black women in undergraduate engineering and mathematics fields at PWIs. Additionally, I have
selected BFT as the appropriate framework for my dissertation research because of its potential
to inform the findings for this inquiry, and to help me analyze and frame the experiences of
Black women through a relevant context.

**Definitions**

_African Diaspora:_ “The term _diaspora_ describes the experiences of people who, through slavery, colonialism, imperialism and migration, have been forced to leave their native lands (Funani 1998, 417). For U.S. Black women and other people of African descent, a diasporic framework suggests a dispersal from Africa to societies in the Caribbean, South America, North America, and Europe” (Collins, 2000, p. 29).

_Black:_ Refers to all members of the African Diaspora and is a socially constructed racial identity.

_Black/African American:_ Reflects a “distinctive pattern of dispersal associated with forced immigration [of people of African descent] to the United States and subsequent enslavement” (Collins, 2000, p. 29).

_High achieving engineering or mathematics major:_ is a junior or senior that has a cumulative GPA of 3.0 or higher on a 4.0 scale, completed college calculus, and is enrolled or previously enrolled in at least one upper level engineering or mathematics course (Ellington, 2006).

_Marginalized students:_ Students that hold an “insider within” status, where the dominant group has assembled, and they therefore have no voice and remain invisible when dialogue occurs (Howard-Hamilton, 2003, p. 21). Ultimately, they are made to feel their lived experiences are insignificant in academic spaces.

_Persistence:_ “Students’ decision to continue a particular course of study through college” (Ellington, 2006, p. 16).

_Predominantly white institutions:_ institutions in higher education that primarily serve the majority population, which are White students.

_Self-definition:_ “the power to name one’s own reality” (Hill-Collins, 2000, p. 300).

_STEM education:_ the fields of engineering, natural sciences, mathematics, computer sciences, and physical sciences. Not including social/behavioral sciences.

_Underrepresented students of color:_ African American, Latino/a Americans and Native Americans—groups that’s representation in post-secondary STEM education is lower than their proportion in the general U.S. population (Martin, 2009).

_Voice:_ “the assertion and acknowledgment of the importance of the personal and community experiences of people of colour as sources of knowledge…the term ‘voice’ in the singular does
not imply the belief that there exists a single common voice for all persons of colour...[Instead,] there is a common experience of racism that structures the stories of people of colour and allows for the use of the term voice” (Dixson & Rousseau, 2005, p. 10-11).

**Delimitations**

Since the theoretical framework for this study was rooted in preexisting theories and literature, my purpose was to apply existing theories to practice, to develop a qualitative inquiry in engineering and mathematics education that is unique and fills a gap in existing literature on the experiences and characterizations of Black women as undergraduate students. The purpose of this inquiry was to (1) understand the experiences of Black women as undergraduate students in engineering and mathematics disciplines and (2) explore how these experiences shaped their academic persistence and overall well-being.

Furthermore, since my lived experiences have influenced who I am as a researcher, I wondered the appropriate ways in which this inquiry can be replicated. I attended an HBCU and a PWI; I am also a mathematician and a mathematics educator and researcher. Finally, I have made a personal decision to develop my critical consciousness and explore research relative to social justice, gender, race and class. Earlier in this chapter, I elaborated on my lived experiences in more detail, and these experiences are significant to who I am and what I represent as a Black woman, as well as a researcher. Therefore, a delimitation might be the conditions under which this study can be replicated by other researchers.

**Summary**

In Chapter one I introduced this inquiry that I designed to investigate the experiences of Black women as undergraduate students enrolled in engineering and mathematics programs at a PWI. I presented the underlying purpose and significance of this study, along with the study’s research questions. Finally, I defined the key terms I referenced in this study and I discussed the
delimitations. In the next section, Chapter two, I provide an analysis of the literature relevant to Black women in engineering and mathematics fields and describe the theoretical framework that guided my study.
CHAPTER TWO:

LITERATURE REVIEW

In this chapter I discuss the relevant research and scholarly literature on Black women as undergraduate students in engineering and mathematics disciplines at PWIs. This review of literature has been organized to respond to the research questions:

1. How do Black women in pursuit of engineering and mathematics degrees at PWIs characterize their experiences while enrolled in their respective undergraduate programs?
   a. How have those experiences shaped their academic persistence?
   b. How have those experiences shaped their overall well-being?

As a result, in this literature review I include four major sections. As part of the introduction to this chapter, I describe the process I used to identify relevant literature. Then I describe the historical context of race and gender in the U.S. relative to the discussion of Black women in the U.S. I continue this chapter with a discussion of Black women who are undergraduate students in engineering and mathematics fields. Due to the limited research available on Black women as they persist as undergraduate students enrolled in engineering and mathematics disciplines, in this review I also include literature that focuses on Black women who are graduate students, career professionals and researchers in engineering and mathematics fields, as they persisted in their undergraduate programs. I also include relevant literature on women of color who persist in undergraduate engineering and mathematics disciplines as well as Black women in higher education. In the last section I summarize the literature I reviewed as I identify gaps in the
literature and the need for further research. I conclude this chapter with a synopsis of the theoretical framework that guided this inquiry.

**My Process in Identifying Relevant Literature**

To begin the literature review process, I identified keywords based upon the preliminary readings that informed my research study, as well as, what emerged in the development in this research topic (as recommended by Creswell, 2014). Some of the literature sources I used as preliminary readings for this study have been identified by other researchers in the field who provided me a list of author’s names and dissertations to review, since this work aligns with my research topic. Additionally, I sought out additional literature sources using the citations presented in the preliminary literature sources.

I continued this review of literature through a search on Google scholar, EBSCO and ProQuest (as recommended by Galvan, 2009; Creswell, 2014) for peer reviewed journals and book chapters, and dissertations pertaining to the scope of this dissertation study. The keywords I used in my search embodied 6 major themes, including: (1) Black women, (2) STEM fields, (3) academic persistence, (4) overall well-being, (5) undergraduate experience, and (6) retention.

The resulting search included 85 reports of research in journals and books, 3 conference proceedings, and 29 dissertation studies. To organize and condense the resulting literature, I created 9 major categorical groupings based upon the keywords and title of each study that are Black women: (a) as undergraduate students in STEM disciplines, (b) in STEM fields, (c) as graduate students, career professionals and/or researchers in STEM fields (d) in higher education. As well as, (e) women of color in STEM fields, (f) Black students in STEM fields, (g) Black men in STEM disciplines, (h) underrepresented students in STEM disciplines, and (i) campus climate for Black students. From these 9 categories I was able to eliminate literature that
exceeded the scope of this inquiry. For the purpose of this literature review I used research on Black women in Engineering and Mathematics fields as a primary source of data. I used all other literature to support the findings of the primary literature.

As I reviewed the research on Black women in engineering and mathematics fields, I skimmed each study to identify the purpose of the inquiry, research questions and participant population. This allowed me to differentiate between studies that focused on the experiences and perspectives of high achieving undergraduate students who persist in STEM majors, as opposed to Ph.D. students, career professionals and/or researchers who persisted as undergraduate students in STEM majors. Through this process I was able to determine whether the studies on Black women in STEM fields belonged in category (a), (b) or (c). This literature operated as a primary data source because it directly informed the research questions presented in this review of literature.

Finally, I decided to not use studies that focused on students as an aggregated STEM category in my primary literature sources. Gregory (2015) brings attention to the difference between the STEM categories, stating

> engineering involves the practical application of science and mathematics, as in the design of structures and systems [whereas]...science entails the systematic knowledge of the physical or material world gained through observation and experimentation (Steinmetz & Braham, 1993). The distinctiveness of the disciplines must be examined separately as each may possess idiosyncrasies, which impact the persistence among various student groups in disparate ways (Gregory, 2015, pp. 7-8).
For this reason, studies that focus on Black women in STEM fields as an aggregate, or science and computer science are not within the scope of this inquiry. As a result, I only cited these studies to support the findings of the primary sources identified in this inquiry.

**Historical Context of Race and Gender in America**

The historical context of race and gender of Black women in the United States is essential to this review of literature because it provides a context or lens to interpret the research on the experiences of Black women in undergraduate engineering and mathematics disciplines. Without this historical context this literature review would fail to acknowledge the historical influence that is imbedded in society and the lineage of experiences that add significance to the complexity of being a Black woman. Furthermore, I found in my review of literature that other fields are having conversations about the historical context of Black women in the United States, in order to address the influence of this relevant context on Black women (e.g., Johnson, 2015; Shavers, 2010). Although the historical context of Black women in the United States is important to a critical analysis of their experiences, the literature I reviewed in the field of engineering and mathematics often lacks a discussion of this context. Therefore, I include a discussion of this historical context to make connections with oppressive norms that are used to characterize and interpret the experiences of Black women and provide insights to the systematic issues at hand that dominate undergraduate engineering and mathematics disciplines.

**Origins of Race in America**

Race relations in America are imbedded and deeply rooted in slavery. Jay (1998) explains that racial difference, as we know it today, emerged as a need to differentiate “colonizers and the colonized, or the slave traders and the enslaved” (p. 98). As a result, during the early 1800’s courts assigned humans a race in order to distinguish those individuals with “free maternal
ancestry” from those without (Haney-Lopez, 1994, p. 2). Since the American race was “originated as a white race” represented by individuals that were descendants of Europe, those outside of this majority needed a descriptor as well (Jay, 1998, p. 100). It was at this time Africans and American Indians (now referenced as Native Americans) were labeled as “pagans, heathens, barbarians, or savages…creatures without souls” (Jay, 1998, pp. 98-99), a stereotype that would follow my ancestors for years to come. As an example of the courts assigning humans a race, Haney-Lopez (1994) highlights the case of Hudgins v. Wright in Virginia where women’s fate was dependent upon the “complexion of their face, the texture of their hair, and the width of their nose” (p. 2). The result of this court decision freed three generations of enslaved women because one of the American Indian plaintiffs had, “long, straight, black hair of the native aborigines of this country” (Haney-Lopez, 1994, p. 2). This case emphasizes the power that race has on our society and how ancestry and physical appearance effect it. Therefore, being of African descent has often justified mistreatment and discrimination in this country, which brings me to a discussion of race as a social construct.

Social construction: What is race? Aligned with the decision in the Virginia court case, Haney-Lopez (1994) defines “a ‘race’ as a vast group of people loosely bound together by historically contingent, socially significant elements of their morphology and/or ancestry” (p. 3). Similarly, Omi and Winant (1994) proposed the following definition of race as, “a concept which signifies and symbolizes social conflicts and interests by referring to different types of human bodies” (p. 55). Through these definitions, I am led to the reality that race is not inherent, fixed or objective (Delgado & Stefancic, 2012). Furthermore, race does not have a biological or genetic reality that correlates with any racial category (Closson, 2010; Delgado & Stefancic, 2012; Haney-Lopez, 1994). Instead, races are categories invented by society that are manipulated
and retired when convenient (Delgado & Stefancic, 2012). People with common historical roots share physical attributes, such as skin color, hair texture and physique (Delgado & Stefancic, 2012; Haney-Lopez, 1994). We see evidence of this in Haney-Lopez’s (2005) article entitled *Race on the 2010 census: Hispanics & the shrinking white majority*, where he offers suggestions to progress the census racial data through the implementation of relevant questions. He suggests we not only ask people a question of their ethnicity and race, but also include a follow-up on national origin, ethnic background, ancestry, and/or tribal affiliation. And it should also have a question on color. I do not mean one whose answer would require a literal skin color test, such as a melanin count. Color here means somatic details that translate in racially significant ways—hair color and texture, facial features, skin tone, and so on. Few studies have tracked the influence of color on intragroup differences among minorities, and no study that I know of examines color among whites. Yet existing studies confirm a remarkably consistent and pernicious dynamic: light color correlates to privilege, dark to disadvantage (Haney-Lopez, 2005).

Through this example we see that Haney-Lopez (2005) recognizes that the U.S. census assesses race in a way that represents race as a biological or genetic reality. However, if we transition to a culturally relevant assessment, race must be considered as social construct, which transforms the discussion of race to a relevant discussion focused on privilege, oppression and the operation of power.

Delgado and Stefancic (2012) make connections between the social construction of race and stereotypes as they bring attention to the shift in the popular images of minority groups over time. While
In one era, a group color may be depicted as happy-go-lucky, simpleminded, and content to serve white folks. A little later, when conditions change, that very same group may appear in cartoons, movies, and other cultural scripts as menacing brutish, and out of control, requiring close monitoring and repression (Delgado & Stefancic, 2012, p. 9)

This example is representative of the social construction of race and will potentially expose how it serves as a basis for systemic and social discrimination. Thus, to support this connection, I now transition to a discussion of the social construction of gender.

**Gender as a Social Construct**

Gender is a term used to emphasize and differentiate biological sex from enacted identities of masculinity and femininity that are socially constructed (Cole, Manuh & Miescher, 2007). Cole, Manuh and Miescher (2007) provide a historical context of the social construction of gender where

> in Europe and North America the term ‘gender’ gained popularity in the wake of older monikers such as ‘women’s studies’ and ‘feminism’ and came to the fore for several reasons: gender allowed for the study of men as well as women and it placed greater emphasis on relational analysis between the sexes. (p. 2).

To continue this discussion of gender, I particularly discuss the social construction of African American women, who have not traditionally been viewed as sympathetic or mainstream feminine figures (Beauroeuf-Lafontant, 2007; Hill-Collins, 2000). Instead, they are often normalized and depicted through exoticism, presumed wild, amoral and sexually promiscuous (Hill-Collins, 2000; Stephens & Phillips, 2003). These descriptors are majoritarian perspectives that are broadly socialized, accepted, and used to shape ideologies about this population (Hill-
Collins, 2000; hooks, 1992). As a result, African American women frequently experience being sexually abused, which takes on many forms including emotional sexual abuse, verbal sexual abuse, and physical sexual abuse (Stephens & Phillips, 2003), and are often covertly and overtly performed (Harris-Perry, 2011). Abuse is enacted by Black women’s families, peers and society, and begins as early as childhood and early adolescent years (Harris-Perry, 2011; Souljah, 1994). Furthermore, as Stephens and Phillips (2003) state “The pain of these experiences directly impacts their feelings about themselves as sexual beings as sexual identity lies at the core of any individual’s sense of self” (p. 4).

The dominant stereotypes of Black women originated during slavery and have transitioned over time to characterize Black women in the current time period. Three main stereotypes of Black women are: The Mammy, Jezebel and Sapphire. This discussion connects the social construction of race and gender to the sociohistorical scripts that are assigned to African American women.

**Mammy.** The Mammy is representative of an African American woman that is a domestic servant or slave (Harris-Perry, 2011; Hill-Collins, 2000; Stephens & Phillips, 2003). Her job entails being the nurturer to the White family, ultimately putting the master’s family before the needs of her own family (Harris-Perry, 2011; Stephens & Phillips, 2003). On the physical and emotional level, the image of this woman is of an asexual being (Harris-Perry, 2011; Hill-Collins, 2000; Morton, 1991). The Mammy is portrayed as a dark-skinned, overweight woman with African features (Harris-Perry, 2011; Stephens & Phillips, 2003) and is often remembered through the “Aunt Jemima,” which has been used as an iconic depiction of Black womanhood (Hill-Collins, 2000; Ladson-Billings, 2009). This iconic image displays an African American woman that perpetually smiles (Ladson-Billings, 2009). As I reviewed
literature on Black women in academia, I found the work of Kupenda (2012) who discussed her experiences as a pre-tenure scholar working at a PWI. I use her narrative as an example of the Mammy in current time and in academia. She begins by describing the requirements of tenure, in which

Publications and developing a national reputation were critical if I hoped to be promoted and get tenure. The problem for me was a summer program the school had for beginning students who needed a little extra help. I agreed that the program was necessary, but as a beginning instructor, I knew that teaching in the program during the summer would ultimately mean I would not be promoted because I would not be able to devote the summer to my writing the way my white male colleagues who were assistant professors could…I painstakingly—in email and then later in person—explained to my white academic dean why I would not be able to take overrunning the program in my first year on the faculty…He did not like that. He said that some of our colleagues were not good teachers, although he admitted that they made far more money than I did…[He said ‘] we need and want you…We need you to teach in the summer program because you are black, you are a woman, you are a great teacher, and you nurture, mother, feed, and nurse all the students.’…I was talking to my mother [about the occurrence and]…She said, ‘You are so tired because you feel like a clown. You smile when you do not feel like smiling. You bite your tongue and make no sound when you want to speak. You try to make the casual and watchful observers so comfortable with you, but now you are uncomfortable with this false self. You take care of others’ feelings, instead of your own’ (Kupenda, 2012, pp. 22-23).
Furthermore, Kupenda (2012) adds to “be my Mammy” was close kin to the request to “be my clown.” Through this narrative reflection, Kupenda (2012) articulates her frustration as she constantly negotiates her being in navigating academia, while dealing with microaggressions and the Mammy stereotype. Additionally, Kupenda’s (2012) discussion with her mother begins to connect the emotional tolls that coexist with these negative experiences. She terms the need for the Mammy from her White counterparts as the “I want my Mammy” that essentially highlights the need for Black women to operate as the Mammy did during slavery days.

**Jezebel.** “Jezebel” is a Biblical reference, as Ladson-Billings (2009) defines as the “treacherous queen who turned the heart of her husband, King Ahab away from worship of the one true God and righteous living” (p. 89). The traits of the Jezebel is described as exotic, young, promiscuous, over-sexed woman that uses her sexuality to acquire and receive love, attention and material goods (Harris-Perry, 2011; Hill-Collins, 2000; Morton, 1991). Furthermore, the Jezebel is often portrayed as having long hair, light skin and a curvy body. Similar to the animalistic terms she referenced as a half-breed or mulatto woman. During slavery, an acceptable assumption was that these African American women seduced their masters in order to satisfy personal animalistic desires for sex (Hill-Collins, 2000; Villarosa, 1994). In reality, the Jezebel was an African American woman sexually abused to fulfill the sexual and economical needs of the masters (Harris-Perry, 2011; Stephens & Phillips, 2003). In recent years, Halle Berry won an academy award for her role in ‘Monster’s Ball’ (Ladson-Billings, 2009); however, this award was for a role that required her to perform Jezebel characteristics.

**Sapphire.** The third image of African American women that persists is the “Sapphire” (Harris-Perry, 2011; Hill-Collins, 2000). The Sapphire is the antithesis of the Mammy since she is portrayed as bossy, stubborn, bitchy and hateful (Harris-Perry; 2011; Ladson-Billings, 2009;
West, 1995). Her physical depiction is that of a brown or dark brown complexion with a large, yet not obese body (West, 1995). This historical reference is connected to the 1950’s television series entitled “Amos and Andy”, where the wife named Sapphire is depicted as the hostile, nagging wife of Kingfish, and was portrayed as ‘…iron-willed, effectual, [and] treacherous toward and contemptuous of Black men’ (Bond and Perry, 1970, p. 166) …[The Sapphire’s] primary role was to emasculate Black men with frequent verbal assaults, which she conducted in a loud animated, verbose fashion (West, 1995, p. 461).

Unfortunately, when a Black woman is in an authoritative position, she is often stereotyped as “hostile” and “pushy” (Harris-Perry, 2011; West, 1995). Furthermore, her efforts to be assertive are often regarded as aggressive (Harris-Perry, 2011; West, 1995). Consequently, internalizing this image can potentially engender Black women to “assume responsibility for the discomfort and fear of others (Greene, 1994b) or modify their behavior in an attempt to appear nonthreatening when interacting with other ethnic groups (Lineberger & Calhoun, 1983)” (West, 1995, pp. 461-462).

**The new stereotypes.** The aforementioned foundational images used to characterize African American women’s sexuality are reflective of the social, economic and political conditions that exist in society (Harris-Perry, 2011; Hill-Collins, 2000; Stephens & Phillips, 2003). Therefore, present day sexual scripts remain three-dimensional but shift as the female icons that dominate the culture of African American youth heavily inform them (Love, 2012). In turn African American youth embody and demonstrate these sexual scripts through daily dialogue (Stephens & Phillips, 2003). Stephen and Phillips (2003) present eight images of the present day and connect these scripts to references within Hip Hop. Stephens and Phillips (2003)
have termed these present-day scripts as “the Diva, Gold Digger, Freak, Dyke, Gang-sister Bitch, Sister Savior, Earth Mother, and Baby Mama”, that adolescent African American girls are forced to constantly negotiate (p. 11).

The sexual scripts of African American women today are interrelated, as they are constantly shifting between sexual script behaviors (Harris-Perry, 2011; Hill-Collins, 2000). Often the shift occurs depending on the social context they are in, but in other cases they can enact multiple scripts at one time (Harris-Perry, 2011; Hill-Collins, 2000; Stephens & Phillips, 2003). For example, a woman may differentiate how she portrays herself at a church function, at school, at a music conference, or at a family dinner. As an alternative, the woman may choose to refrain from conforming to these sexual script behaviors, which may be brought upon by feelings of comfort with her context, sexuality and herself (Harris-Perry, 2011; Hill-Collins, 2000; Stephens & Phillips, 2003).

As I conclude this section, I want to acknowledge that some might proclaim truth in these socially constructed depictions of Black women. However, it is important to consider how these socially constructed roles force Black girls and women to assimilate to these mainstream ideologies of Black womanhood in order to be accepted by society and to also consider the words of Paul Lawrence Dunbar (1896) in his famous historical poem entitled We Wear the Mask,

It hides our cheeks and shades our eyes, This debt we pay to human guile; With torn and bleeding hearts we smile, And mouth with myriad subtleties. Why should the world be over-wise, In counting all our tears and sighs? Nay let them only see us, while We wear the mask. We smile, but O great Christ, our cries To thee from tortured souls arise. We sing, but oh the clay is vile Beneath our feet, and long the
mile; But let the world dream otherwise, We wear the mask! And miles to go before I sleep, And miles to go before I sleep.

As Dunbar (1896) refers to “the Mask”, he references the persistent need to assimilate to the dominant culture in order to survive. This directly connects to the experiences of Black women. For that reason, I raise the question, how does a Black girl discover her identity if everyone and everything in her life socially constructs her in such negative ways? I suggest that the individual must disrupt these stereotypes. Those who challenge and resist the status quo, encounter this identity struggle on a daily basis. As a result, the barriers and challenges Black girls and women face to disprove and resist stereotypes, produce social, mental and emotional damage that researchers should investigate to humanize their experiences (Harris-Perry, 2011; Hill-Collins, 2000; McGee & Bentley, 2017; West, 1995). Since this can significantly influence a person to assimilate or resist such dominant norms (Harris-Perry, 2011; Hill-Collins, 2000; McGee & Bentley, 2017), this leads to the question of, how do we strengthen and mitigate the experiences of Black women so that they are likely to resist dominant norms?

Institutional Norms and Values in Education: Predominantly White Institutions

The basis of higher education was built on “white, male, upper-class norms, [and] racism is still part of colleges and universities [today]” (Bergerson, 2003, p. 56). Therefore, the foundation of our educational school system was built on norms and traditions that excluded those individuals that were racial minorities in society (Battey & Leyva, 2016; Haney-Lopez, 1994; Martin, 2009). Despite, the changes that have been made in the field of education, there still exists evidence of our historical past within educational policies today (Battey & Leyva, 2016; Haney-Lopez, 1994; Martin, 2009; Yosso, Smith, Ceja & Solorzano, 2009).
Closson (2010) presents evidence of the operation of power through such dominant norms in her discussion of the work of Rocco and Gallagher (2004) and their take on the “perpetrator perspective” (p. 269) that addresses the normalcy and the extent that racism is maintained. In this article, Rocco and Gallagher (2004) consider how this perspective allows White faculty to escape responsibility and accountability for racism by defining racism as an overt act. Rocco and Gallagher emphasize that because [if] White faculty assume no accountability, they are continuously at risk of unfairly discriminating (Closson, 2010, p. 269).

I found this to be a powerful statement because it is a display of the existence of privilege within the field of education in relation to faculty and student relationships (Battey & Leyva, 2016; Yosso et al., 2009). This reinforces notions of the dominant culture, since faculty members that lack critical consciousness or demonstrate a colorblind mentality are operating against change that is in support of students, especially those who have been historically marginalized (Battey & Leyva, 2016; Beauboeuf-Lafontant, 2002; Hill-Collins, 2000; Ladson-Billings, 1995; Martin, 2009; Yosso et al., 2009).

**Microaggressions.** Educators that only view racism as an overt act have the ability to damage racial minorities’ experience at white institutions because the enactment of this normality can lead to traumatizing and discouraging encounters. Solórzano, Ceja and Yosso (2000) addressed this issue of only viewing racism as an overt act with an in-depth discussion of the experiences of African American college students with racial microaggressions. In addressing this issue Solórzano et al. (2000) notes, “overt racist acts are usually not socially condoned and that examples of overt racism in the public discourse are rare” (p. 61). This is a key understanding to establish because oftentimes White Americans have a difficult time...
grasping racial microaggressions. Bergerson (2003) presents an example of overt racism regarding employment in education and he acknowledges his privilege in being white because “no one will ever question whether I got a job based on my race or my qualifications” (p. 58). Oftentimes microaggressions such as this one is a result of negative stereotypes.

The stereotype threat arises because of negative stereotypes that are popular regarding one’s cultural group. The meaning behind this idea is that “anything one does or any of one’s features that conform to it make the stereotypes more plausible as a self-characterization in the eyes of others, and perhaps even in one’s own eyes” (Solórzano et al., 2000, p. 62). Ultimately, microaggressions negatively impact the racial climate for African American students who are left with “feelings of self-doubt and frustration as well as isolation” (Solórzano et al., 2000, p. 69).

The importance of history and traditions. Historically, PWIs have significantly contributed to the preservation of the status of elite White men in the U.S. society. As a result, I discuss PWIs as sociopolitical structures. I emphasize the presence of a majority and minority population in PWI spaces to highlight how minority populations have been used as negotiation tools. This serves relevance to understand the effects PWIs have had in the preservation of the majority population and the status quo. Policies and practices that pretend race is a self-contained issue, ignores how race and racism have been institutionalized and affects society in immensely public systematic ways (Solórzano & Yosso, 2002). The reality is that people of color have been negotiated according to socioeconomic and political convenience (Martin, 2009; Solórzano & Yosso, 2002). To explore this discussion, I emphasize the historical or traditional (Closson, 2010) institutional status of PWIs, in addition to their predominantly white status. In other words, by addressing the traditional or historical context of White institutions we are
acknowledging the systematic concerns that are embedded in the institution that are just as important as the institutions’ status as a majority serving institution.

Solórzano and Yosso’s (2002) article, *A Critical Race Counterstory of Race, Racism, and Affirmative Action*, and in this dialogic script they discuss the need for a new definition of “prestige”, raising the question

why are Ivy League universities labeled as prestigious institutions if they start with the top students and turn out top students? In reality, the real challenges and rewards are at institutions where ‘average’ students are nurtured and mentored through graduation and on to the service professions such as doctors, lawyers, teachers, politicians, and community leaders (Solórzano, 1996) ….historically black colleges and universities have been doing the ‘hard work’…for generations. They produce the most African American doctorates in the sciences and engineering in comparison to other colleges and universities (Solórzano, 1995). Yet they are not perceived as the most prestigious institutions compared to places such as Harvard or Stanford” (pp. 158-159).

There are a variety of studies that indicate there is much to be learned from minority serving institutions when the discussion of retention of African American students arises (Flowers, Scott, Riley & Palmer, 2015; Palmer, Davis & Maramba, 2011), and particularly when the students are in the STEM fields (Borum & Walker, 2012; Borum, Hilton & Walker, 2016; Jackson, Charleston, Gilbert & Seals, 2013; Perna et al., 2009; Strayhorn, 2013). My personal experience supports this nuance since I entered college at an HBCU and was deemed an “average” student, but I am now pursuing a doctoral degree. Furthermore, because I have attended both types of institutions, I understand the dichotomy described first hand.
**Interest convergence.** In some instances, African American students will leave Traditionally White Institutions (TWIs) and transfer into HBCUs because of the presence of microaggressions (Closson, 2010). HBCUs were developed in response to segregation at the collegiate level (Borum, Hilton & Walker, 2016; Closson, 2010; Perna et al., 2009). These institutions were established as schools for Negros that would allow Black men and women access to job opportunities that were among income levels comparable to their White middle- and upper-class counterparts (Borum, Hilton & Walker, 2016). Nonetheless, HBCUs are different from TWIs for numerous reasons one being that they mentor their students to become successful leaders that are influential within society (Borum, Hilton & Walker, 2016; Flowers et al., 2015; Perna et al., 2009). However, interest convergence has greatly impacted the level of effectiveness HBCUs are able to have and produce, compatible with TWIs educational opportunities for communities of color in the 21st century (Closson, 2010; Taylor, 1999).

Taylor (1999) and Closson (2010) briefly discuss the legal history of public HBCUs and the struggle they have encountered due to interest convergence. An interest convergence lens exposes “(a) a persistent refusal of states to implement court rulings requiring the enhancement of HBCUs via increased fiscal equity and (b) an environment in which directives to dismantle segregated institutions were interpreted as the dismantling of the HBCU” in support of this discussion (Closson, 2010, p. 273). Interest convergence is impactful in reestablishing systems of oppression and privilege in education (Closson, 2010; Taylor, 1999).

**Culture of engineering and mathematics.** Similar to the foundation of higher education, the engineering and mathematics fields were built to preserve the elite status of the White, man middle-class in society (Battey & Leyva, 2016; Borum & Walker, 2012; Castro, 2014; Leyva, 2017; Martin, 2009; NSF, 2011; NSF, 2015). There is evidence of this preservation
decade after decade in the demographic projections presented by NSF. This leads to the question of, how does one operate in multiple contexts that are not developed or intended for them, and essentially marginalize and oppress certain groups of people in order to maintain other persons’ elite status? I continue this discussion with a review of literature on high achieving Black women as undergraduate students enrolled in engineering and mathematics disciplines.

**Black women in Engineering and Mathematics**

In this section I present the common barriers and systems of support that have been identified in qualitative research as an analysis of Black women’s experiences in engineering and mathematics disciplines at PWIs. Through this review of engineering and mathematics literature I identify the characterizations of Black women to provide insights to their experiences. I begin this section with a discussion on stereotype threat.

**Stereotype Threat**

In an attempt to examine the persistence of African American women as undergraduate students persisting in engineering disciplines in stereotype threatening environments, Gregory (2015) conducted a qualitative dissertation study. Gregory (2015) defines stereotype threat as “anxiety caused by the expectation of being judged based on a negative group stereotype” (Beasley & Fischer, 2012, p. 427). The researcher interviewed 10 participants who were either current undergraduate Engineering students or recent Engineering graduates. The methodology selected for this inquiry was counterstorytelling through narratives. The data collection process included two semi-structured interviews and participant reactions to a reading. The author required the participants to read an 8-page article entitled *Snow Brown and the Seven Detergents: A Metanarrative on Science and the Scientific Method* (Subramanin, 2000). This article tells the story of a woman who is forced to assimilate to the dominant culture to become a scientist. The
findings of this study presented three primary contributors to stereotype threat that highlight (1) fellow students and professors’ lack of awareness of the issues encountered by African American women on a day-to-day basis in Engineering, (2) demoralizing and uncaring/disregarding professors, and (3) microaggressions. All of the participants in Gregory (2015) experienced stereotype threat. Furthermore, there was evidence of alienation and isolation in Engineering environments and the desire/need to prove others wrong that made the African American women question their belongingness and experience self-doubt in engineering degree programs. Furthermore, the participants reported struggles with health issues including severe anxiety and depression as a result of having to constantly contend with stereotype threat.

Similarly, Gibson and Espino (2016) examined Black undergraduate women to determine how they make meaning of Black womanhood in an Engineering culture at a PWI, male dominated, southeast region research institution. This qualitative inquiry interviewed eight undergraduate students that classify as upperclassmen. It is important to note that three of the participants were transfer students, and two of these students transferred from HBCUs. The data collected included semi-structured interviews and implemented member checking. The participant in this study reported the evidence of stereotypes through concerns of how others perceive them and evidence of gender disparities. For example, many of the participants explained that women that looked more “manly” experienced more equitable treatment by men. A participant explained,

She noticed that during labs she was treated differently depending on what she wore. If she appeared more feminine (i.e. wearing makeup and form-fitting clothes), the men in the group seemed more concerned with her safety and well-being and were less likely to involve her in experiments. This usually meant that
she was discouraged from using lab equipment even though she was not violating any lab regulations with her attire (Gibson & Espino, 2016, p. 9).

In addition, participants reported the constant need to prove that they belong in this academic space (Gibson & Espino, 2016).

Likewise, Somerville-Midgette (2014) identified participants as leaders and trailblazers in the field of engineering since they represent a unique population, being African American women. For this inquiry, six African American career women currently employed in the field of Engineering for a minimum of 4.5 years (and the years not necessarily consecutive) were interviewed. In this qualitative transcendental phenomenological inquiry participants were charged with the responsibility to dispel myths that were connected to the common sexual scripts of African American women. The women described hard work to demonstrate and establish varying identities to dismantle these stereotypes that can be connected to the need for the participants to prove that they are worthy of being in the field of Engineering (Somerville-Midgette, 2014).

Frillman (2011) examined the experiences of African American women enrolled as undergraduate engineering students to determine the mentoring programs, social support and academic climate that hinder or support the success of the participants in STEM disciplines. Frillman (2011) interviewed African American women enrolled full-time as undergraduate juniors and seniors at two research institutions. Twelve participants attended a southeastern region HBCU and the remaining seven participants attended a mid-western region TWI in the United States. In this qualitative study participants were asked three open-ended probing questions to conduct loosely structured interviews where the participants’ lives became the context of the study, as this study implements a hermeneutical approach. Frillman (2011)
reported sources of negative stress identified by the participants including the need to assert themselves from time to time, to alleviate stressful situations. The participants also struggled with negative input and the need to fend off naysayers that may have had good intentions as well as sexist men, which was often accompanied by moments of self-doubt and the prominence of sexism even more so than racism. Unlike the HBCU participants, the PWI attendees frequently referenced feelings of loneliness and isolation.

**Mathematics.** The qualitative inquiry, Borum and Walker (2012) implemented a grounded theory approach and used semi-structured interviews to explore the undergraduate and graduate experiences of 12 Black women who have obtained doctoral degrees in the field of mathematics. Seven of the twelve participants attended an HBCU for their undergraduate degrees, and five of the twelve participants attended PWIs as undergraduate or graduate students (Borum & Walker, 2012). Two of the five participants that attended PWIs did not indicate racial or gender discrimination, although they were often the only Black student or woman in their mathematics courses (Borum & Walker, 2012). Of these two women, one was part of the honors program and worked independently for the last two years of her coursework and did not have to attend classes. The other student did express rethinking her major due to the demanding workload but applied herself to earn the respect of her professors.

The remaining three women’s experiences at PWIs demonstrate characteristics relative to discrimination and alienation at their undergraduate institution (Borum & Walker, 2012). Furthermore, notions of isolation (just as in Gregory, 2015 and Frillman, 2011) were prevalent in PWIs and the participants expressed feelings of being targeted because of their race or gender during their undergraduate experiences. Similar to Gregory (2015) whose participants experienced stereotype threat during group work, Borum & Walker (2012) highlight the
experience of a participant who felt the need to constantly prove her intelligence to the other members in her study group, which she felt was a reflection of gender or racial discrimination. The participant recounts a statement from a fellow study group member that is a man, who said to her after she scored higher on an exam, “You know I thought I’d done at least as good as you”, the participant added “That’s how bad he did. He did worse than the Black girl” (Borum & Walker, 2012, p. 372). The women that attended a PWI for their undergraduate degree mentioned the support they received, the lack of support or poor advisement, as minorities in their institution (Borum & Walker, 2012). A student recalled her experience in changing her undergraduate major from mathematics to another field. She was advised to do so by a professor, whom other sources revealed later is a professor who is known to be sexist and wanted to maintain the field of mathematics as a field dominated by men (Borum & Walker, 2012).

**Proving them wrong is exhausting!** The findings presented in the literature review on Black women in engineering and mathematics undergraduate programs consistently demonstrates a trend that these women feel motivated by their isolating environment to prove they are worthy of their status as equal contributors and members of the engineering or mathematics community (Borum & Walker, 2012; Gregory, 2015; Gibson & Espino, 2016; McGee & Martin, 2011; Somerville-Midgette, 2014). Furthermore, stereotypes relative to gender and race that are prevalent in this environment influence these women to assert themselves and demonstrate that they can succeed and excel in these spaces. The research consistently demonstrates evidence of the “prove-them-wrong syndrome”, a term that emerged from the research of Moore, Madison-Colmore and Smith (2003), which becomes an exhausting experience for these women (Gibson & Espino, 2016; McGee & Martin, 2011). Although proving oneself in the context of engineering and mathematics environments often requires these
Black women to work hard and demonstrate high academic achievement, the exhausting process of it all can affect how the women view themselves and the field (Gibson & Espino, 2016). I wonder how often the “prove-them-wrong syndrome” gets mistaken for intrinsic motivation when really it is extrinsic. Furthermore, how does the source of this extrinsic motivation, such as a negative stereotype, affect these Black women in their persistence in the engineering and mathematics pipeline? Support for these undergraduate students as young women in transition from adolescence to adulthood is urgent. Spaces are needed to recognize their self-worth and assert that who they are is enough as they transition into “Black womanhood” (Gibson & Espino, 2016, p. 12). As a field we need to provide nurturing environments to foster Black women’s self-esteem, self-efficacy and confidence and simultaneously challenge the common desire these women experience to demonstrate their worth, since they are equal members and contributors of the field of engineering and mathematics. I now transition to a discussion of the support systems and tools for persistence presented in the literature on Black women in engineering and mathematics fields.

**Supports and Tools for Persistence**

Mentorship is commonly cited as a method of support for the success and persistence of Black women enrolled in engineering and mathematics disciplines as undergraduate students (Borum & Walker, 2012; Frillman, 2011; Smith, 2015). Participants in the research of Frillman (2011) frequently mentioned family members, mentoring organizations such as the Society of Women Engineers and the National Society of Black Engineers, strong role models, staff members, and classmates as support systems in their PWIs. The wide majority of participants in this inquiry stated that they would not have persisted without their support systems (Frillman, 2011). Familial capital and the desire to give back to their families are commonly cited as
contributors to persistence (Bush, 2013; Frillman, 2011; Gregory, 2015; Rice & Alfred, 2014; Somerville-Midgette, 2014). Furthermore, Rice and Alfred (2014) also discuss the systems of support during college for Black women Engineers as pre-college programs, university resources, and the minority network.

Bush (2013) conducted a qualitative phenomenology inquiry, where she interviews five Black women currently employed as engineers for a minimum of 5 years, in the northeastern region of the United States. The participants selected for inclusion were all over the age of 30 since this is the age frequently cited that women exit the engineering profession at significantly higher rates. The purpose in this inquiry was to explore and identify the lived experiences of Black women Engineers that are currently employed in the field. Participants in Bush (2013) commonly cited a strong external support system that significantly influenced their persistence in their engineering major and career. There solid foundation of encouragement was supportive as they encountered racism, sexism, isolation in the chilly climate of their engineering programs, both as college students and career professionals (Bush, 2013).

Furthermore, the participants listed their connection to their church communities, Black leaders in the church, their internal faith, and belief in themselves, as primary contributors to their persistence (Bush, 2013). Similarly, the work of Gregory (2015) highlights a common support system for these Black women that has been their strong sense of faith. Somerville-Midgette (2014) stated that all participants referenced their relationship with God. For example, a participant stated that God predetermined her life’s journey and that it was through God’s will she persisted (Somerville-Midgette, 2014). Additionally, just as Gregory (2015) found, the participants in Bush (2013) address their passion for giving back to the next generation of Black
women, which Bush (2013) asserts influenced their persistence in engineering as well as their drive to increase diversity efforts in the field.

**K-12 exposure to STEM.** Somerville-Midgette (2014) reported that students had rigorous mathematics and science courses during their high school experience. Bush (2013) found participants’ exposure to educational support programs for minorities and women, provided tremendous support throughout students’ high school and college experience. Such opportunities granted students exposure to college skills and knowledge, as well as hands-on experiences relative to mathematics and science fields (Bush, 2013).

**Mentorship.** Smith (2015) focused on African American women as undergraduate engineering students and the mentorship they receive from faculty in a qualitative phenomenographic inquiry. Smith (2015) discussed the findings of 16 participants at one institution, of which two participants were transfer students. The findings presented seven categories to describe the types of faculty mentorship that the African American women felt positively influenced their experience as undergraduate engineering majors, they are (a) nurturer, (b) caring, (c) guide, (d) proactive supporter, (e) role model, (f) just in time: render useful advice, and (g) reactive listener (Smith, 2015). These types of faculty mentorship span two major aspects that access professional (e.g., development, opportunity, advice and example) and interpersonal (e.g., listening, investment, and shared experiences) components (Smith, 2015). Furthermore, the findings of this study suggest that diversity in gender and race can all contribute to successful mentorship. However, the most common characteristic of successful faculty mentorship was that the faculty member was a woman, especially within the field of engineering. Access to African Americans in the field was limited, especially African American women. However, the participants commonly referenced guides who were African American professors in their
engineering disciplines, and nurturers as African American women who were program directors but could only offer limited support because they were not Engineers (Smith, 2015).

**Role modeling.** Gibson and Espino (2016) discuss African American women in engineering’s desire to inspire the next generation of young girls through outreach opportunities. Additionally, the participants of this inquiry expressed interest in doctoral level education in hopes of becoming a faculty member that can serve as a role model and mentor to students that might not consider engineering as a profession (Gibson & Espino, 2016). Being a role model and mentor to current and future women engineers was a priority for these Black undergraduate women (Gibson & Espino, 2016).

**Intrinsic support.** Although the research findings I have cited as support systems have been dominated by external systems of support, intrinsic systems of support have been frequently cited as contributing to success and persistence for Black women in engineering and mathematics fields (Borum, 2012; Rice & Alfred, 2014). Furthermore, intrinsic factors of support discussed by Rice and Alfred (2014) include perseverance, determination, perception of self, and Borum (2012) contributes self-perception of mathematics ability and mathematical enjoyment. Similarly, the Black women participants in the study of Gibson & Espino (2016) described their self-characterizations as hard-working, strong, and team players, which positively attributed as mechanisms to navigate the White, man dominating culture of engineering.

**Embracing cultural identity.** In addressing supportive tools for Black women in engineering and mathematics fields, it is important to note that the literature acknowledges that African American women that embrace their identities are more likely to persist (Gregory, 2015). In other words, those women who chose not to acculturate to the dominant culture of Engineering and Mathematics fields at PWIs are more likely to persist. This finding is significant
to the need for Black women to develop their cultural identities and embrace who they are to develop a strong sense-of-self, being self-defined and self-valuing (Hill-Collins, 1986). Hill-Collins (1986) positions Black women who retain a “grip over their definition… as full humans, and rejecting definitions of themselves as the objectified ‘other’… [as they are individuals that] become activists…[since they return] subjectivity to Black women” (p. S24).

Summary

This review of literature demonstrates that although the context of the experiences in engineering and mathematics may differ, the experiences of Black women in both disciplines overall, are similar. Black women in engineering and mathematics disciplines experience barriers, challenges, opportunities, and support as undergraduate students at PWIs. Themes that stood out are stereotype-threatening environments that are most noticeable relative to gender and race, as well as the need for the participants to prove their worth to their peers.

Gaps in the Literature

The discussion of Black women’s overall well-being is not frequently discussed in Engineering and Mathematics education research. Therefore, there is a need to investigate how the climate in engineering and mathematics disciplines at PWIs influence Black women’s success and persistence. Furthermore, we need to consider the ways in which negative outcomes that lead to academic success simultaneously negatively influence student’s overall well-being and academic persistence. Additionally, research is needed on culturally relevant and gender specific methodologies when researching the experiences of Black women as undergraduate engineering and mathematics majors at PWIs. Furthermore, there is a need for exploring initiatives that assist Black women to navigate ego-threatening experiences so that they learn how to not negotiate the self-perception at the command of other people.
Furthermore, “Given the fear of stereotype confirmation is, by definition, an ego-threatening experience that can increase doubt” (Johns, Inzlicht & Schmader, 2008). Additionally, “stereotype threat produces ego depletion and increases reliance on the intuitive system, stereotype threat may also affect decision making, and increase loss aversion and risk aversion” (Carr & Steele, 2010). Therefore, when the ego feels threatened due to stereotype threat a common response among Black women is to try to prove themselves to others. This response is a reflection of the Black women’s self-doubt increasing. What are the effects of self-doubt? How can we support these women in recognizing stereotype threat when it occurs and realize that although their ego is threatened that they are enough just the way they are. Their self-worth does not depreciate because of others’ biased uninformed presumptions. In this case stereotype threat operates as an extrinsic motivator that often influences high achievement and performance. However, stereotype threat operates as a barrier for Black women in negotiating their persistence in engineering and mathematics disciplines. In consideration of this finding the fields of engineering and mathematics must develop systems of support for Black women that consider the experience of stereotype threat as a threat to the ego and develop support to reject these negative assumptions that are constantly projected on them by other people. For example, Carr and Steele (2010) state “gender differences in decision making are not necessarily innate and would highlight the need for creating environments that do not interfere with the decision-making process: environments that are nonthreatening and identify [as] safe (i.e., that do not trigger stereotype threat or highlight negative stereotypes)” (Carr & Steele, 2010, p. 1412). As a result, culturally relevant, gender specific spaces are necessary to properly support Black women as undergraduate students in engineering and mathematics disciplines at PWIs.

**The Need for Future Research**
A significant number of studies on Black women relevant to my research topic are concentrated in dissertation work and were published within the last six years. I conducted an additional search to identify literature on Black women in STEM programs in peer reviewed journals or books, published by these same authors. What I discovered was that most of the authors have not published on this topic in peer reviewed journals or books yet (although a few have e.g., Borum, 2012; Rice, 2016). Future research is needed about the influence of post-PhD publication support, the researchers serving as peer reviewers and decision makers that determine what is published in the field, the time allotted for these authors to work on publications while in post-Ph.D. positions, etc. I am interested to see how trends in the field shift over the next five years as it relates to gender and ethnic specific published literature on women in STEM fields.

Additionally, I was able to find minimal peer reviewed journals on Latinas in undergraduate STEM programs and I could not find anything that focused on Native American women or men in undergraduate STEM programs. However, I was able to find information on Latino and Black men and Latino(a), Black and Native American students in general (without specifications to gender). Further research is needed to inform the field on the experiences of these ethnic and gender specific population groups in the STEM fields. In the next chapter I describe the methodology for this inquiry.
CHAPTER THREE: METHODOLOGY

In this chapter, I describe the methodological approach I used to understand the experiences of Black women as undergraduate engineering and mathematics majors at a predominantly white institution (PWI). Through this research I sought to understand the undergraduate experiences of high achieving Black women, in order to identify factors that contributed to their academic persistence and overall well-being. In this research I sought to reclaim the voice of Black women as undergraduate engineering and mathematics majors as they shared their individual experiences in a *sista circle*.

In this chapter I outline the research design, data sources and data analysis for this research. Furthermore, in the research design for this study I implemented a *sista circle* methodology (Johnson, 2015, 2016b), an ethnographic method that embodies a culturally relevant, gender specific research methodology (Neal-Barnett et al., 2011a, 2011b). I selected this methodology because of my experience as a program administrator in the Future Engineers Program (FEP) (See Chapter one). Finally, the instruments I used in this study are pre- and post-interview protocols, *sista circle* protocols, electronic reflections, and archival data that included an artifact (vision board collage) and a participant correspondence interaction log.

**Research Design**

My goal in this study was to capture the individual and shared experiences of Black women undergraduate students enrolled in engineering and mathematics disciplines at a predominantly white institution (PWI). In addition, since I explored *sista circle* methodology,
my goal was to provide the field of STEM education an example of a culturally relevant methodology that can and has been implemented by a STEM researcher. As a result, the research design operates as an ethnographic method. I briefly discussed the use of Black Feminist Thought (BFT) because it largely informs the interpretive lens for this study. Next, I provided a brief overview of the research design and proceeded with the data sources and analysis for this inquiry.

**Qualitative Research**

In mathematics and engineering education research, intentionality in our methodological decisions must conjecture a clear methodological approach that expands the current methodological repertoire to embrace new alternatives, if as a field our intent is to broaden the methodological landscape and develop diverse ways to address concerns relative to equity in the field (Bullock, 2012). *Generic qualitative research* is defined as “that which is not guided by an explicit or established set of philosophic assumptions in the form of one of the known qualitative methodologies” (Caelli, Ray & Mill, 2003, p. 2). Therefore, when methodological clarity is a deficiency, researchers are left to demonstrate precision in their description of what they do (method), but demonstrate deficiencies in their explanation of why they do it (methodology) (Bullock, 2012; Carter & Little, 2007). As a result, in the development of the methodological stance for this inquiry, I always asked myself why questions in order to speak to my core beliefs about the participants of this inquiry (Carter & Little, 2007). For example: Why use *sista circles*? Why use semi-structured interview questions? Why use a particular number of participants? Why use member checking? I believe that as researchers we need to consider how we can make life better for people. We need to think beyond our take-for-granted ideas of well-being and what is good and make those ideas the objects of
serious, communal inquiry. Serving people’s well-being is a great challenge, but it is also our greatest calling (Hostetler, 2005, p. 21).

Through explanations in this section, the methodological choices I presented in this inquiry reflect my value for the participants of this inquiry who are Black women undergraduate students enrolled in Engineering and Mathematics disciplines.

**Sista Circle Methodology**

*Sista circle* methodology is a “culturally relevant, gender specific” (Neal-Barnett et al., 2011a, 2011b) research methodology that is suitable for the analysis of Black women and their lived experiences, as it functions as a support group and qualitative research methodology. The *sista circle* methodology expands beyond traditional methodology because it includes practices that draw on social relations and the wisdom of Black women that extends beyond national boundaries.

**History of sista circles.** For over 150 years Black women’s lives have been significantly impacted from the role of *sista circles*. Traditionally, *sista circles* serve as support groups of Black women from the same profession, community or organization, and *sista circles* were established on existing networks and friendships among Black women (Neal-Barnett et al., 2011a). Early educators, community leaders and activist such as Mary Church Terrell, Ida B. Wells-Barnett, Harriet Tubman, Frances E.W. Harper, Josephine St. Pierre Ruffin, and Margaret Murray Washington in the late 1800s used *sista circles* as a space to found the first Black women’s club. Throughout the late 1800s Black women were neglected in feminist conversations, as these discussions focused on the needs of White women. Similarly, conversations on the inclusion of Black persons often neglected the experiences of being a woman since they were dominated by the discussion of Black men (Springer, 2005). As a result,
*sista circles* became formalized to establish Black women’s clubs (Johnson, 2016b), and the first organization was named the Afro-American Federation of Colored Women and was renamed the National Association of Colored Women (NACW). In the early, 1900s, Black women at HBCUs (which some were also founders of NACW) began to transform their informal *sista circles* into sororities (Johnson, 2016b). Similarly, in 1996 Black women at Tennessee State University (an HBCU and my alma mater) transformed their informal *sista circles* to develop the first collegiate chapter of what is now called the National Association of Colored Women’s Clubs incorporated (NACWC) Women of Empowerment Frankie J. Pierce Federated Chapter. During my time as an undergraduate student I became a member of this organization, and as a graduate student I was the first student to become a campus advisor for the organization. This experience has significantly informed my understanding of *sista circles*, and our motto of *Lifting as We Climb* has significantly shaped how I support and encourage all people, especially Black women.

Although *sista circles* are unfamiliar to social scientists and qualitative research, *sista circles* have been cited in research in psychology on Black women (Neal-Barnett et al., 2011a, 2011b; Thomas, Gatson, Porter & Anderson, 2016). Also, *sista circles* have recently been used in educational research as a data collection method and methodology (Green, 2017; Haddix, 2012; Johnson, 2015).

**Distinguishing features of *sista circles***. *Sista Circle* methodology implements three distinguishing features that are: (1) communication dynamics, (2) centrality of empowerment, and (3) researcher as participant (Johnson, 2015, 2016b). *Sista circles* are unique and differ from focus groups and group interviews in many ways. In the sections that follow I unveiled the ways in which *sista circles* are different. It serves relevance to note that *sista circles* do share some qualities as other research methods.
Communication dynamics. Sista circles are informal, unlike most group interviews and focus groups, they encourage organic social interactions between participants (Johnson, 2016b). Verbal expressions allow participants to use Black English Vernacular and casual phrases relevant to the culture of Black women. Johnson (2016b) also makes reference to the dynamics that are uncommon in mentor settings and formal research such as “participants finishing one another’s thoughts, being outspoken, or standing to give high fives as a sign of agreement is also common” (p. 4). In a relaxed environment, participants are more secure with existing as their “true” selves (Dorsey, 2001). Sista circles must occur outside of the school similar setting because “You want to take the oppressed away from the environment that may be oppressing them” (Johnson, 2016b, p. 4). Thus, the organization of discussions around the kitchen table was a relevant space, especially since the kitchen table has served as a social location for conversations of Black women throughout history (Anzaldua & Keating, 2002).

Centrality of empowerment. Sista circles foster collective empowerment of Black women. Johnson (2016b) motivated participants to strengthen one another through their collective and personal power, since sista circle methodology values Black women’s wealth of knowledge as well as their experiences as sources of power. Through conversations about shared experiences and provided insights, advice and wisdom among participants, sista circles encompass support for Black women that is irreplaceable (Johnson, 2016b).

Researcher as participant. In sista circles, the researcher’s role is not to simply facilitate the group discussion, as it is in a focus group (Hennik, 2014). Sista circles differ from traditional mentorship strategies because it does not implement a “top-down” method where there is a novice and an expert (Johnson, 2016b). Instead there is a shift in the structure of power, since the sista circle values every sista as an expert because they each have valuable knowledge and
wisdom to contribute to the circle (Johnson, 2016b). The researcher is a participant in the *sista circle*, contributes to group dialogue and offers her personal experiences as a reference to empower the sista’s (Hill-Collins, 2009). Now I transition to a discussion of the epistemological perspective that aligns with this inquiry.

**Black Feminist Epistemology**

Hill-Collins (2000) discussed an epistemology that centers African American women as agents of knowledge. Epistemologies of traditional scholarship pervade the interest of elite White men because they have controlled Western structures of validated knowledge. As a result, the experiences of U.S. Black women and women of African descent have transnationally been consistently distorted within or isolated from what is regarded as knowledge. Alternatively, U.S. Black women’s collective experiences and supplemental worldviews, which have been rooted in our distinct intersectional history, undergirds a Black feminist epistemology (Hill-Collins, 2000). When these experiences are shared and passed on they represent the collective wisdom of a Black woman’s standpoint (Hill-Collins, 2000). Hill-Collins (2000) provides a set of principles that pass into a more general Black women’s wisdom including (a) lived experiences as a criterion of meaning, (b) the use of dialogue in assessing knowledge claims, (c) ethics of caring, and (d) the ethics of personal accountability. Now I will provide a brief synopsis of the four tenets.

**Lived experiences as a criterion of meaning.** Hill-Collins (2000) discussed the Black perspective, which states the limitations of written documents is that they are restricted on what they can provide about life and survival in the world. Specifically, one can display knowledge by being educated and book smart, but could simultaneously lack wisdom (Hill-Collins, 2000). Hill-Collins (2000) states “Knowledge without wisdom is adequate for the powerful but wisdom
is essential to the survival of the subordinate” (p. 257). What has been key to Black women’s survival is the distinction between knowledge and wisdom, from which experience is often used as the invigorating quality dividing them. As an example of experience as criterion of meaning, I present the quote of Sojourner Truth who proclaimed, “Look at my arm! I have ploughed, and planted, and gathered into barns, and no man could head me! And ain’t I a woman?” (Hill-Collins, 2000, p. 258). In this quote, Sojourner Truth deconstructed prevalent understandings of womanhood by making reference to examples in her own life and used these examples as symbolism to provide context to new meanings of Black womanhood.

**The use of dialogue in assessing knowledge claims.** Dialogue is a humanizing speech that requires discourse between two subjects (Hill-Collins, 2000). The underlying assumption in this principle of Black feminist epistemeology is that connectedness, as opposed to separation, is a key component of the process of knowledge validation (Hill-Collins, 2000). Therefore, this humanizing speech is a form of resistance since it challenges dominate understanding of methodological adequacy. Further, “People become more human and empowered primarily in the context of a community, and only when they ‘become seekers of the type of connections, interactions, and meetings that lead to harmony’” (Hill-Collins, 2000, p. 261).

**The ethics of caring.** Ethics of caring centers personal expressiveness, emotions and empathy in the process of knowledge validation (Hill-Collins, 2000). Further, Hill-Collins (2000) list these ideas as three interrelated components in the ethic of caring: (a) emphasis on individual uniqueness, (b) the appropriateness of emotions in dialogue, and (c) developing the capacity for empathy. Two contrasting positions typify knowing, which includes a separatist perspective founded in impersonal methods to construct truth and connection that enables truth to transpire
through care. Hill-Collins (2000) explicitly describes the difference between these types of knowers to emphasize the concepts of ethics of care:

Separate knowers try to subtract the personality of an individual from his or her ideas because they see personality as biasing those ideas. In contrast, connected knowers see personality as adding to an individual’s ideas and feel that the personality of each group member enriches a group’s understanding (p. 264).

**The ethic of personal accountability.** Individuals are assumed to be accountable for their knowledge claims. To define this principle of Black feminist epistemology I will use the example discussed by Hill-Collins (2000) who recalled an undergraduate class of Black women. In this class the students were asked to identify a prominent Black man scholar’s interpretation of Black feminism (Hill-Collins, 2000). However, before the students were willing to move forward with this task, they insisted that they have an opportunity to review the dimensions of his personal life first (e.g. his relationships with Black women, his marital status, his social class background) (Hill-Collins, 2000). The process of understanding the facets of one’s personal life is a practice commonly absent from positivist approaches to validate knowledge (Hill-Collins, 2000). However, the students in this class “refused to evaluate the rationality of his written ideas without some indication of his personal credibility as an ethical human being” (Hill-Collins, 2000). Personal accountability is an ethical consideration often employed by Black women.

**Theoretical perspective.** The theoretical perspective that I use as a lens to conceptualize the experiences of Black women in engineering and mathematics undergraduate programs at a PWI is Black feminist thought (BFT). As discussed in detail in Chapter two, the historical context of Black women had to be considered to conduct a rich relevant analysis of their experiences. As a result, race and gender cannot be separated from their experience as
undergraduate engineering and mathematics majors at a PWI because racism and sexism follow them wherever they go. Since racism and sexism is inseparable from their experiences, Black feminist thought provides a lens to understand, analyse and interpret the findings of this study. Reference Figure 3-1 for a graphical representation of this concept. For details on how and why I intend to use this theory please refer to Chapter one.

![Figure 3-1](image)

Figure 3-1. Black Feminist Thought Supports the Analysis of the Participants Experiences

**Role of the Researcher**

As I stated in my experience as a program administrator in the Future Engineers Program (see Chapter one), in the mentor interviews I found the interview setting limited and the women’s struggles seemed isolating as a result. This research study differs from my experience doing program assessment in the Future Engineers Program because it provided an outlet for these women to engage with each other and I was able to be an active participant. After I completed the program assessment for the Future Engineers Program, I knew the selected
methodology for my dissertation research needed to implement a culturally relevant and gender specific setting to provide an opportunity for Black women to engage as a collective.

All participants in my dissertation research benefited from engaging with each other and me, since I was also an active member in the study. Sista circles required me to negotiate my power as the researcher, with the participants of this study, unlike traditional focus group settings that maintain hierarchal power structures with the researcher as the head. During the sista circles I decided to print out the sista circle protocol questions (Appendix J-K) and cut them into individual slips of paper, so that each piece of paper listed one single question. I folded each slip of paper into small squares and with a marker I numbered each question in its original order. This allowed me to maintain a structure for the sista circles so that the questions would be presented in a logical order that is represented in the sista circle protocols (Appendix J-K). I then placed each folded piece of paper into a large bowl so that each participant could blindly draw a question. Since there were 7-8 questions for each sista circle, and four active participants (including me, the researcher) in the sista circle, I requested that each participant draw two questions from the bowl before we began the conversation. I then revealed to each participant that there was a number on each of their questions that would let them know the order in which they would present their question to the group. Collectively the participants decided that when it is your turn to read a question, you will allow the other participants to answer the question first and then you will answer last. As a result, I asked no more than two questions to the participants during the sista circle discussion, which also meant I responded last for two of the questions. This provided balance to the conversation and supported me in negotiating my power during the sista circles.
I also entered this study with an understanding that mentorship empowers Black women and is essential to *sista circles* (Allan, 2013; Johnson 2015). Allan (2013) asserts that mentorship “empowers black women ‘by passing on the everyday knowledge essential to survival as African-American women’” (Allan, 2013, p. 5). During the *sista circle* discussion I provided a personal response to every question and shared details of my undergraduate and graduate level experiences. My transparency and honesty were essential to the discussion. In the member checking the participants highlighted that an essential component to the success of the *sista circles* was the opportunity they had to hear parts of my personal journal as an undergraduate and graduate student in mathematics in both an historically black college/university and a PWI. As well as being able to engage with me and ask questions about the logistics of those experiences. During the member checking the participants revealed my transparency supported them in understanding their own day-to-day experiences in their programs, validated them and also helped them navigate the discussion of their own survival as persistent members in the engineering and mathematics fields. Passing along my everyday knowledge allowed me to access mentorship in order to empower the participants and my vulnerability during the *sista circle* discussion allowed me to negotiate my power with the participants.

Since in this section I introduced a variety of ethical, strategic, and personal issues into the inquiry (Lock, Spirduso & Silverman, 2013), as the researcher of this inquiry it was important that I identified in detail reflexively my biases as a researcher (which can be found at the end of this chapter) and my personal background (Creswell, 2014). Furthermore, Creswell (2014) suggested that I identify the history, culture, gender, and socioeconomic status that shaped the interpretations that I formed in this research. Therefore, my personal background is important to this study (See Chapter one).
Context of the Inquiry

In this inquiry I sought to understand the undergraduate experiences of Black women enrolled in Engineering and Mathematics programs at a PWI. The participants of this study were all enrolled as undergraduate students at the same university in the southeastern region of the United States. The university was classified as a public, research one, and predominantly white institution and was the setting for this inquiry. The data collection process for this study occurred in the Fall of 2016.

Purpose of the Inquiry

My primary purpose in this study was to (1) understand the experiences of Black women as undergraduate students in engineering and mathematics disciplines and (2) explore how these experiences shaped their academic persistence and overall well-being. Additionally, in this study I implemented sista circle methodology, which is an example of mentorship as a research methodology that will potentially support the participants as engineering and mathematics majors beyond the parameters of this research study.

I drew upon the work of Johnson (2015) who suggested that mentorship as a research methodology requires the researcher to reject

the detached position of the traditional researcher and engaging in the community in which we work both during and after the study...[and] challenges us to seek a ‘higher moral responsibility’ that transcends our pursuit of career advancement (p. 43).

Ultimately, I viewed the sista circle as a counterspace for Black women that provided them a supportive space away from the daily torrent of microaggressions and stereotype threat (Howard-Hamilton, 2003). This dissertation research has the potential to inform the Engineering and
Mathematics fields as I identified factors that contributed to the academic persistence of Black women as undergraduate students at a PWI, as well as, identified the benefits of providing *sista circles* for these Black women. In this study I seek to gained insights into the experiences of Black undergraduate women and the ways they persist, despite the challenges/barriers in existence at PWIs. This inquiry also provided insight into the strategies these students developed in order to overcome barriers and navigate their institutions and disciplines.

**Research questions.** Through the research questions for this inquiry I intend to understand their undergraduate experiences and identify factors that contribute to the academic persistence and overall well-being of Black women as undergraduate Engineering and Mathematics majors and examine their response to *sista circles* developed to attend to their psychosocial and cultural needs.

1. How do Black women in pursuit of engineering and mathematics degrees at PWIs characterize their experiences while enrolled in their respective undergraduate programs?
   a. How have those experiences shaped their academic persistence?
   b. How have those experiences shaped their overall well-being?

In the next section I provide a detailed description of the sample that will be analyzed in this inquiry.

**Participant selection**

Black women undergraduate engineering and mathematics majors at a southeastern university are the group I targeted for this study. My experience in the Future Engineers Program (discussed in Chapter one) assisted me in narrowing the focus of my research interest for this proposed study. Since in this study I sought to explore high achieving and high performing Black women, the factors for inclusion were students with a 3.0 GPA or higher and classified as juniors.
or seniors in engineering and mathematics disciplines. Juniors and seniors were selected for this study because they have demonstrated success in persisting in their programs as high achieving students since they currently have a 3.0 GPA. The factors for exclusion were women that do not identify as a Black woman, African American woman, or a member of the African diaspora. If a student’s GPA fell below a 3.0, they were not classified as high achieving and were therefore excluded from this study. Also, if the student was not currently enrolled in an undergraduate engineering or mathematics program that was housed in the college of engineering or the college of arts and sciences at the selected university, then they were not eligible to participate in this study. I identified participants through the GroupMe phone application for the Future Engineers Program mentor group since the program hires underrepresented undergraduate students enrolled in STEM programs. Additionally, I used the university listserv to recruit members of the university chapters of the American Association of University Women (AAUW), National Society of Black Engineers (NSBE), Society of Women Engineers (SWE), Omega Chi Epsilon, Mathematical Association of America (MAA), American Statistical Association, Actuarial Society, Statistics Club, Pi Mu Epsilon Florida Epsilon Chapter, Women in Computer Science and Engineering, Black Student Union (BSU), Black Female Development Circle, Inc., National Council of Negro Women, Inc., Delta Sigma Theta Sorority, Inc., Alpha Kappa Alpha Sorority, Inc., African Students Association, diversity and inclusion director, and engineering and mathematics faculty. I sent emails out to all potential participants to request that they complete the participant inclusion survey in order to determine if they qualify for the study. Additionally, snowball sampling was used, although it did not yield any additional participants. Finally, I recruited five participants for this study and each participant identified a pseudonym.
Eight students completed the Participant screening survey, and two students were identified as ineligible for the study. One student did not meet the high achieving criteria and the other student had completed her undergraduate program in December 2016, before the data collection for this study began. Six students proceeded by providing consent to participate in the study and completed the Demographic Survey. One of the six students would have been unable to participate in the *Sista Circle* Unity Getaway and declined moving forward with the pre-interview as an alternative participant to this study. Two of the remaining five participants informed me that they would also be unable to attend the *Sista Circle* Unity Getaway but agreed to remain members of the study as alternative participants (which I discuss in more detail in the data sources section). Three of the five participants in this study participated in the *Sista Circle* Unity Getaway. Five participants completed the entire study. Now I will discuss the components of the screening survey that I administered to the participants.

**Participant screening survey.** The participant screening survey allowed me to identify potential participants for this research inquiry. I used *Google forms* as the platform to develop and disseminate this survey. Please see Appendix E for a copy of the survey. I listed this survey as a link in the participant recruitment email that was administered to potential participants. It was mandatory that all students be available to attend the *sista circle* unity getaway (those who meet the requirements but are unable to attend the *sista circle* will be asked to schedule an alternative interview that will not be included in this dissertation study).

**Data Sources**

The data I collected as part of this study were a pre- and post- *sista circle* unity getaway interview, *sista circles*, a vision board collage and an electronic post-*sista circle* reflection (see Figure 3-2). I used these data sources to inform this research since qualitative research ordinarily
entails multiple methods of data collection, rather than implementing one data source (Creswell, 2009; Creswell, 2014; Glesne, 2006).

**Figure 3-2.** Data Collection Process

The resulting data I collected created a convergence of methods that represented triangulation of the data sources (Creswell, 2014; Shenton, 2004) with respect to the experiences of Black women as undergraduate students in Engineering and Mathematics disciplines at a PWI. Further, the pre- interview protocol, and *sista circle* protocols that I used in this inquiry, were guided by Black Feminist Thought and I used them to inform this study (see Appendix I-K).

To sustain ethical considerations in this study, I obtained consultation and approval from the Institutional Review Board (IRB) to conduct this study, prior to beginning the data collection process (Appendix A). I then disseminated the request for participants in the Recruitment email (Appendix B). Once potential participants expressed interest, I sent an email with the Screening: Informed Consent form (Appendix C), in which they authorized their participation in the screening process and were provided a link to proceed with the Participant Screening Survey (Appendix E). The eligible participants then received an Informed Consent to Participate in
Research form (Appendix D), and I asked them to review the document and sign the form prior to completing the demographic survey (Appendix F). The demographic survey was completed before the pre-interview. Prior to each pre-interview I verbally reviewed the Informed Consent to Participate in Research form with the participant and obtained verbal informed consent from each participant and allowed each participant to ask questions or terminate their participation in the study. Additionally, I requested the participants to give me verbal consent to audio-record the interviews and *sista circles*, and video-record during each *sista circle*. I then collected to signed Informed Consent to Participate in Research form from the participant, and I signed and dated the form as well. I logged this information on a participant sheet (Appendix G) that included the participant names and their corresponding codes and pseudonyms. Next, I explain how each research method will be implemented in this study.

**Pre-Sista Circle Unity Getaway Interview**

I conducted a pre-interview with each participant in January 2017. This allowed me the opportunity to gather background information on each participant (including educational background, and undergraduate experiences) and to understand the unique experiences of individual Engineering and Mathematics participants. Face-to-face interviews took place in my home, a confidential preventive space so that I could ensure the participants safety and comfort (Johnson, 2015). I conducted a semi-structured interview comprised of open-ended questions. The interview questions I designed to help participants to recount their experiences in response to open-ended questions encouraging them to share their demographical information and perspective on their academic persistence as Engineering and Mathematics majors at a PWI. I use the interview protocol used by (Shavers, 2010) who in her dissertation did a similar study, except the context of her interview focused on Black women as doctoral students. Thus, I
changed the context of the interview protocol to align with the focus of this study. For example, Shavers (2010) presented the interview questions: “How do you think others describe you, in general at your undergraduate institution? At your master’s institution? What about individuals in your doctoral program? Advisor? Doctoral peers? Other faculty?” For this study I altered the question to read: How do you think others describe you in general at the University? Advisor? Undergraduate peers? Engineering/Mathematics peers? Other faculty? Similar to Shavers (2010), the interview protocol allowed me to do a demographical overview with each participant and assess their perception of their experiences. Please see the extended list of questions in Appendix I.

I completed all pre-interviews in person and they lasted 30-60 minutes. With participant consent, I audio recorded each pre-interview. During each pre-interview I made notes to record major points, note relevant body language, and highlight ideas that stood out to me, that I needed to understand after the pre-interview. I reviewed each pre-interview prior to the sista circle unity getaway.

**Demographic survey.** The demographic survey was completed prior to the pre-interview (see Table 3-1). This survey helped me to identify appropriate questions for the pre-interview. *Google forms* is the resource I selected to develop and disseminate this survey (see Appendix F). I listed this survey as a link in the email I sent to officially schedule the pre-interview with participants.
Table 3-1. Participant Profile Chart, Spring 2017. *

<table>
<thead>
<tr>
<th>Participant Pseudonym</th>
<th>Age</th>
<th>SES</th>
<th>Student Status/ Classification</th>
<th>Department</th>
<th>Undergrad GPA</th>
<th>H.S. GPA</th>
<th>Self-Identified Ethnicity</th>
<th>Race</th>
<th>First Generation College</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aprille J. Ericsson-Jackson, Ph.D.</td>
<td>22</td>
<td>Working-class</td>
<td>4th year, Junior</td>
<td>Chemical Engineering</td>
<td>3.58</td>
<td>3.99</td>
<td>Jamaican</td>
<td>African American</td>
<td>No</td>
</tr>
<tr>
<td>Mae C. Jemison, M.D.</td>
<td>20</td>
<td>Middle-class</td>
<td>3rd year, Junior</td>
<td>Chemical Engineering</td>
<td>3.2</td>
<td>4.2</td>
<td>African American</td>
<td>African American</td>
<td>Yes</td>
</tr>
<tr>
<td>Aletha Maybank, M.D.</td>
<td>22</td>
<td>Working-class</td>
<td>4th year, Junior</td>
<td>Chemical Engineering</td>
<td>3.61</td>
<td>3.93</td>
<td>Haitian</td>
<td>African American</td>
<td>Yes</td>
</tr>
<tr>
<td>Erica Walker, Ed.D.</td>
<td>20</td>
<td>Middle-class</td>
<td>3rd year, Senior</td>
<td>General Mathematics</td>
<td>3.33</td>
<td>5.49</td>
<td>African American</td>
<td>African American</td>
<td>No</td>
</tr>
<tr>
<td>Katherine Johnson</td>
<td>21</td>
<td>Lower-middle class</td>
<td>3rd year, Senior</td>
<td>Applied/Computational Mathematics</td>
<td>3.28</td>
<td>4.3</td>
<td>Haitian</td>
<td>African American</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*The participants provided these data during the demographic survey, for the purposes of this study.*
Sista Circle Unity Getaway

Sista circles were the second data collection method. I adapted the sista circle methodology informed by Johnson (2015; 2016b) who in her research investigated Black women schoolteachers. When I developed the setting for the sista circles, I chose to implement a sista circle unity getaway, in which I decided to use the term “unity” because in English it stands for the Swahilian term Umoja. Umoja (Unity) is significant because it is a tenet of Africentricity theory; a theory developed to center particularly African American students, inside their cultural, historical, and scientific roots (Harris, 1999), in opposition to the interpretation of the human experience as marginal to Europe.

Furthermore, I expanded on Johnson’s (2015) sista circle setting through the implementation of a sista circle unity getaway because I wanted to develop a safe space (Allan, 2013; Hill-Collins, 2000), to exceed the allotted time for the sista circles. The sista circle unity getaway was a safe space that fostered relationships among the participants as their collective stories produced sense of shared identity among them (Allan, 2013). This safe space provided opportunities for the women to self-define (Hill-Collins, 2000). Figure 3-3 is a graphical representation of this safe space.
The Sista Circle Unity Getaway was an opportunity for participants to engage in emotional bonding. This additional time promoted strong emotional and social bonding that heightened the participants’ desire to remain in contact with other participants and provided space for them to identify commonalities with other participants to develop a variety of reasons to maintain contact after the sista circle unity getaway concluded.

For the sista circle unity getaway I rented a two-bedroom Villa at a local resort that had a kitchen and dining room table. I invited each participant to attend the two-day getaway. In the invitation I asked the participants to spend the night at the villa, with arrival on the afternoon of the first day and departure in the morning of the second day. There were two sista circles during
the getaway, one occurring over dinner and the other at breakfast—which occurred in early-
February 2017. I provided food for the participants to enjoy dinner on the first day, and it
resembled a Sunday dinner with a three-course meal, and a continental breakfast for the next
morning.

The purpose of the *sista circles* was to examine the collective experience of the
participants, who are from historically marginalized populations in engineering and mathematics
disciplines, as undergraduate majors at a PWI. Haddix’s (2012) explored *sista circles*, and she
highlights the work of Dixson (2005) who made a metaphorical reference to “jazz” to explain the
difference between traditional qualitative research methods and those that are culturally relevant
(e.g., *sista circles*):

> Traditional interview methods would have the researcher follow a predetermined
list of questions that allow for some conversational spontaneity but primarily limit
the type of “call and response” and the nonlinear manner that is sometimes found
in the narrative and speech styles of African Americans (Etter-Lewis, 1993;
Smitherman, 2000). Hence, in the jazz interview, transcripts are quite often
lengthy and colloquial because both the researcher and the participant may engage
in storytelling and testifyin’ sessions during the course of the interview. Thus, the
jazz methodology is an interactive, synergistic process. It is much like that of
musicians on the bandstand who create and recreate music using the ideas and
energy of not only the other members of the band (the researcher and the
participant) but also the audience. Moreover, relationship and trust building are
essential elements within a jazz methodology (pp. 132-133).
Similarly, the *sista circles* were designed to support participants as they recounted their undergraduate experiences in response to open-ended questions. I encouraged participants to share their perspective on their academic persistence and overall well-being. As I used the *sista circle* protocol, I sought to provide structural and textural descriptions of the experiences of Black women as undergraduate students enrolled in Engineering and Mathematics programs at a PWI (Creswell, 2014). In each *sista circle* I focused on a category relevant to the research questions. The two meta-categories that allow me to explore this inquiry were participants’ *undergraduate experiences* and their *academic persistence and overall well-being*. I operated as a facilitator and participant to the discussion. I allowed the participants to ask the pre-formulated questions I developed to provoke rich in-depth conversations (see Appendix J-K). I placed each individual question into a bowl and requested each participant draw two questions. This allowed everyone to participate in posing questions to the group and allowed me to engage focus on being an equal contributor to the conversation that developed. Similar to the pre-interview protocol for this inquiry, I modified the *sista circle* protocols based on the interview protocol developed by Shavers (2010). I audio and video recorded each *sista circle*, which each lasted 60-120 minutes.

I used the video recording to capture participants’ body movements, facial expressions, timing in-between responses, to provide visual verification of which participant was speaking at all times, spatial proximity and to capture all that provided a deeper understanding of the *sista circle* after the data had been collected. In the *sista circle* unity getaway I did not take notes because I want to be careful not to influence the participants’ perception of my interactions. I was also careful of my gestures and conversation fillers, as I didn’t want to become the focal
point of the conversation. I had rev.com transcribe the data for the *sista circles* after the unity getaway occurred, and I reviewed all transcripts before the post-interviews began.

**Sista circle alternative interview.** Although each participant was asked to attend the *sista circle* unity getaway, two of the participants were unable to attend due to extraneous circumstances. As a result, the two participants were asked to complete a face-to-face “*Sista Circle*” Alternative Interview in which they provided their responses to the first and second *sista circle* interview protocol. The *sista circle* alternative interview lasted 60-120 minutes and was audio recorded. Finally, since the two participants unable to attend the *sista circle* unity getaway were the only mathematics majors in this study, it became essential that I use the *sista circle* alternative interview data in the analysis of this study.

**Hidden figures activity.** During the *sista circle* unity getaway I implemented a hidden figures activity to highlight the contributions of Black women in engineering and mathematics fields. I took the term hidden figures from the popular film entitled *Hidden Figures*, which highlighted the contributions of Black women in NASA who were essential in calculating the launch of the first astronaut to orbit the earth (Gigliotti et al., 2016). The Black women mathematicians in this film are referred to as hidden figures because they had not been acknowledged for their remarkable and historical contributions to the field.

Since there are so many Black women hidden figures in society, I wanted the participants of this study to take a moment to highlight a persistent Black woman in an engineering or mathematics field that was significant to them. We began the *Sista Circle* Unity Getaway with participants’ introduction of themselves and their selected hidden figure. I posed the following questions to assist the participants in preparing for the activity.
1. What is the hidden figures significant contribution to the field of Engineering/Mathematics?

2. Where is the hidden figure from and what is her family background?

3. Why did you select her as the person you wanted to present?

Once the participants completed the hidden figures activity, I informed them that their pseudonym for this study would be the hidden figure they identified in this study (see Appendix G). I wanted to honor Black women in engineering and mathematics fields because the participants personally identified with the selected hidden figure, and to give visibility to the once hidden figure. I assigned a hidden figure pseudonym to the participants that were unable to participate in the *sista circle* unity getaway.

**Artifact: Vision Board Collage**

As an icebreaker activity, during the *Sista Circle* Unity Getaway I asked the participants to develop a Vision Board Collage that represented where they currently see themselves. Similar to the work of Davis-Warra, Dooley and Excley (2011) who used handprints to represent the signature of one’s personal identity in the “Dream Circle”, which functioned as a safe space developed to empower Indigenous identities for children. I also used the Vision Board Collage as a visual representation of the participants’ personal identity. The Vision Board Collage was an opportunity for participants to reflect on and establish in this safe space a display of their personal identity for the other participants in the *sista circle* unity getaway.

I administered the Vision Board Collage materials to the participants as they entered the *sista circle* unity getaway and allotted two hours for the participants to engage in casual conversation as they prepared their collage to be shared with the group. I requested that the participants bring magazines and pictures to the getaway to help them create their boards. I also
provided small poster boards, additional magazines, stickers, markers, scissors and tape for the participants. The categories of the magazines used during the getaway were: mathematics and science teacher education magazines, engineering education magazines, science and technology magazines, sports magazines, fashion magazines, teen magazines, women’s magazines, African American cultural insight, news and entertainment magazines, and Black women’s lifestyle guide (fashion trends, Black hair, love, etc.) magazines. Upon the completion of the Vision Board Collages, the participants each presented their Board to the entire group and articulated the significance behind the images presented on the board to their personal identity. The Vision Board Collage became a moment of liberation for the participants because they were able to self-define and share their self-valuation in this safe space (Allan, 2013; Hill-Collins, 2000). The presentations were audio recorded and I took pictures of each participant’s board (see Appendix L). This artifact is used as anonymized data. The participants took their Vision Board Collage home with them so that it could be used as a reminder of their self-definition and a method of goal setting as they progress in their personal journeys.

**Electronic Post-Sista Circle Reflection**

I disseminated an electronic reflection that included seven probing questions to assess the participants after the *sista circle* unity getaway (see Appendix M). Through the electronic reflection I sought to capture the words and thoughts of the participants after the *sista circle* unity getaway. The participants completed this reflection before the post-interview so that I would have time to review the reflections and ask any questions that arose during the post-interview. I used *Google forms* to disseminate the electronic reflections.

**Post-Sista Circle Unity Getaway Interview**
The post-interview served as a follow-up for clarity and/or elaboration of participants’ interactions in the pre-interview and *sista circles*, reflect on what they stated in their Electronic reflection, as well as member checking of emergent themes. I began conducting the post-interviews in March 2017 and concluded the process in February 2018. Each interview lasted 30-45 minutes. I audio recorded each post-interview and transcribed the data as needed. During each post-interview I made notes to record major points, note relevant body language, and highlight ideas that stood out to me, that I needed to understand after the post-interview.

**Participant Correspondence: Interaction Logs**

I logged all email correspondence and text messages interactions with participants. My intent was to note all interactions I had with the participants outside of the interviews and *sista circle* unity getaway. This information captured the participants’ thoughts, concerns, questions, etc. during the research process, because this information can potentially inform the outcomes of this study.

**Timeline**

The data collection process began as I obtained IRB approval in January 2017. I sent a Recruitment email (see Appendix B) through the university listserv to request potential participants to personally email me. Once the potential participants identified themselves they were sent another email that included the Screening: Informed Consent form (Appendix C). Potential Participants authorized their participation in this study by proceeding to the Participant Screening Survey (see Appendix E), since the link was provided at the closure of the Screening: Informed Consent form. As potential participants were identified, I sent a follow up email to request the Informed Consent to Participate in Research form be reviewed and signed. This email also included the link to the demographic survey (see Appendix F). I began the pre-interview
immediately, during mid-January 2017 and I continued to schedule pre-interviews up until two days before the getaway. This was the cut off since I reviewed relevant sections of the pre-interviews immediately after each interview and I wanted to have the task complete before the getaway began. The *sista circle* unity getaway occurred during February 2017. The Electronic Post-*Sista Circle* Reflection (see Appendix M) was sent out on the last day of the *sista circle* unity getaway, once all activities ended. Participants involved in the alternative option for this study completed the *Sista Circle* Alternative Interview after the *sista circle* unity getaway concluded. Post-interviews began a month after the *sista circle* unity getaway, and *sista circle* alternative interviews, were completed so that I would have time to review the *sista circle* data prior to the post-interview.

**Data Analysis**

In the demographic survey the participants identified a pseudonym that I used to maintain and organize the data collected for each participant. Once the data was collected and analyzed I changed the pseudonyms to the hidden figure pseudonym each participant identified during the *sista circle* unity getaway (see Appendix G). For the two participants that did not participate in the getaway I assigned a hidden figure pseudonym. After the data was collected, I had the video and audio recordings transcribed for each interview.

I used the transcript for each interview to identify and isolate unique experiences of participants through a-priori and open coding. Specifically, I read each of the transcripts five times. One of the times that I reviewed the transcripts, I watched the video or listened to the corresponding audio recording to support my interpretation of the data collected. During this process I made notes writing the participants ideas in my own words, writing my own thoughts as it related to the topic, and I identified themes and categories that could potentially help me to
organize the data collected. I then organized the data, corresponding notes and potential codes into a table, which I used to group the quotes based upon themes that stood out. Once I completed this data coding process I had an understanding of the emergent themes and categories that arose in this study (Creswell, 2014; Gall, Gall & Borg, 2003; Schwandt, 2007).

Additionally, I implemented a two-step coding process that applied concepts and categories to yield rich descriptions of the participants’ experiences (Blaikie, 2010). First, I established two meta-categories relevant to the research questions: (1) undergraduate experiences and (2) academic persistence and overall well-being. Through open coding, I reduced the data to these meta-categories to represent discrete ideas and themes relevant to the research questions (Miles & Huberman, 1994). I then conducted a thematic analysis to present emergent themes and categories and support them with multiple perspectives from participants through divergent quotes and specific evidence that supports the findings of this study (Creswell, 2014). This process is displayed in Figure 3-4.

**Figure 3-4.** Data Analysis Process
I engaged in the analysis process throughout my study and began a formal analysis of the data in late-March 2017.

During the data analysis process, I explored how the participants' experiences shaped their academic persistence and overall well-being. It was also evident that the participants' academic persistence and overall well-being interact, and in many cases were inseparable. As racism and sexism infiltrated the experiences of the participants and was unavoidable, Black feminist thought was essential to the analysis process because it served as a guide that supported the development of my understanding and interpretation of the data collected. Figure 3-5 is a graphical representation of this understanding.

**Figure 3-5.** Black Feminist Thought Supports the Analysis of Racism and Sexism

**Qualitative codebook.** Guest, MacQueen and Namey (2012) discuss the use of codebooks in qualitative research. The purpose of a codebook is to produce code definitions and maximize consistency among codes, especially since this research involves multiple coders.
Shavers (2010) identified emergent themes in a study focused on Black women as doctoral students at a PWI, similarly my research focuses on Black women as undergraduate students enrolled in Engineering and Mathematics programs at a PWI. As a result, I used the emergent themes presented by Shavers (2010) to develop a working codebook that include a list of codes, code labels for each individual code, a brief and full definition per code, information as to when each code should be used or not used, and an example quote that exemplifies the code (Creswell, 2014). For example, Shavers (2010) presents the emergent theme “TOK: Tokenism, overly visible”, I added this to my codebook and used the findings of Shavers (2010) to identify a full definition, when this code should and should not be used, and an example that exemplifies this code. I expanded on and adjusted this codebook as needed once the data was collected. The codebook was used as a standard reference to identify consistency and themes in the data collected in this study. I then used the finalized codebook to analyze the data for this dissertation research.

**Researcher Bias**

In this section I discuss my perceived biases as the researcher and how my lived experiences contribute to this research inquiry. As a critical educator for social justice I constantly engage in literature, research projects, outreach activities, research conferences, journal writing, scholarly conversations, etc. that continuously challenge my interpretation, perspective and thought process relative to my critical consciousness, in every aspect of my life. Additionally, my lived experiences were in some ways connected to the experiences of these Black women that were undergraduate students enrolled in Engineering and Mathematics programs. Especially since who I am, my values and beliefs, and my lived experiences have all influenced my interest in “what” I chose to study, the selected methods and “how” I researched,
and defined my purpose as to “why” I research. With this revelation to my research, this can be problematic for me as the researcher because I was a member of a historically underrepresented population (a marginalized racial/cultural and gender group) in the field of Mathematics.

In the work of Ladson-Billings (1995) she raised questions about presumption of a “native” perspective where she cited the work of Narayan (1993), who states:

“Native” anthropologists, then, are perceived as insiders regardless of their complex backgrounds. The differences between kinds of “native” anthropologists are also obviously passed over. Can a person from an impoverished American minority background who, despite all prejudices, manages to get an education and study her own community be equated with a member of a Third World elite group who, backed by excellent schooling and parental funds, studies anthropology abroad yet returns home for fieldwork among the less privileged? Is it not insensitive to suppress the issue of location, acknowledging that a scholar who chooses an institutional base in the Third World might have a different engagement with Western-based theories, books, political stances, and technologies of written production? Is a middle-class white professional researching aspects of her own society also a “native” anthropologist? (p. 677)

Just as Ladson-Billings (1995) suggest, my position as native can potentially operate against me. Furthermore, my research may be distinguished as biased or a skewed perception because of my vested interest in Black women and girls, and the African-American community. As a result, I theoretically grounded this research in the work of Patricia Hill-Collins (1989, 1998, 2000, 2002) on Black Feminist Thought because it acknowledged my standpoint as a researcher and simultaneously compels me to problematize my standpoint.
Credibility and Verisimilitude

In this section I discuss the credibility and verisimilitude of this research as my own lived experiences add value to the credibility of this research, as well as, how I triangulated my data to construct deeper meaning, and how I made meaning of the data to maintain verisimilitude (Ladson-Billings, 1995; Shenton, 2004). To carry out this purpose, I quote Patricia Hill-Collins (1991), who states “individuals who have lived through the experiences about which they claim to be experts are more believable and credible than those who have merely read and thought about such experience” (p. 209). In an evaluation of Patricia Hill-Collins (1991) words, my lived experience, as a mathematician was valuable to my research on undergraduate mathematics and engineering students. The experience of being an undergraduate student in mathematics courses, as I navigated a similar course load in mathematics is an experience I had in common with the participants. Similarly, as a Black woman, I shared the lived experience of what it is like to be a Black woman in the United States. As I addressed in Chapter two, the U.S. has a long history of oppressive structures relative to race and gender. The historical context leads me to the importance of addressing the intersection of being Black, a woman, undergraduate student, and in the field of mathematics or engineering, since this is a distinct experience. The complexity of this intersectional experience is one that I have also lived, and I had in common with the participants. I was able to draw from my own experiences as I engaged with the participants of this inquiry.

I have expertise in the culture of the participants being studied as a researcher within the culture. I grew up in an African American household, with an African American family and lineage, in a predominately Black (people part of the African Diaspora but not necessarily African American) neighbourhood that had a predominately Black school system. Not to
mention I attended a Black church in the heart of Detroit, Michigan, and a wide variety of my experiences growing up engaged me a wide range (relative to socioeconomic status) of African American people. From this experience I conclude that the African American culture is significant to my life as it provides a foundation to understand my culture. A fictitious presumption is that every Black person living in America has grown up in African American culture throughout his or her life span, in the way that it has been imbedded in my journey. With regard, my cultural knowledge allowed me to navigate from within the culture, as I understood the linguistics, gestures, facial expressions, body movements, etc. and the emotions behind them. I am able to navigate this cultural setting and interact with the participants selected for this research, in ways that allowed me to obtain a rich understanding of their perspective and collective voice. Overall, there is credibility in positionality in this work as my lived experiences and perspective allowed me to navigate beyond the surface and capture the deeper meaning in the participants’ experiences and as Black woman in undergraduate engineering and mathematics programs in the U.S.

I coded the data for this research and indicated emergent themes. In coding the data collected I used three data sources (including pre- and post- *sista circle* unity getaway interviews, the first and second *sista circle*, and a post-*sista circle* electronic reflection) to identify codes that appeared in all three sources (Shenton, 2004). I used these codes and refuted others that on the contrary may have only appeared once or in only one source. This process allowed me to triangulate the data since I identified participants’ individual viewpoints and experiences to generate a rich picture of the characterizations of Black women undergraduate engineering and mathematics majors (Shenton, 2004). Additionally, it was imperative that I honour the words of my participants through the implementation of member checking, in which
we (researcher and participants) constructed the overall meaning of their words (to make meaning of the data) (Ladson-Billings, 1995). During member checking the participants had the opportunity to read transcripts of the dialogue they participated in, verify their intent was aligned with their words, and verify their articulations were accurately captured (Shenton, 2004). Participants also verified the emerging themes and inferences I formulated from the dialogue (Shenton, 2004). Member checking minimized the misinterpretation of the data collected and added mutual enlightenment among the participants and the researcher and preserved the credibility and verisimilitude of this study (Miles & Huberman, 1994; Shenton, 2004).

**Summary**

Chapter three presented the design of the study. I used *sista circle* methodology because it represents a qualitative, culturally relevant, gender-specific methodology to examine how Black women characterized their experiences as undergraduate students enrolled in engineering and mathematics disciplines at a PWI. The research protocol was rigorously examined in this chapter and included the procedures that were implemented to recruit and identify participants, collect and analyse data. In the next chapter I provide the findings of this inquiry.
CHAPTER FOUR:

FINDINGS

In this study I sought to learn about the experiences of Black women as undergraduate Engineering and Mathematics majors at a predominantly white institution (PWI). As described in the previous chapter, I collected and analyzed qualitative data from the following sources: the demographic questionnaire, pre- and post- interviews, *sista circles*, and electronic post-*sista circle* reflection. In this chapter I describe the findings from the study for the following research question and related sub-questions:

1. How do Black women in pursuit of engineering and mathematics degrees at PWIs characterize their experiences while enrolled in their respective undergraduate programs?
   a. How have those experiences shaped their academic persistence?
   b. How have those experiences shaped their overall well-being?

Analysis of the data revealed several patterns regarding the study participants’ characterizations of their experiences. These patterns suggest that certain key factors and processes were at work to shape their academic persistence and overall well-being. These are what I refer to as themes.

I have divided this chapter into three sections, in which I present the eight major themes that emerged through analyzing the data. In the first finding, I address normalized policies and practices that reproduced an unwelcoming academic climate and specifically, 1) access to caring professors and the 2) competitive isolating environment. Then in the second finding I discuss how the academic climate forced the participants to negotiate self-doubt as they question if their program is the appropriate means to pursue their future career endeavors, the participants
experienced 3) variations in program expectations and reality, 4) a shift in academic self-concept, and 5) negotiated alternatives to persistence. In the third finding, the participants responded to the conditions in the academic climate through forms of resistance, which include the construction of a 6) professional persona, 7) sense of community and peer bonds, and identifying 8) academic opportunities as motivational tools. Together these eight themes provided insight to the academic persistence and overall well-being of the participants as they pursue undergraduate engineering and mathematics degrees.

**Systemic Oppression: Normalized Policies and Practices Reproduce Unwelcoming Climate**

Academic climate refers to the overall racial and gendered environment of the university that has the potential to nurture exceptional academic outcomes and graduation rates in all students yet too frequently it subscribes to high dropout rates and deficient academic performance for students of color and women (Yosso et al., 2009). In this section I shed light on the root of this frequent occurrence as I discuss the structural oppression that was evident in the academic climate from the perspective of high achieving, persistent, Black women undergraduate engineering and mathematics majors. It is important to note that structural racism, sexism, and discrimination have both individual and institutional components (McGee & Bentley, 2017; Yosso et al., 2009). Therefore, it is critical to consider individual/personal acts of bias that occur, and the racialized and gendered assumptions, practices, and policies that are embedded in academia (McGee & Bentley, 2017; Yosso et al., 2009). In this finding, two of the emergent themes yield evidence of structural oppression on the institutional and individual level, which include 1) access to caring professors and 2) the competitive nature of engineering and mathematics programs. A sub-category also arose with the respect to competitive nature of the academic climate, which included an a) isolated and alienated environment. Now I will begin
this section with an analysis of the participants’ experiences with undergraduate engineering and mathematics professors.

**Caring and Uncaring Professors**

When the discussion of undergraduate program experiences occurred, a common topic that was mentioned in the data was regarding their professors and advisors. Participants frequently described their experience with professors using the term care. When asked about the challenges and barriers the participants have faced in their engineering and mathematics courses, Aletha (4th year, Junior, Chemical Engineering) makes reference to professors that she has had negative experiences with in her classes. These professors typically have an expectation for students to remember everything they have learned and be able to recall information in an instant, which Aletha describes as an unsupportive classroom environment. This classroom dynamic makes her feel like she should question her abilities as a student and compare her academic performance to her peers. Aletha feels that the professor and the way s/he teaches has a major influence on the classroom environment. She feels the professor has the power to strengthen students’ confidence simply by building students up, reassuring them that they can excel and succeed in the course even when they doubt themselves. Creating a positive classroom environment is crucial to Aletha’s success as a student, academic persistence and overall well-being. Aletha explains:

Aletha: Okay. I say the biggest thing for me is not feeling I'm enough to complete it. I feel like it's partly because of the teachers, because they kinda like, "Oh, you should know this," and just kind of bring me down in little ways, and not very supportive in class, and stuff. When you do ask the questions, but yeah, just not feeling like ... That's the biggest challenge in engineering, not feeling like I can do this or like I'm just as smart as everybody else and I can learn this material. It's not my fault. It's like the teacher, how you're being taught, and just the environment too that gives you the confidence to be like, "Yeah, I'm an engineer." I know this stuff.
How do you get over that? I guess getting better teachers and having a personal relationship with your teacher, not just talking about school, but like, life and what you can do with engineering overall. I feel like that helps and finding a teacher that understands it. You can talk more than school, because office hours, I just go and talk about the class, and that's it. So, it's kinda dry in the end. Like, yeah, I knew you were my teacher, but you're a person too. You're so much more. You have knowledge, and stuff. You could help impart on me to help me grow to get into the right field I'm interested in, and what not.

I feel like I'm not capitalizing on all the experiences, or the knowledge, or the wisdom that they have, if they don't want to give it. They set the dynamic of office hours and for the type of person that they are, and if they're willing to help you out or not. Most teachers are not, or they don't have that dynamic. You just go to them, like, it's all business. After that, it's on your own. I hope more teachers would be more open to sharing their knowledge, and helping people out, and students out a lot more than it is now.

(SC2 Audio, p. 28)

Aletha’s solution to her concern is to create opportunities for professors to develop a deep connection and bond with students. She desires a bond that exceeds the classroom and functions on a personal level. She points out that professors are so much more than just course instructors, they are human beings with their own set of experiences, knowledge and wisdom that students, as the next generation of engineers, can learn from. Mae (3rd year, Junior, Chemical Engineering) shares a similar experience about a professor that allowed her to access his passion for the field of engineering in a meeting. Mae stated that the professor was helpful and supportive in advising her because she demonstrated her personal passion for what she was being advised on. This was Mae’s response to being asked her motivators to stay in her major and specifically who motivates her.

Mae: And then I was like "While we're talking, let me see what track I'm on right now to finish my degree for chemical engineering," and he was like "Right now you just have a beautiful track. [crosstalk 03:14:15], you can do this this and this, your upper elective can be this thing that you're doing in Greece, right now it's just looking pretty good." And I was like "That's great," I was like asking questions and stuff, "Do you think I could take a copy of that?" He goes "Oh go ahead, actually I'm going to keep this one, but I'll go copy you one." So, I was like "He's being really nice, really helpful." He responded to my passion, he responded to me being passionate about it. So, if a student comes in they're just
like basic, I'm pretty sure he's going to be basic because he's not going to give his
all into something where the other person isn't doing the same. I feel like he was
receptive, and he saw my passion, so then it hyped him up a little bit to be like
"Okay, let me ask your focus a little bit more, I'm going to give a little bit more
to her because she's serious about this, she isn't just coming in here to be like
'When am I graduating?'"

I think for him it might be different. Which isn't always good. I don't know, I feel
like if a professor was just upfront with that passion to anybody, it would actually
instill more passion in the students to be more passionate about what they're
doing. But I can see now it's more like "Okay, well if the students don't care then
I don't care." And I don't think that's right. But it shows the type of college we go
to, I guess.

(SC1 Audio, p. 80)

Mae and her professor discussed her academic track. Mae noticed the professor being receptive
of her academic interest specifically the fact that she was deeply interested in it and
demonstrated her passion for what she is doing. It is evident that Mae did not expect the
professor to be as responsive as he was to her, but she felt he did so because she is so passionate
about it. In return the professor offered her more information than he normally would.

Although this incident was a positive experience for Mae, she points out that professors
withhold sharing their personal passion for the field until students display their own commitment
to the work. This display of commitment translates to proof that you are indeed worthy of
accessing the professor’s support, knowledge and wisdom. Mae points out that professors are not
upfront about sharing their perceived wisdom with students. Instead this form of caring is only
accessible under the condition that students prove themselves worthy of such support and in this
case of Mae, she proved she was worthy by expressing her passion. In return she received caring
professor support.

Also, during the discussion of barriers and challenges the participants highlighted the
way the professors teach as a concern of great importance. Mae (3rd year, Junior, Chemical
Engineering) mentions the complexity of her major and connects this to the urgency for
professors to be aware of the importance of developing strong Engineering majors and invests this awareness into improved teaching skills. Mae continues:

Mae: And I think that one of the things that really irks me is, and this just started with major courses, like calculus, and stuff like that, that was different ... I think the professors. It's kind of like what gets me, and not just the professors, but the way that they teach. Engineering is one of the most difficult majors you ever have to deal with, so it's kind of like why aren't the professors understanding that and teaching better? Like, this is something ... If you say engineering is stressful. You say the world depends on engineers. If engineers mess up it could cause a catastrophe. Okay, so why aren't you teaching us better? Why aren't you teaching the ins and outs? Why aren't you going over practice steps and practice problems and making sure that we get it? Why aren't you caring about if we get it or not? Why does the lecture have to end in the hour and fifteen minutes, and then we don't see you until the next Thursday, or office hours? Why aren't you caring about the way you're teaching and how we are responding to it? Why aren't you caring about if we understand the material? Why are you putting it all on us? You know.

(SC2 Audio, p. 20)

Mae recognizes the success of Engineering majors is directly connected to economical solutions across the world. Mae ponders why professors are not concerned and more involved with their students since there are such high stakes in obtaining such a degree. It is evident that Mae’s concerns are centered on teaching and “caring”. As Mae continues, she shares an example of a Calculus professor that she had whom she describes as a model professor because he continuously went out of his way to support student learning in his classroom. She explains:

Mae: It was really crazy, but I will say his teaching method, he wanted us to get it. We had open discourse in the classroom when we felt like he made a mistake, because he made mistakes a lot. So, we would either correct him and he'd be like, "Oh, okay," you know, like change it and then keep going. So, it was just like this ... I felt like I could interact with the teacher during class, but like, in engineering major courses, I don't really feel like I can interact with the teacher in class. I don't feel like I can ask my questions and it be okay without some type of slip remark, or some type of uncomfortable feeling because I asked a question. I just feel like the teachers should really be more supportive in itself, because you already know how hard engineering is. You've been through it, so why aren't you being ... Why aren't you catering to that? You know, catering to the fact that you know this is hard, so let me help my students get through this. Let me be the best teacher I can be. I don't think they focus on being teachers. I think they focus on research, or whatever else they have going on.

(SC2 Audio, p. 20)
Mae expresses her struggle to identify caring professors in her major courses, and among these professors, good teaching is rare. She feels professors do not provide a welcoming classroom environment for students to ask questions and it makes her feel uncomfortable especially since she fears the professor will be rude to her in the case that she does ask a question in class. Mae describes the field of Engineering as complex and since professors are experienced in the field, they know firsthand what students are experiencing, so she feels professors should be more supportive since they know the academic climate. She feels that professors are more focused on their research agenda rather than perfecting the classroom experience and their method of teaching in order to support student learning. It is evident that being a caring professor is a necessity, but Mae also desires this trait be matched with “good teaching” skills. Mae (3rd year, Junior, Chemical Engineering) provides more detail as she shares the example of a professor who was not a strong teacher but was a caring professor.

Mae: So, that's my main one I would say. How do I overcome it? Going to the teachers who do care. For example, Dr. Apple, horrible professor. Horrible, but great person. I talked to him about almost anything related to what I want to do in life, or just like what's going on in the news. Like, he's one of those people who knows a little bit about everything, so you can sit there and have a thirty minute or forty-five-minute conversation with him about literally one thing. So, I like talking to him. It's refreshing. I just wish he'd teach better. I wish I could go to him to understand this one problem, MEB type things, you know. I wish he was like that all around, like he was a good teacher and a good person. But, I go to him just to get that vibe of like, you know what? I have someone I can talk to who's a professor.

Really, he's the only one. Dr. Banana's my research professor and I definitely don't even tell him about anything. He doesn't even know I'm going to Greece this summer. That's how bad it is. Then everyone else, like Mr. Cantaloupe like you guys said, he's just so busy. You can't really rely on him either to a certain extent. And then no one else. Well, Dr. Dates, he's a black professor in mechanical engineering. I can go to him for certain things.

Aprille: I don't know him too well.

Mae: So, he's pretty cool, but you can only talk to him to a certain extent, because it's just like ... I don't know. I don't know. It's just like everybody's so busy, but it just
doesn't' seem like some of the professors’ care about their students and how they’re actually doing, and you know, like, their lives and is this the right path for you, and, you know, yeah. I don't think it's that type of environment. I would love that.

I don't even know if I answered the how you overcome it thing, but overcome it by going to teachers who do care, even though they're not well rounded in the whole teaching aspect, they're still a good person, so you just converse with them and build a relationship with them, and ... It helps.

(SC2 Audio, pp. 20-21)

Mae states the professor, although he was personable she wishes she could utilize him for academic support as well, but she does not feel that he has strong teaching skills. She then listed a few professors and an Engineering faculty member that are accessible to her. However, of these accessible Engineering faculty members, each person has limitations that keep her from accessing what she needs from these individuals. Mae stresses that professors should care about students’ lives and making sure they’re on the right path. She values professors who are personable because she needs them to survive as they positively affect her overall well-being. Mae would rather seek out personal support from a caring professor even though they may not be able to offer her much academic support. Aprille (4th year, Junior, Chemical Engineering) offered a similar response when asked to describe her ideal undergraduate program. Aprille emphasizes the importance of caring professors with access to resources. The conversation continues:

Aprille: Ahhh. So, I feel like we have not only people who ... We not only need people who are caring, but also who know resources ...

Everyone: Mm-hmm (affirmative).

Aprille: ... And, who know ... Programs, and who know ... The struggle.

Everyone: Mm-hmm (affirmative).

Aprille: But yeah, the university would definitely have to replace their entire chemical engineering staff, because ...
Mae: Yeah, none of them are working out.
Aletha: Yeah.
Aprille: To me, Dr Fig’s cool.
Aletha: Yeah, yeah, he's cool.
Aprille: But, otherwise ...
Aletha: Yeah.
Mae: Everybody just stays in their own lane.
Aletha: Yeah, and they care for ... Yeah, they don't care for the students, as far as student growth, and isn't that what professors are supposed to care about? Isn't that the main thing?
Aprille: All they care about is their research.
Aletha: Yeah, right? Yeah.
Mae: Their research, getting tenure, getting grants, it's not even about the students anymore.
Aletha: Yeah.

(SC1 Audio, pp. 92-93)

Aprille feels the professors at her current university are incompatible with her request for caring relatable professors who have access to resources. Aletha (4th year, Junior, Chemical Engineering) adds that the professors don't care about student growth although she feels student growth should be the primary focus for professors. Instead, Aprille mentions professors are focused on research, and Mae (3rd year, Junior, Chemical Engineering) extends this statement by adding, getting tenure and grants to the list of professors’ concerns. This university practice indicates to the participants their academic success is not the primary concern of the institution. Katherine (3rd year, Senior, Applied/Computational Mathematics) shares a similar sentiment as she discusses her struggle to identify quality support pertaining to her upper level mathematics courses. Katherine explains:
Katherine: My experience has been limited resources and opportunities at the University. And again, that there's not really somewhere I can always go to for help. And sometimes, to be honest, some things are too far out of my reach. As in I have too much to do, so I can't even go and get that help. Cause of course there's always help from somewhere, but sometimes it's just too far out of my reach from what I've got going on kind of thing. … when it comes to math, you got to go searching. You got to go searching for quality help. For someone that's actually going to be caring, and not just think you're stupid. My experience has been that. And mostly just, that I get a whole bunch of professors that don't know how to facilitate the information. Like they're very bright, but as far as caring about if their students actually understand, I don't get that at all.

(ASC1 Audio, p. 5)

Katherine feels limited in the resources and opportunities that are accessible to her at the university, especially since she is a part-time working student who is responsible for paying her living expenses and supporting her family financially. Katherine does not find quality support accessible to her and it is evident that she does not feel her professors or classmates care about her. She recognizes that her vulnerability in requesting help to support her in her courses is often correlated with negative characterizations of her intellectual level as she is discredited and devalued as a student learner. Katherine does not feel supported by her professors. Katherine acknowledges her professors’ mathematical brilliance, but she is disappointed that the facilitation of the course does not demonstrate good teaching skills. Additionally, Katherine emphasized her professors lack of concern for students’ academic performance and ability to learn and understand the required course material. In another discussion Aprille (4th year, Junior, Chemical Engineering) attributes the lack of support and engagement by professors as a primary reason for students’ choice to withdraw from the program. Aprille discusses how she envisions her ideal institution and how her current institution would need to change in order to achieve this vision.

Aprille: For, especially like the university to go from competitive and, like, teachers acting slick and rude to, like, supportive and engaging. That would take a lot of work. I'm just trying to think how that would come to fruition. 'Cause that would be really nice. I feel like, you know, that's probably one of the main reasons that people drop out. Not only because it’s hard, but because ... where's the support?
Mae: Like, whose shoulder can I cry on?

Aprille: Right.
(SC1 Audio, pp. 89-90)

It is evident that the participants are in need of supportive and caring professors. They need an outlet to talk to someone who fully understands their experience within their major. Mae (3rd year, Junior, Chemical Engineering) describes her desire for professors and advisors to be proactive about mentorship that exceeds students’ academic success. Mae shared her struggle as a freshman student to connect with a large institution and entering such a competitive major, she felt isolated and did not know how to interject herself into her new life as an Engineering major and a college student.

Mae: I wish I'd had professors or advisors or people who cared enough to email me or just find me or just have a meeting with all the freshman and be like "are you guys going out? You know, okay if you're not I'm going to make sure you go to this meeting. I'm going to email you and if you don't ..." I feel like that's the type of support freshman need in general, because you're coming into this big city and you're a small little fish and that can really make you feel insecure. It can really make you feel small. And it can really mess with your confidence.

Aletha: Mm-hmm (affirmative)

Researcher: Mm-hmm (affirmative).

Mae: So, I feel like if people, they had advisors specifically for freshman to make sure each and every single freshman had a place to go at the university, the university would be such ... would be more of a friendlier environment, more of a family environment, and just more of an environment people would want to be around. Like, I remember ... I know a guy who goes to Grape University and he was talking about how he might go to Grape University for one weekend. It was like some random weekend, nothing even happened that weekend. He just wanted to go back. I was like people do that? People go back to their colleges like that? Even if you're an alumnus, you can just go back and chill with the people you knew? He was like "yeah, people from Grape University do that all the time." I'm like nobody at my university would ever come back.

Aletha: That must be like a good ...

Mae: You know? To just chill. Nobody does that at this university.
Mae feels the support provided to freshmen entering a large institution, especially as an Engineering major, should be hands on and interactive. She discussed a lot of fear with entering this new space, which she describes this experience as feeling like a “small fish” in such a large sea of people and opportunities. A feeling that triggers her insecurities and has a negative effect on her confidence. She feels that if the faculty were involved and would reach out to students to make sure they are okay and offer support in them getting involved that this would create a family-oriented environment as opposed to a competitive, isolating environment that makes students feel insecure. Mae’s desire for a family-oriented environment directly connects to what Stinson (2011) references as the anthropological ideology fictive kinship, which he defines as “a kinship-like connection between and among persons in a society not related by blood or marriage, who have maintained essential reciprocal social or economic relationships” (pp. 50-51). Mae makes the connection that she would like to develop a departmental norm that is reflective of a fictive kinship because she is interested in building deeper connections with the members of her department. Building a sense of community within her department culture denotes a collective chemical engineering identity. In this case the isolating environment and competitive nature of the program represent a White male ideal that the participants feel pressured to construct themselves into. The concept of a fictive kinship disrupts the competitive nature of the program because it opposes the “every man for himself” ideology that praises self-reliance and isolation, which can be characterized as dominant cultural norms of Whiteness and
masculinity that infiltrate undergraduate engineering and mathematics disciplines. Aprille (4th year, Junior, Chemical Engineering) feels there is a lack of support for students across the STEM fields, especially for Black students. She shares the experience of a friend in the biomedical sciences who sought out advisement because they were having a difficult time in their courses. In return the student was advised to select a major that would not be as demanding.

Aprille: Yeah, for sure. I feel like our school doesn't really care either way. Especially about Black students. It's like "Oh, well if you can't do this, go do something easier. Whatever, we still get our money anyway." It's mostly in biomedical science, I see that all the time. A lot of Black kids switch out to health sciences because their advisors told them "Oh look, we can't really do what.

Aletha: Really? I would have never known.

Aprille: A lot of my Black friends switched from biomedical sciences to health sciences, because they were like "That was kind of too hard."

Mae: Really? And their advisors just let them do it?

Aprille: Yeah of course, they don't care.

SC1 Audio, pp. 78-79

Aprille felt the advisement was biased because the student should have been encouraged to persist and offered suggestions to support them in doing so. Throughout this study it was evident that the participants experience numerous challenges and barriers, but they always persist, quitting is not an option. So often times when barriers present themselves they look for support and advisement to help them remain focused and to assure them that they can be successful even though the current times may be tough.

As the engineering participants described the makeup of their undergraduate programs they emphasized the lack of faculty of color and women within the college of engineering. These factors were even scarcer in the mathematics department as there were no professors of color and few women. Participants in engineering described the Director of Diversity and Inclusion (who is
a Black man) who is designated to “diversity relations,” for the entire college of engineering. The participants knew this faculty member had the potential to be an excellent resource, but they found it to be a limitation that he was not teaching engineering coursework. This minimized the type of support they could receive from the Director of Diversity and Inclusion. The participants also stressed that Director of Diversity and Inclusion was always overwhelmed with handling the needs of so many students across the college of engineering. This also made the participants shy away from using the Director of Diversity and Inclusion as a consistent resource. The mathematics participants did not have a faculty member designated to diversity affairs within their department. The lack of race and gender diversity among professors in the participants’ undergraduate engineering and mathematics programs reiterated professors’ inability to identify with the participants on a personal level. These institutional microinvalidations (Yosso et al., 2009) devalue Black women as undergraduate engineering and mathematics majors in the university community because the institution fails to recruit and retain diverse faculty members. Yosso et al. (2009) define institutional microaggressions as

racially marginalizing actions and inertia of the university evidenced in structures, practices and discourses that endorse a campus racial climate hostile to People of Color. These assaults appear to be ‘collectively approved and promoted’ by the university power structures (p. 673).

The passive aggressive institutional microaggressions presented in this section can leave students to feel disregarded and unimportant (Yosso et al., 2009).

The participants in this study struggle to identify support that meets their needs as engineering and mathematics majors. Participants emphasized the need for caring individuals that are supportive and engaging in their teaching methods. They also highlighted their desire to
have a personal relationship with professors because they want to learn about professors in ways that exceed the limitations of the engineering and mathematics classroom. The participants value their professors because they have already persisted in the field and have completed the degree, which they are trying to obtain. As a result, the participants yearn to learn from professors, access their wisdom, knowledge and experiences. In doing so the participants feel that it would positively influence their academic persistence but most importantly, their overall well-being. I will now share more detail about the competitive nature of the engineering and mathematics disciplines as it appeared in the data.

**It's all a competition!**

The competitive nature of the department fosters a culture that encourages and rewards separation and detachment practices that maintain an isolating environment. I see evidence of competition in the data when I asked the participants about the difference in the way they present themselves in their undergraduate courses in comparison to their engineering and mathematics courses. Aletha (4th year, Junior, Chemical Engineering) explains that she is able to be vulnerable in her non-engineering courses without repercussions. However, in her engineering courses she feels that she must work hard, come to class prepared and avoid showing weakness to maintain a model student persona for her classmates and professors. Aletha explains:

**Aletha:** So yeah, non-engineering classes, you can ask an off question. The teacher just slides it (laughs) you know, it would be okay but engineering classes, I feel like it's competitive and you have to be on point. You got to know what F=MA means, like you can't forget gravity-

**Aprille:** Right.

**Aletha:** -you can't forget ... the littlest things and stuff, you just got to know every single detail and what not. You can't mix things up-

**Boog:** Yeah.
Aletha: -and what not and so it's just a little intense, it's more intense and so I don't ask questions as much as before in like the past freshman, sophomore year, at least in class. I usually tend to go to office hours and figure out everything but yeah, it's different. I'm feeling really dumb. (laughs)

Mae: Yeah, right. Like don't make mistakes in normal classes.

Aprille: Yeah. Yeah.

Researcher: I think that's all a part of learning. It's like healthy.

Mae: But not in those classes.

Aprille: Yeah.

Mae: You can't show weakness.

Aprille: Yeah.

Aletha: It'll bring me down and people be like, "Oh, she's not that smart."

Aprille: Yeah, right.

Aletha: You know.

Mae: I'm like, duh, you were supposed to know that.

Aprille: Yeah, yeah.

Mae: I don't want her in my study groups.

Jadea: Yeah.

Aletha: Right, oh gosh, yeah. Yeah, that's for sure, so.

(SC1 Audio, pp. 28-29)

Aletha explains that the competitive nature of her engineering courses is an intense experience and has led her to stop asking questions in class. If she has to ask a question she will wait until office hours to ask the question. As the conversation progresses I challenge the conversation by insisting that making mistakes is a part of learning and is quite healthy. Still the participants support Aletha in her statement as she points out her classmates will be judgmental in the case that she is vulnerable during class and they will discredit her intellectual level if she is expressive.
about not understanding something in class. Therefore, no mistakes should be made during class.

The participants also share that this competitive nature among their engineering classmates carries over to their study groups. Aprille (4th year, Junior, Chemical Engineering) shares her experience in her non-engineering courses. In this space she felt the classroom environment was welcoming to questions and less consumed with competition. She adds that professors in non-engineering courses were also more open to speaking to students and would even develop personal relationships with the students.

Aprille: For me my non-engineering courses what I usually tend to take is like, at least my freshman year was like art classes, English classes, analogy of psychology class. Present myself, I guess, I'm definitely more like open to asking questions for sure. For me in most spaces, especially like art and stuff, it's definitely easier to I feel like to talk to the teacher. There's like less competition or whatever, that we talked about earlier like engineer and some fields, there's less of that and more of like, okay, let's all share our thoughts, so whatever, you know, and duh, duh, duh.

Especially my freshman year, that was definitely like my non-engineer courses that was definitely like a thing, like share your thoughts. Like, "Oh, go to the teacher's office and have a good conversation", you know, and whatever and I felt like the teachers were a lot more open to talking to you and it was just like you can actually develop a relationship with them. So yeah, I wouldn't feel afraid or intimidated to ask questions or whatever it is. It was just more open, and it was more relaxed, even though some people tend to isolate me, like in class, they're like, "Oh, you're an engineer major oh my God, that's (laughs) so hard. You must be so smart."

(SC1 Audio, p. 27)

Aprille expressed not feeling afraid or intimidated in this environment about asking questions or other common classroom interactions. However, Aprille did feel isolated among her classmates in her non-engineering courses because of her status as an engineering major. She felt that her classmates viewed her as an exceptional student or above average because of her major.

Erica (3rd year, Senior, General Mathematics) highlighted the popular practice of “grading on a curve” in order to ensure enough students are passing their mathematics courses. Grading on a curve is when an assignment or exam has been scored and the average score on the
exam is curved to the highest possible grade. All other scores, below or above the average score are redistributed accordingly. For example, if the average grade on an assignment is a C, then a C becomes an A. Therefore, those students earning an F on the assignment would receive a passing grade of a C for the assignment. This popular practice among professors of undergraduate engineering and mathematics courses fosters competition since it places pressure on students to get a higher grade than their classmates in order to perform well in the course. Erica explains:

Erica: I would say it has been stressful. A lot of the teachers don’t realize that they have tests on the same day or same week but other than that I guess, I don’t know. I guess it’s been weird because they say in the math program itself that it’s really hard to maintain your GPA because a lot of the classes you will be getting Cs and a lot of teachers do just pass you. Some of them do, well not pass you but they’ll raise everyone's grades up in order to pass you. It’s just like-

Researcher: Like a curve.

Erica: Yeah, it’s a huge curve, I'm like okay well then if there's a huge curve maybe we should change the teaching strategy, I don’t know. But yeah so those are my experiences. … Low expectations are not my thing.

(LSC Audio, p. 4)

Erica suggest it would be more beneficial to students if professors reflect on and assess the course. An example, Erica provides is by evaluating the teaching strategies that are implemented in these courses to understand why there is a commonality of low performance among students. Grading on a curve grading scale, although it ensures enough students are passing the course, it does not respond to the greater issue that students are not retaining the required course content in ways that demonstrate they are prepared to continue to the next course and on to their field of study. Grading on a scale is a passive aggressive solution to a greater issue, because it doesn’t really solve anything. Erica connects grading on a curve as a professional practice enacted by Mathematics professors and Mathematics programs to display their low expectations of student’s performance. Grading on a curve and not addressing the greater issue, does not place accountability for students’ low performance on the program, classroom structure, teaching
strategies, etc. that were unsuccessful and may need to be revised and improved. Instead, it places blame on the students and carries the deficit assumption that students are incapable of high academic performance in upper level Mathematics courses, which is a false assumption.

The participants mentioned an informal social space in the college of engineering that all of the students refer to as the malebox. This informal social space has plenty of tables and chairs for students to congregate and study outside of their classes. However, when the participants described this informal social space, they made it clear that there are predominately white men that occupy this space and that there is “so much ego in the malebox” (Mae, SC1 Audio, p. 38).

Mae (3rd year, Junior, Chemical Engineering) goes on to describe the type of engineering students that occupy the malebox. She states that the majority of students are involved in engineering societies, but students from the National Society of Black Engineers (NSBE) do not occupy the malebox. Mae explains:

Mae: There’s majority people that are involved in the engineering societies, like not in NSBE. I don't see any people from NSBE. SWE, SHPE, AICHE and ASME. You see all those people in there, which are just engineering societies, mechanical, one's just for women and one's for chemical engineering, and then one's for Hispanic people. And then you have predominately light skinned people in general. White people in general, European descent that includes Spanish people too. And then predominately male. (SC1 Audio, p. 38)

Mae describes the students in the malebox as White and mostly men. She also describes the white students’ ethnicity as European and Spanish people. The participants explained that since they are not members of these engineering societies they often feel like they “stick out” when entering the malebox. During the member checking Mae provided clarity to this description of the malebox and stated that the students being White was not the issue but that these White men had personalities that were disconnected and lacked relatability. My understanding of Mae’s words is there was a cultural disconnect between the White men and particularly the Black
women in this study. Aprille (4th year, Junior, Chemical Engineering) describes this experience as awkward, Mae used the term weird and Aletha (4th year, Junior, Chemical Engineering) described it as intense. The participants add the majority of students already know each other and function in the malebox as groups. Mae explains:

Mae: And the same people that are in there one day are the same people that are in there the next day. You kind of have to build your repertoire in there, because it's like the same people every day, they all know each other, they all talk to each other, so like, my engineering friends, like Ashley and them, they never go to the malebox. Because, they feel like they're not welcome. Those people don't look like them, those people don't talk like them, it's just weird. It's just not. It's just weird.

(Sc1 Audio, p. 39)

Mae sees the same students in the malebox each day and because of this she states you must build a status or reputation in this informal social space in order to enter this space. Mae’s friends who are Black students do not go to the malebox because they do not feel welcome. She elaborates that by stating the students in the malebox do not look like them nor do they speak like them. Aprille (4th year, Junior, Chemical Engineering) mentioned that she doesn't have anything to talk about with the white men that occupy the malebox because they don't have anything in common. So, the students don't feel that they can relate or that their presence in the malebox is even wanted to begin with. Aletha (4th year, Junior, Chemical Engineering) shares a time that she scheduled a meeting in the malebox on a day where there are not many students in there.

Aletha: So, like, I had a meeting with this girl, she's my assistant, in the malebox, it was Friday, so it was very light, there wasn't as much people, so I was like, Okay, I'm going to the malebox and I'm about to sit down. When I sat down, you could see people like, "What's she doing?" Kind of thing, I felt kinda awkward, because even people who know you-

Mae: They'll say Hi, but they won't-
Aletha: Yeah. And they'll just be like, "Okay, what did she do? I've never seen her here before." kind of thing. It's probably why my son-

Aletha: It's cold. (SC1 Audio, pp. 39-40)

Aletha’s presence in the malebox was highly visible and unwelcomed. The malebox is an example of institutional microaggressions. Yosso et al. (2009) state institutional microaggressions “comprise what social psychologist Claude Steele (1997) calls a ‘threat in the air’” (p. 673). Interestingly enough, as the participants concluded their description of the malebox we laughed together as they described the “chilly” environment. Aprille explicitly states, “It’s in the air” you can feel it. The participants go on to collectively describe the malebox as a weird feeling environment and tense because there are so many White men that occupy this informal social space. The participants in this study have explicitly described and acknowledged that they feel a “threat in the air” upon entering this informal social space (Yosso et al., 2009; Larnell, Boston & Bragelman, 2014).

In an analysis of the academic climate, the discussion of access to caring professors and the competitive isolating culture presented evidence of interpersonal and institutional microaggressions (Yosso et al., 2009). Yosso et al. (2009) define interpersonal microaggressions as verbal and nonverbal insults people of color experience at the hands of students, faculty or other persons in academic and social spaces. Together interpersonal and institutional microaggressions are evidence that structural oppression is embedded in the academic climate of undergraduate engineering and mathematics disciplines (Yosso et al., 2009). Furthermore, the isolating and competitive environment of the academic climate is aligned with elements of Eurocentricism and masculinity. Specifically, the unemotional and competitive nature of the participants experience can be characterized as a masculine trait (Rhoton, 2011). Also, Eurocentricism parallels with division, as opposed to unity an Afrocentric characteristic.
Negotiating Self-doubt: Does this program align with my future career endeavors?

In the previous section I identified the first finding with examples of systemic oppression evident in the policies and practices that reproduce an unwelcoming climate for participants undergraduate engineering and mathematics program. McGee and Bentley (2017) list ongoing exposure to structural oppression as a threat to students’ overall well-being. As a result, in this section I discuss the individual/personal effects the supposed academic climate has and on the participants’ experience as they negotiate self-doubt regarding their current program track being the appropriate track to obtain their future career endeavors. In this finding I analyze three major themes comprised of participants’ 1) undergraduate program being different what they initially anticipated when they selected their major. Along with a 2) shift in their academic self-concept and 3) consistent negotiation of alternatives to persistence in their current undergraduate programs, of which both experiences triggered impostors phenomenon in the participants. I begin this section with a discussion of the participants’ program expectations.

This isn’t what I expected!

During the study it was evident that the participants experience was not what they expected when they selected their engineering/mathematics majors. Specifically, Mae (3rd year, Junior, Chemical Engineering) describes how she discovered her interest in biomedical engineering. She adds that her initial interest was in biomedical engineering but her undergraduate institution does not offer a biomedical engineering program. Mae decided on chemical engineering as her undergraduate major with the understanding that she could explore biomedical engineering for graduate school. Mae explains:

Mae: Took my first anatomy class in junior year, and I was sold. I was like ... and plus I had the best teacher ever. I was sold. I love the body. I love learning about different parts of the body and the different mechanisms of the body just to be able to have some life. That was just so dope to me. So, then I thought I need to
be able to integrate science, chemistry, math, and the body. Let me research. Found biomedical engineer. Bam. That's what I want to do. That's it. That's going to make me love my job for the rest of my life.

And then senior year came along, and that was the same thing, but I said I saw the university didn't have an undergrad for biomedical engineering, so I was like, let me re-explore my chemical engineering thing just for undergrad because I know I can still do a master's in Biomedical or a Ph.D. And I always knew that I was going to not stop at the bachelors. I always knew I was going to go beyond that. So, I decided to do the chemical engineering thing, and then do the biomedical for a higher degree, and so that's how I figured out that I wanted to do chemical engineering. But like you said, it's nothing how the definition is. You know, like chemical engineers, they don't normally create new inventions that'll help -

(SC1 Audio, p. 65-66)

Mae reiterates that her experience as a chemical engineering major does not align with what she initially researched when she selected an undergraduate major. Mae also emphasized her interest in creating new inventions, which will allow her to apply what she is currently learning. Similarly, Aprille (4th year, Junior, Chemical Engineering) was interested in pursuing a biomedical engineering program but selected chemical engineering as her major because that was the closest option that her university offered. Aprille discusses her mindset when she entered her program.

Aprille: So, I was just like, alright, I'll be a chemical engineer. I originally didn't want to do chemical engineering, just like you Mae, because I was like, working the plan, like no. I wanted to do bio-medical engineering. And, I wanted to specifically do that, like, I didn't want to do chemical, but then, people were like, "Oh, chemical is so much broader, like what if you don't like bio-medical? Then you can switch to something else, remember." I was just like, "Well, alright, I guess." But yeah, I never expected chemical to be this struggle. I never expected just one breakdown over assignments. I knew it was going to be difficult, but I thought like, "what's difficult?" People said that college in general was difficult, I'm like, "Man, it'll be alright."

But no, this is like, so breaking me, like difficult. But, in my experience in the field, I haven't really been in a plant, I've worked in a ... what's it called?

Aletha: Industry?

Aprille: I forgot. What's it called when you make all the cars?
Aletha: Oh.

Aprille: I guess a plant.

Aletha: Facility?

Mae: Assembly, maybe?

Aletha: Manufacturing facility?

Aprille: Yeah, yeah, not really like, a traditional plant, where they like make chemicals or whatever. So, I haven't really had like a, chemical engineering experience yet, so, I've yet to see like ... I've yet to compare that I guess. I've more like, had a research, bio-medical engineering, scientist sort of experience. Which is still cool that you get to do that as a chemical engineering major, but yeah, it's really nothing like I thought. I thought it would be more fun.

Everyone: [laughter]

When entering her program Aprille knew that chemical engineering was not her interest, but she pursued this major with the understanding that it would broaden her future career options. As her program began Aprille anticipated that the course content would be complex and difficult at times and she was not intimidated by this reality. However, the struggle that she endures each day as a chemical engineering major is far more excruciating than Aprille would have ever expected. Aprille has had internships in biomedical engineering and research opportunities, but she wishes her program was more exciting. She acknowledges that she has yet to have an internship in chemical engineering, which has the potential to positively change her experience thus far, if she indeed finds it enjoyable. Similar to what Mae (3rd year, Junior, Chemical Engineering) mentioned, it seems that Aprille would find her chemical engineering program more exciting if she was able to apply what she is currently learning, for instance if she had an applied chemical engineering internship. Also, Aletha (4th year, Junior, Chemical Engineering) explains that her program is not what she expected when she selected her major and provides more detail on her interest in applied chemical engineering.
Aletha: And you make the highest of that ... all right. Yes, yes, yes. But then there's really cool picture with the lab coat and stuff. It's just like looking like, working application with your hands. So that's one big thing that I know is valuable to me when I'm able to apply something or just create something. So that's what I thought engineering would be, like creating application using science and biology as well.

And in some ways, it's like that, but it takes a lot of time to go from what you learn to application. From what I've seen, everything nowadays is reinventing the old, and so it's just really hard because research, like you said, to try to make something new takes a lot of time in between that. And there's a lot of in-depth things that you have to know. So, it's a lot different.

It's a lot of theoretical and calculations and laws and mass balance laws and whatnot. And industry focus, what goes in, what goes out. Money, economics is a major thing. So that's a little different than what I thought it would be. I thought it was just going to be like using math and science in order to create to something that could save lives, like an invention, cure, whatever, but it's not. It doesn't directly translate to that. There's a lot of different components that go into it, and it takes a while to use like base engineering to do something great, from what I can see. So that's my experience.

Aletha points out that research in chemical engineering is not applied. Instead it is reinventing what has already been done in the field. Aletha points out that she thought she would be doing applied chemical engineering, which directly connects to new inventions and cures that can potentially save lives. Aletha is interested in helping people through her chemical engineering efforts and this sheds light on Aprille (4th year, Junior, Chemical Engineering) and Mae’s (3rd year, Junior, Chemical Engineering) interest in Biomedical Engineering and pursuing an M.D. because these majors will also allow them direct impact on people through their field of study.

Ultimately the participants are interested in the human component of their work, which is quite disconnected from the work they are currently doing as undergraduate chemical engineering majors. Mae reiterates her understanding of chemical engineering and how it has shifted over time.

Mae: You know, like chemical engineers, they don't normally create new inventions that'll help -
Aletha: No.

Mae: No, they're checking the efficiency of old things that are already made and trying to make them better and seeing how you can save money in the process. I didn't want to deal with money. I never wanted to touch money, I hate money. To be honest, I hate the idea of money. Looking at all the things that they do, like even working in a power plant and stuff, that does not interest me to this day, I hate it when he tried say, "Well, you can work in a power plant, like you have to always relate it back, to working in a power plant -

Aletha: Really?

Mae: And working with different processes, and this is what a column looks like at a power plant, I'm just like," This does not interest me." But then, I'll go in the book and read the bio-engineering application, and I'm like "Oh, okay, I can see where I could use this in the future."

Aletha: Mm-hmm (affirmative)

Mae: So, that's where I'm at right now. So, it's really difficult for me to be able to still be passionate about what I'm actually learning because it doesn't apply directly to what I want to do. But, I know it's a stepping stone. If I can get through this, I can get through anything. So, that's where I'm at right now.

(SC1 Audio, pp. 66)

Mae also shares that her professor often helps her build connections between what she is learning and how it would be applied in the workforce by referencing its application in power plants. This does not support Mae’s interest because she has no interest in working in a power plant, so it would be more beneficial for the connection to be made relative to her area of interest. She notices however that connections made to biomedical engineering application are often applicable to her future and help her make sense of things. This direct connection or application of what she is learning to what she will be exploring in her future endeavors is crucial in this stage of her development as an undergraduate student. Understanding the application directly connects to what she is passionate about. The ability to connect what she is learning to what she is passionate about is what helps her to academically persist in the field. Without this she becomes disconnected from her passion, which leaves her disconnected from what she is learning in her undergraduate major. Now I will discuss how participants’ perception of their
academic progress has shifted because of their undergraduate engineering and mathematics program experience.

**Am I smart enough?**

The participants’ perception of their academic progress in their courses shifted as they persist in their programs. Academic self-concept refers to the general self-confidence individuals feel that is based on experiences and interpretations of those experiences (DeFreitas & Rinn, 2013), which can serve as a predictor of an individuals’ ability to complete an academic task successfully or unsuccessfully (Awan, Noureen & Naz, 2011). Understanding the participants’ academic self-concept supports an analysis of the successful functioning, academic persistence, and overall well-being of participants in their respective undergraduate programs (Awan, Noureen & Naz, 2011). In this section I will provide examples from the *sista circles* where participants displayed a shift in their academic self-concept.

Mae (3rd year, Junior, Chemical Engineering) describes her stress as it pertains to the isolating environment in her program. She notices the struggles she endures in her program differ from students who are outside of the field of engineering. Mae states that she is fighting to maintain her GPA and how this fight makes her emotional because it is such a complex challenge for her.

Mae: She doesn't stress about school. She doesn't literally cry over things. She doesn't feel the stress of trying to get a B or a C to pass the class. She's never experienced going to get help from people you really don't want to even talk to.

Aprille: Yeah!

Mae: She never experienced going to office hours, she never had to do that. Cause she just never had to do it. Cause business is not something strenuous like that. So, to go through this and like you said, not have a support system or not have a support system that you can relate to in certain areas, or in all areas, is difficult. Cause you wake up thinking, "Oh God, why am I doing this?" Nowadays I wake up for ever. I'm glad I have my support group cause they're cool and stuff. But still
sometimes I'm just like, "Good lord, I just wish I can get through this, so I can just move on."

And I was literally thinking after MEB comes Transport Separations, and right now that doesn't interest me at all. So, do I even want to do this? That's what I've been thinking lately. Do I want to do this? I wish they would come out with biomedical undergrad so quick. Like a biomedical engineer undergrad, I literally went to Dr. Honeydew and asked him. Because they said the university was making one.

Aletha: Yeah.
(SC1 Audio, pp. 58-59)

Mae feels disconnected and disinterested in what is currently being taught in her coursework, which forces her to negotiate whether or not the completion of her current program of study is the best choice for her future career endeavors. During the *sista circle* the participants share the experience of stressing over the successful completion of their coursework. Mae elaborates on this experience as she describes the fear of progressing to the next course on her program track when she does not deeply understand the course she is currently in.

Aprille: It's just like, "Oh no." Or break down. Like you said, people don't know what it is to cry over a grade or cry over an assignment.

Mae: That you spent six hours on.

Aprille: Or a whole weekend. You spend your whole weekend on this quiz and you still failed this quiz? You have no idea.

Aletha: When you try to understand something that you just can't, like it doesn't make sense. It just doesn't.

Mae: You don't see the other side of it, you're like "I'll never be able to understand this so how do I move onto the next class?" It's like "Oh god, it's so much." It's so hard to be positive. That's why the only thing that gets you through it, like you said, it's your passion. What are you passionate about? You have to find it some way, shape, or form. If you're doing extracurriculars or research, then great for you. Because that's the only thing that's gonna keep you through it. Passion and a support system.

Aletha: That's right yeah.

Aprille: Yep.
McGee and Bentley (2017) noted that traditionally education has been distinguished by a survival-of-the-fittest approach. In this academic culture, lack of success in engineering and mathematics is attributed to student characteristics (McGee & Bentley, 2017). This way of thinking arises more frequently and severely in engineering and mathematics disciplines as opposed to other fields (McGee & Bentley, 2017). When I speak of student characteristics I want to remind you of the participants intersectional identity as Black women in undergraduate engineering and mathematics disciplines. Essentially, a survival-of-the-fittest approach ascribes failure in their undergraduate discipline to this intersectional identity. For example, there exist an extensive deficit-burden master narrative about the academic underperformance specifically of Black students in America (Larnell, Boston & Bragelman, 2014). Although this defective narrative is a false stereotype, the survival-of-the-fittest approach only empowers this deficit perception of student performance in engineering and mathematics. The complexity of this threat negatively effects students’ self-concept and overall well-being. It is evident that the struggle the participants endure in their courses triggers a fear of failure. Neureiter and Traut-Mattausch (2016) define a fear of failure as the “‘tendency to appraise threat and feel anxious during situations that involve the possibility of failing’ (Conroy et al., 2007, p. 239)” (p. 2). Neureiter and Traut-Mattausch (2016) categorize a fear of failure as an “impostor feeling”, from which the impostor phenomenon is defined as an “internal experience of intellectual and professional incapability despite objective evidence to the contrary” (p. 1). Even still, Mae displays her sense of agency as she maintains faith in her ability to progress, as she remains focused on her passion for the field. Hill-Collins (2000) defines agency as “an individual or social group’s will to be
self-defining and self-determining” (p. 298). It seems that passion is directly connected to academic persistence for Mae.

**Is this for me?**

A common theme in this study was the participants’ frequent negotiation with whether or not they should remain in their current undergraduate programs. It was evident that the academic climate of their undergraduate program significantly influenced how they experienced their engineering/mathematics disciplines and whether or not their current program track was still appropriate for them. In a conversation with Aprille (4th year, Junior, Chemical Engineering) she stated that she works hard in her engineering courses although the results of her efforts are mediocre. In her engineering courses Aprille does not feel like the exceptional student she has always been known to be. When Aprille made this statement during the *sista circle*, her words and body language stood out to me. She stared into space and looked sad, as if she was holding back tears. In this moment I assured Aprille that I understood her sentiments and had felt similarly before. I then inquired by asking her how this shift in her academic identity made her feel. Her response was:

Aprille: Sometimes it makes me feel sad.

Researcher: Mm-hmm (affirmative)

Aprille: And not really like ... I don't really want to continue sometimes. But then it just becomes ... I become apathetic. Where it's like, I kinda have to get through this, like, cause if I don't I don't really know what else I'm going to do. So ...

(SC1 Audio, p. 75)

Aprille considers abandoning her current program because it is emotionally taxing. Her disdain for her program causes her to disconnect and lack interest or enthusiasm about her academic persistence. Aprille credits her persistence to her focus on concurring this academic obstacle because she does not have an alternative to her existing academic career track. Engineering is all
she knows. Similarly, when Mae (3rd year, Junior, Chemical Engineering) was asked about what motivates her to persist in her undergraduate program she also discusses a fear of being indecisive. Mae shares that her sister who is finishing her undergraduate degree is uncertain about what she wants to do for her career and Mae does not want to put the burden of uncertainty about her own career on her parents as well.

Mae: Mmmm, I think my parents motivate me because ... They're always supporting me, so to see me come this far, I wouldn't want to let them down in a way because, I don't know, just my sister, like seeing her struggle. She doesn't even know what she wants to do in life. Yeah, she has a degree, but she still doesn't know what she wants to do, and she's a senior graduating, so ...

Researcher: Mm-hmm (affirmative)

Mae: They've been through so much with her and her ups and downs and stuff. I wouldn't want to add extra weight on them by saying, "Well now I don't know if I want to do this," or, "Now I don't know if I want to finish chemical engineering," and stuff like that. So, they motivate me in a way, and especially cause all of the sacrifices they made for me to even be here.

(Sc1 Audio, p. 76)

Persistence for Mae is an obligation. Mae is indebted to her family and the expense of her debt is the act of persistence and completion of her undergraduate degree. Aletha (4th year, junior, Chemical Engineering) similarly discusses an obligation or debt as the reason for her persistence. She states that her persistence is less driven by her passion for the field but is deeply rooted in an academic scholarship she received that is paying the expense of her entire undergraduate education. Aletha is indebted to those individuals that have invested in the financial award that affords for her to attend college and the only way to pay her debt is through the persistence and completion of her undergraduate engineering degree.

Aletha (4th year, Junior, Chemical Engineering) displays evidence of impostors’ phenomenon as she emphasizes her fear of failure in entering the field of engineering. Her fear is connected to the critical reliance on accuracy within the field of engineering. Aletha questions
her value to the field and her ability to withstand the structure of her undergraduate program.

Aletha understands that not being able to recall what she has learned, or a miscalculation could lead to major problems in the workforce.

Aletha: The biggest thing you said ... like, it breaks you down. The sin of sciences, it breaks you down. It's rough because it does make you question your ability to do it. For me, I'm like, I'm not this smart. I should just get out, but it's not even about smartness, it's just about diligence, completing it.

But sometimes I get all messed up and I'm like, yeah, I'm not Einstein. I just can't. I can't. It doesn't come easy or whatever, so ... It breaks you down for sure, and other majors I don't know if it ... yeah, it doesn't really do that. It doesn't go intent.

What kills me is that in industry too like you have to know everything, but in industry, you forget stuff. But you have to know the stuff because engineering matters. If you make like one little miscalculation-

Researcher: A bridge could fall.

Aletha: Yeah, the impact is huge-

Researcher: And everybody is dead.

Aletha: And so that's what scares me, because yeah, I can learn it through school but to apply it and to make sure that I'm like getting everything that I've learned correctly, it's like-

Mae: It's a whole other stress.

Aletha: Yes. Yeah. It's scary because I know through my internship experience, I know that I've had experiences where I know, oh yeah, I didn't do that calculation right and stuff. But as intern, it's easier to fall back on, but you can't ... It's just different so that's what like my fear is. It's a legit fear, but it shouldn't be legit because everyone makes mistakes but just knowing that ... I guess you do the best that you can. The way you do a problem, you just make sure that you analyze it the way that you do it, the best that you can. But that's like it does break you down. Like you start asking life questions. What is life? I just getting mad at people because they're happy. Every time. I can't. I just can't. I don't know. I just stay out of it. Oh please, but ... I'm just ... the battle you got to go through with engineering, math, STEM, yeah.

(SC1 Audio, p. 62-63)

Aletha emphasizes that her program breaks her down. Furthermore, her program makes her question her life fulfillment and makes her search for her own happiness, which she sometimes
feels disconnected from. Another important realization of Aletha is that her program is not structured to assess one’s intelligence. Instead, the program is a test of diligence and endurance. Similarly, Mae (3rd year, Junior, Chemical Engineering) reiterates that her program breaks her down.

Mae: So, I went to him [referring to her advisor] last week and was like, "When are they coming out with this undergraduate [biomedical engineering] program?" And he was like, "Honestly probably four to five years." It takes that long to build up a whole different major. It has to be accredited and all that stuff. I was just like, "Doggone it." And I'm not a quitter so I'm obviously gonna go through it, but it's so hard to see the other side. It's so hard to still keep a happy face and smile when you know these classes are breaking you down.

Aletha: Yeah, yeah breaking you down.

Mae: And it's supposed to. That's what really sucks, they're supposed to weed out the ones who can't make it. That's kinda messed up, I get why but at the same time do you want me to feel like this?

Aletha: Breaking you down, that's for sure. (SC1 Audio, pp. 58-59)

Mae makes the connection that her courses have been developed and structured to break students down and “weed out” those students that are not compatible engineering majors (Borum & Walker, 2012; Geisinger & Raman, 2013; Perna et al., 2009). Geisinger and Raman (2013) define weeding out as a process often perceived as an “unavoidable” consequence by faculty members from engineering programs, to convince “unmotivated” or “underprepared” students to withdraw from engineering degree programs. Research shows that the students that leave engineering programs are often performing well academically, but women and students of color withdraw from STEM majors at disproportionally higher rates (Geisinger & Raman, 2013). As a result, students are leaving STEM majors for reasons that greatly exceed motivation and preparedness (Geisinger & Raman, 2013). Mae is taken back by the reality that her program is structured to break her down because she finds it disheartening that they want her to feel as
poorly as she does about herself and her performance. In other words, it seems that her program is structured to negatively affect her overall well-being and her academic persistence, because only the “fittest” survive and those are the students that deserve access to the field of engineering based on the guidelines of the weeding out process (McGee & Bentley, 2017). Aprille (4th year, Junior, Chemical Engineering) demonstrates evidence that her program is breaking her down academically and emotionally when she describes an incident where she doubts her loved ones positive feedback about her academic progress. This is another example of impostors’ phenomenon because she discredits her intellectual ability despite her academic success and accolades. It is evident that her perception of self is quite different from her reality.

Aprille: But yeah, that's the support system we lived in, really helpful. Cause some days, most days, "Why am I doing this? Why am I here? Do I really want to do this as a job?" But then it's like, "What else would I do?" (laughs).

Aletha: What's the other alternative?

Aprille: Yeah, I'm just like, "I don't know." And yeah, it's just been very difficult. Even going to friends outside of my major. They always try to hype me up, which is good, and then I feel kinda bad cause I'm like, "I'm not really that smart though." (laughs) My boyfriend will always, every time he introduces me to his friends, he'll always be like, "Yeah, she went to Jackfruit University [an Ivy League school] for research, she's so smart blah blah." And I'll be like, "Awww" but at the same time I'm like, "But I'm really not that smart!" Do I even deserve all the support cause I feel like I'm still struggling, every day it's a struggle. So yeah. But like Aletha said, once I get out it'll just be better (laughs). It'll just be no more grades and all that. Even though you still have to do your best and work hard and stuff, and it's a different dynamic at work, I feel like it'll just be better. Hopefully. [Pain in voice throughout statement]

Mae: Sometimes I feel like people in other colleges don't go through what we go through.

(SC1 Audio, pp. 57-58)

Aprille looks to her future career endeavors as her motivation for academic persistence. The struggle she endures each day in her academics makes her doubt herself, but she reassures herself that the experience will be different once she enters the workforce. Aprille also mentions being
hopeful, which is a connection to her faith in positive future outcomes. Similarly, Aletha (4th year, Junior, Chemical Engineering) describes her program as a “love-hate relationship”.

Aletha: And it's kind of hard, but I feel like if you have a purpose, if you know where you're going and I know like for me, I really have that stand firm, like I like the medical field but I kind of like lost my hope in it, and energy like, I like it still, kind of, whatever. You know where you're going, that will help you through, but not knowing just makes it a lot more hesitant and a lot harder I guess, overall. But it's been okay, it's a love-hate relationship with Cobb, and when I graduate I will definitely be proud that I made it and our GPA's are still on point and we're not like 2.0 or whatever, 3.5 or higher, so that will be great.

But I don't think I want to go to graduate school for engineering, like, I'm done. You know med school, I can love med school or like business school or something else, but it's just a different type...you have to be...it's not my breed it's not for me anymore, it was good while it lasted.

(SC1 Audio, p. 47)

Although Aletha will academically persist through the completion of her undergraduate degree and be proud of her success, she clearly states that she is not interested in pursuing graduate level education in the field of engineering. Similarly, Erica (3rd year, Senior, General Mathematics) revealed during the member checking that she will be pursuing graduate level education, but it will not be in the field of Mathematics. Even still, Erica values her choice in selecting mathematics as her major. When asked what motivates her to stay in her program, Erica responded:

Erica: I don’t know I guess because I'm so close to the end and it motivates me to finish it. But I guess also just the knowledge of like I did it. What motivates me as well is me as a Black female I did math and like there's not a lot of Black women in that field and it is a tough major regardless of your intersectionality. I feel like it’s okay if I can do it then I can do like almost anything.

(LSC Audio, p. 9)

Erica honors and values her intersectional experience as a Black woman pursuing an undergraduate mathematics degree. Erica values her persistence to degree completion because she it empowers her to have the agency to successfully pursue anything that she chooses. When I
asked Erica if her institution or the mathematics departmental climate influenced or motivated her to remain her program, she stated:

Erica:  No, I wouldn’t say they’ve influenced me to stay, I just feel like for me I’m a person, like once I start something I kind of got to finish it. I had thought, what if I do switch? But I never really gave it too much thought. I guess because I don’t know, I really don’t know actually. I don’t really see the point in quitting to me so it’s not like, well it is kind of quitting. I wouldn’t really say anyone else has influenced me more than I’ve influenced or motivated myself to finish it.

(LSC Audio, p. 9)

Erica did not feel her academic persistence motivated her to stay or leave her program. Instead, Erica was self-motivated and determined to excel and achieve her goal of degree completion. She made it clear that quitting was not an option. Although changing her major crossed her mind, she never seriously pursued an alternative option. Persistence until degree completion was the only option for Erica and she was successful as she completed her degree during the spring 2017 semester.

In this section I described the individual/personal effects of the academic climate on the participants’ experience. Despite their achieved success in their undergraduate engineering and mathematics programs, they continue to doubt the possibility of being perceived as competent (McGee & Bentley, 2017). Even with their extraneous efforts to maintain their academic status and success (e.g. independently obtaining and participating in summer research opportunities and summer internships, scholarships, taking on leadership positions, and maintain high GPA’s). In the next section I will discuss acts of resistance displayed by the participants in order to combat the academic climate and preserve their academically persistent status and overall well-being.

**Survival Mode: Developing Methods to Resist and Survive in the Academic Climate**

To begin this chapter I described the first finding, systemic oppression, as it was embedded in the practices and policies that reproduce an unwelcoming academic climate in the
participants undergraduate engineering and mathematics programs. I then discussed the second finding, which explores the individual/personal effects the academic climate had on the participants’ experience as it forced them to negotiate self-doubt pertaining to the selected current academic program being the appropriate route to obtaining their future career endeavors. Thus, in this section I present the participants response to the academic climate, which revealed methods of resistance to manage the threat of stereotypes and support their persistence in their program as they maintain a “high achieving” student status. McGee and Martin (2011) describe stereotype management as a strategic response to the continuous existence of stereotype threat. Three major themes emerged in this finding that revealed the participants’ implementation of stereotype management to challenge the ever-present academic climate, including 1) professional persona, which yields two sub-categories including a) the superstrong Black woman and parasocial mentorship and b) the depiction of their identity was essential to their academic persistence. The participants also developed 2) opportunities for peer bonding and sense of community. Two sub-categories arose in this theme, a) extracurricular activities and organizations and the participants embrace of b) sistahood. I conclude with the participants display of resistance through 3) academic opportunities and using them as motivational tools.

**Professional Persona**

Another theme that was evident in the data was the need for the participants to construct a professional persona in order to perform their task and interact with peers as undergraduate engineering/mathematics majors. I will unpack this theme by grouping the findings into two sub-categories. To construct a professional persona the participants, describe: a) using a parasocial mentorship relationship from popular culture to help them navigate oppressive structures in their
programs and b) hide parts of themselves as a method to navigate the competitive and alienating culture of their programs.

**The superstrong Black woman and parasocial mentorship.** Mentors can come in many forms but are inclusive of those individuals that help one to reveal and demonstrate a reality, recommend a course of action, or to ponder an alternative viewpoint (Hamlet, 2015). Offered by Horton and Wohl (1956) and cited in Blight (2016), Gleason, Theran and Newberg (2017), and Hamlet (2015), a parasocial mentorship relationship is a one-sided relationship where one person extends time, interest and emotion toward the personae while he or she is completely unaware of the other’s existence. …The fictional character is the one whom the viewer develops the parasocial relationship with often resulting in the viewer’s feelings as if he or she knows the personae as if they were friends. Movies and television programs are instructive and full of liberating potential (Hamlet, 2015, pp. 302-303).

Mae (3rd year, Junior, Chemical Engineering) referenced her parasocial mentor throughout the *Sista Circle* Unity Getaway, particularly when she presented her Vision Board and again during the *Sista Circle* discussion. In this portion of the *Sista Circle* discussion the participants are discussing incidents of discrimination that have occurred within their programs. To give context to the mention of a parasocial mentor, I will first share a segment of the conversation that occurred prior to this portion of the discussion.

**Aletha:** I totally agree with speaking out. I feel I need to definitely work on this more, and I know when I talk to people I know, stuff that gets me I seem more passion about it or I get heated, but in the moment I’m not that way, because you know how sometimes you do things and then you’re perceived one way and it affects your whole … I don't want that to happen and so that's what I'm afraid of.

I know last, well not last year, but in October, whatever, I wore out my natural hair and my renter or my owner said like, "Oh, were you electrocuted?"
In this example Aletha (4th year, Junior, Chemical Engineering) shares her experience with microaggressions in the *Sista Circle*. Racial microaggressions are defined as everyday racism that is demonstrated in covert, restrained, indirect and ambiguous ways (McGee & Bentley, 2017; Perez Huber & Solórzano, 2014). Perez Huber and Solorzano (2014) provide an in-depth definition of microaggressions, which they describe as:
(1) verbal and non-verbal assaults directed toward People of Color, often carried out in subtle, automatic or unconscious forms; (2) layered assaults, based on race and its intersections with gender, class, sexuality, language, immigration status, phenotype, accent, or surname; and (3) cumulative assaults that take a psychological, physiological and academic toll on People of Color (p. 6).

Aletha acknowledges her desire to speak up for herself when these situations occur but simultaneously has an underlying fear of confirming the angry Black woman stereotype by speaking out against the occurrence. Pierce (1995) stated, “The most baffling task for victims of racism and sexism is to defend against microaggressions. Knowing how and when to defend requires time and energy that oppressors cannot appreciate” (p. 282). In this case, Aletha expresses her desire to develop a professional persona so that she can respond to microaggressions and inappropriate incidents when she is faced with them without being viewed as unprofessional. Aletha continues the discussion:

Aletha: Yeah, but speaking out, I feel like it's worth it. Some people do need to be checked, and that's not okay. If you do that to me, don't go do it to someone else. 'Cause that, it's not okay, so I want to learn how to do it.

Mae: I'm telling you! Watch Scandal!

Aletha: Just like, someone who, yeah, who doesn't keep the [crosstalk 00:47:54]

Mae: Like that's the only reason why I want to improve my vocabulary just, so I can be able to say all these different words, you might not even know what I'm talking about, but you know I'm going off on you! And then I leave so professionally.

(SC1 Audio, p. 23)

As the conversation developed the participants shared resistance, as they did not want to fall prey to being a victim of stereotype threat by refraining from challenging these instances of discrimination and disrespect when they occur. Stereotype threat is when a situation (e.g. engineering/mathematics course) prompts the judgment of an aspect of one’s social identity (e.g.
race, gender) through the lens of negative group-based stereotypes, also described as a social stigma (Abdou & Fingerhut, 2014; Bush, 2013; Larnell, Boston & Bragelman, 2014; Martin, 2009; McGee & Martin, 2011; Scott & Rodriguez, 2015; Smith, Brown, Thoman & Deemer, 2015; Solórzano, Ceja & Yosso, 2000). Specifically, Aletha speaks about her fear of confirming a negative stereotype relative to her identity as a Black woman. As a solution, Mae responds by reiterating her desire to acquire characteristics embodied by Olivia Pope, the lead character on the popular television series Scandal (Rhimes). I will now give context to the reference of Scandal by providing a brief synopsis of the television series. Hamlet (2015) describes the series:

Scandal is a political thriller television series that takes place in Washington, D.C. and focuses on Olivia Pope. Pope is the head of Olivia Pope and Associates, a crisis management firm. She and her staff are known as “gladiators” who have dedicated their careers to protecting the public image of the nation’s elite, including the president and White House staff. Prior to forming her own crisis management firm, Olivia Pope was the White House Communications Director. She’s also the president’s mistress (p. 313).

Hamlet (2015) goes on to describe how Scandal is connected to her personal life as she mentions feeling empowered by every word that Olivia Pope speaks. Hamlet (2015) suggests that every woman that is a fan of the show Scandal probably shares this conclusion of empowerment through her dedication to the television series. She explicitly states, “We [all] aspire to be more like Olivia Pope” (Hamlet, 2015, p. 314). She describes her characteristics as beautiful, intelligent, feisty, skilled in the rhetoric of argumentation and can communicate powerfully with anyone. Olivia has a swagger that demands respect. Her public persona is a model of proficiency, efficiency and grace. She is always
impeccably dressed. Her personal life is in disarray unfortunately because she has not devoted much time to developing one. But in many ways Olivia Pope represents many professional women (Hamlet, 2015, p. 314).

Pope serves as a parasocial mentor to Mae because Mae seeks to emulate her characteristics in order to develop a professional persona to support her in navigating academic settings with a mission of maintaining a mutually respectful environment for all its contributors. This view aligns with Jordan (1981), who said,

I cannot be expected to respect what somebody else calls self-love if that concept of self-love requires my suicide to any degree…you cannot expect me to respect what somebody else identifies as the Good of The People, if that so-called Good (often translated into manhood or family or nationalism) requires the deferral or the diminution of my self-fulfillment (p. 144).

I highlight this quote because the author connected the importance of self-respect and respect for others as simultaneous functions, which is key to the notion of respect discussed by the participants in this study (Hill-Collins, 2000). Overall, Mae learns to develop her own identity relative to popular culture character Olivia Pope in the television series Scandal. Through the stories of parasocial mentors we learn to endure, honor or exert ourselves in ways we may not have otherwise considered (Hamlet, 2015).

The depiction of my identity is essential to my persistence. Now I will discuss the ways in which participants hide parts of themselves to navigate the competitive and alienating culture of their programs. Often women in STEM disciplines adopt practices that align with the cultural norms and beliefs of their occupation (Rhoton, 2011). This was a salient theme in the data as the participants discussed how they present themselves in public and private settings.
Participant Aprille (4th year, Junior, Chemical Engineering) describes the freedom to be herself and outspoken on social media platforms but she shifts for academic settings. Aprille uses a professional persona in academic settings, which differs from her personal life and her social media presence. Specifically, Aprille refers to her “shell”, a term used to describe her ability to hide parts of herself in order to function within this setting.

Aprille: Yeah, I'd say the same. The social media part, though, I would say I'm more outspoken. Just in terms of what goes on my page or what goes up wherever, my story on Snapchat, whatever. I feel like I'm more outspoken there than I would be in person. Or at school. Yeah.

Mae: Why do you think that is?

Aprille: Why? Usually, people don't really like comment, I guess, and I feel like it's more for me like an open platform to like, express myself. So, I get to say what I want and do what I want unless I step on somebody's toes, which happens sometimes. I'm just like, it's my page, so you can remove yourself, but more about in person it's ... or like at school, or at work, or whatever, I try to maintain that whole shell, where it's just kind of like I talk to most people to get stuff done.

Mae: But never really let them in.

Aprille: Yeah. Of course, there are exceptions, obviously, but, mostly...

Researcher: So, what are the exceptions?

Aprille: Aletha.

Researcher: I already knew what she was talking about, I just wanted to hear her say it. You [referring to Aprille] knew, she [referring to Aletha] didn't though.

Aprille: And, a few select people. But, otherwise, yeah, like they said, I just try to keep my focus at school. Lately, it's been kind of difficult. It's just been like, is this gonna be over soon?

(SC1 Audio, pp. 12-13)

It is evident in this section of the data that Aprille only shares her full identity with a select few in this academic setting, being inclusive of Aletha. This speaks to the strength and importance of their bond as they navigate this space together. Later in this section I discuss the theme peer bonding, in which I provide more detail on the bond between Aprille and Aletha. Similarly, Mae
(3rd year, Junior, Chemical Engineering) describes the experience of being in non-engineering environments and her peers feeling the need to establish a hierarchy of intelligence by comparing their level of intelligence to how Mae presents herself in her personal life. There is an unspoken expectation for Mae to exemplify perfection at all times, but Mae feels that she is human and therefore reserves the right to be multi-faceted. Mae is being put in a box in this regard as she is often viewed as one-dimensional when in reality her identity is dialectical (King, 1988), multi-dimensional (Hill-Collins, 2000), and should be embraced and explored in its complexity.

Mae: When sometimes I act, I'm not going to say dumb, because we're not dumb. But goofy. And just silly, and just say anything that comes to my mind. So, like, my friend will be like, "what? You know this, and this, and this." And then they'll think that in a way, they have something over me, because, "Oh, I knew this, when she didn't. And she's supposed to be a chemical engineer. So that means, I'm hot shit in this area." You know?

So, it kind of like, then they try to condescend you, sometimes in certain areas. And I'm just like, but if you really put it out on paper, and if we had to do a problem, guess who would do it first? Don't play with me like... at the end of the day, like, I want to be this way when I'm not at school. Accept me for who I am and the way I want to be, and the way I want to portray myself right now. Let me live, like you said.

And then when I go to school, I'll be smart, you know? I don't have to be smart all day. There's different facets of me. So, I shouldn't have to be just one dimension for you. So, in my personal life, sometimes I feel like, I'm definitely goofy, and I'm definitely not at school. Like, I'm not as goofy at school. Because, I feel like at school, you kind of have to act your major or whatever.

Aprille: Act your major.

Aprille: Good one.

Mae: I feel like that. I feel like I have to act my major at school, so even if I'm talking to other engineers, "okay, well what courses are you taking?" Then we start talking about courses, and classes and professors, research. And it's just like, we never have a break to just chill or talk about something silly or not engineer related.

(SC1 Audio, pp. 36-37)
Mae’s statement is evidence of shifting from personal self to professional persona and how this takes a toll on her. In the concluding statement we see the participants agree that the professional persona is an unspoken rule that they must perform or “act their major” at all times. In the case that they don’t “act their major” they will be exposed as normal, or less than perfect students. Although the participants express their efforts to hide parts of themselves in Engineering/Mathematics course settings in order to maintain a positive image of their academic standing, we see where this effort deteriorates in other academic and social settings. Outside of Engineering/Mathematics course settings, the participants resist expectations of perfection and characterize such expectations as unnecessary, exhausting, and a method of alienating them in yet another environment. Aletha (4th year, Junior, Chemical Engineering) depicts a similar sentiment as she describes the advantages and disadvantages in considering ones’ self differently in a private versus a public context.

Aletha: For me I think the main advantage, like Aprille said, is that you can show people a little bit of who you are. I like, I love that because you don't expose yourself to hurt like all of the hurt all at once I guess. So, like choosing what you can expose, I feel like is very beneficial. Even though it does have some downfalls as well. So, like that's an advantage, like just letting people see a little bit of you. Like if you're not in that realm they don't know much more about you, so they can't like attack you from different ways.

Whatever...What's a disadvantage? A disadvantage is that you're not able to be like open. So, you know how like sometimes you're in a setting, but you want to talk about something else? The setting doesn't necessarily mean that's what you have to think about, and so you can't be open because they don't know that part of you. So, it's like all a surprise. Oh, you think this way, or whatever, and kind of way. So, it just detracts you from being like your full self. Like you're saying, and um fullness is what we strive for in life. You don't want to live life in parts per say, yeah. Don't have too many faces, just

Researcher: Because you are enough.

Aletha: Yeah. Exactly, like what you bring should be enough for every situation. For every person, it shouldn't matter. So that's a disadvantage, and just learning how to bring those two together.
Researchers: Uh huh.

Aletha: Because people don't deserve to know everything all at once, but you definitely want to make sure that you're not doing. Like you're not holding back because of somebody.

Researchers: Uh huh.

Aletha: Like bring...be full, be 100% all the way. Whatever you want to be, so.

(SC1 Audio, p. 43)

In this section, Aletha points out her desire in life for “fullness”, which she describes as entering each space as her full self and not having to hide her identity to appease others. She states that who she is and what she brings should be good enough for every situation. She extends this idea to others, offering that every person should be considered as good enough just as they are.

Aletha’s expression of fullness emphasizes her desire for acceptance of her full self. However, as a means of protection Aletha feels that she reserves the right to withhold elements of her identity until she feels comfortable with sharing more of herself, especially given the competitive nature of the program. Aletha makes a clear distinction between withholding your identity to make others comfortable as opposed to withholding until you feel comfortable to share more of your identity with others.

In each case participants expressed resisting the competitive culture of the institution as a means for survival. Aletha displayed her sense of agency as she negotiated her identity by hiding parts of herself as a method of resistance to support her as she navigates the competitive culture of the institution. This negotiation of her identity is a form of liberation displayed by Aletha as she chooses to self-define in spite of the hostile academic climate (Hill-Collins, 2000). Hill-Collins (2000) describes this dual consciousness of Black women, in which they ‘become familiar with the language and manners of the oppressor, even sometimes adopting them for some illusion of protection’ (p. 114), while hiding a
self-defined standpoint from the prying eyes of dominant groups. …We’ve always had to live two lives—one for them and one for ourselves (p. 97).

Additionally, Aletha acknowledged the disadvantage of not being able to enter this academic space as her full self. Although the process of withholding parts of her identity is emotionally taxing, I want to highlight here that Aletha’s desire for acceptance of her full identity is a display of her self-valuation (Hill-Collins, 2000).

I describe this as quite the paradox because the women are forced to hide portions of their identity in order to present themselves in a “professional” way and survive, in spite of the hostile academic climate. At the same time, people often assume their identities are one-dimensional, an assumption that dehumanizes them. This is problematic because the academic climate forces Black women into these one-dimensional depictions of their identity. However, this is a display of their sense of self-worth, because they deflect the personal attacks on their identity and attempts to classify them as inferior (Hill-Collins, 2000). Williams (1987) perfectly articulated this phenomenon, as she describes Black women as “irrepressible. She is insulted, but she holds up her head; she is scorned, but she proudly demands respect…. The most interesting girl of this country is the colored girl” (p. 151).

Although the participants demonstrate self-valuation and self-definition as they negotiate their professional persona, I think it is useful to transition this discussion to the overall well-being of the participants. It is relevant to return to the discussion of Olivia Pope and Scandal. Although Pope persists in her career with extraordinary skill and grace, it is consistently evident that embodying these characteristics is emotionally taxing and negatively impacts her overall well-being. This raises the concern of whether or not maintaining a professional persona will have a negative effect on the overall well-being of the participants of this study.
Peer Bonding and Sense of Community

In this study, the participants described opportunities to bond with their undergraduate peers and their desire to have a sense of community in their respective engineering and mathematics disciplines. When present, these opportunities within the participants’ undergraduate experience helped them to persist academically and positively influenced their overall well-being. In this section I discuss the participants a) extracurricular activities and organizations and a discussion on b) sistahood.

**Extracurricular activities and organizations.** Organizational support provided a sense of community within this academic space for the participants in this study. Participants Aletha (4th year, Junior, Chemical Engineering) and Aprille (4th year, Junior, Chemical Engineering) made mention to their participation in the National Society for Black Engineers (NSBE) as an outlet for Black students to receive support as Engineering majors. Aletha and Aprille were the only two participants that expressed being active members of this organization. Specifically, when I asked Aprille about her Engineering peers being invested in her success the discussion of NSBE arose. Aprille stated:

Aprille: It's like an investment to a point. Except maybe like in NSBE where we try to help other people out, more professionally obviously before caucus', but like, otherwise, they're like ... Your peers, especially in our class in particular, absolutely not.

Researcher: So, what kind of support do you get with like NSBE when you're talking about, like, you help…

Aprille: So, we go to regional and national conferences, so we usually try to do resume workshops, or elevator speech pitches before we go.

Researcher: That's really good.

Aprille: And we do it with each other, sometimes. Yeah, so for the conference, we try to hype each other up, like, "You can do it. Yeah."
Researchers: Yeah, yeah.

Aprille: Or be like, "You got seven interviews! How did you do that? What was the magic you put on these recruiters?" Things like that, but otherwise, it's tense like this, really. It's like to an extent, really. It's like, "Oh, I'll help you with this assignment. I'll tell you how to do it," or whatever, but it's not like let's sit here all together and work on it.

(SC2 Audio, p. 9)

Although NSBE was limited in its ability to provide content specific support to the participants because it was not focused specifically on Chemical Engineering, it did provide Aletha and Aprille access to professional opportunities and exposure to presenting their research at regional and national conferences specific to their field. Additionally, Aprille emphasized how the other NSBE students build each other’s ego up to reiterate the “magic” they embody and share with others, even in professional and academic settings. The point I am making here is it is evident the NSBE students view each other as magical on a personal level, but they are fascinated at each other’s success and ability to adapt this magic from personal into their academic and professional life as well. NSBE functions as a system of support that builds Aprille and Aletha’s confidence and is a positive experience to their overall well-being.

Katherine (3rd year, Senior, Applied/Computational Mathematics) also made mention to a support system that builds her ego up in order to reiterate her magic. However, Katherine’s support was accessible outside of her institution, as she found this outlet in the church. When I asked Katherine, what influenced her to pursue a degree in mathematics, her response was:

Katherine: Well, at church, people always hyping me up. I'm in a community with immigrants, and children of immigrants, and for the most part, their children don't do well for themselves. Their children are always trying to be, I guess, product of your environment. It can go either way. You take the bad parts, or you take the good parts. So, when I get to church, people are just like, "You're so bright. You're in school, and all this stuff." So, it kinda like hyped me up, and I was trying to decide what I wanted to study. …

(ASC1 Audio, p. 5)
Katherine highlights her church being essential to her decision to become a mathematics major. This was a space that she could rely on to always provide positive feedback on her student success. She is seen as a model student in her community for academic success and persistence. Katherine characterized this experience as a positive influenced to her overall well-being as it supported her confidence, but also supported her academic persistence since this experience she recognizes influenced her decision to pursue a mathematics degree.

**Sistahood.** The term sistahood is derived from the term “sistas”, commonly used in Black dialect and Black spaces (e.g. churches) by Black persons to refer to Black women (Browdy, 2017). A sistahood refers to a sisterhood among Black women. By virtue of African American women’s sistahoods and friendships, affirmation of one another’s uniqueness, compassion and right to exist cultivates (Browdy, 2017; Hill-Collins, 2000). This served true for Aletha (4th year, Junior, Chemical Engineering) and Aprille (4th year, Junior, Chemical Engineering) as their bond was vital to their survival as chemical engineering majors. Aletha explains:

Aletha: I feel like for me my engineering experience if I didn't have my support system I would've been the worst person ever coming out. That's not right. Finding Aprille, going to class together and we know each other's struggles and stuff and we can see things and whatnot. It's so key. Overall just making sure that you're happy when you come out of it and you have an awesome support and that's great.

(SC1 Audio, p. 52)

Aletha and Aprille share the experience of navigating their undergraduate engineering majors. This experience helps them to understand one another’s struggle deeply. Similarly, Hill-Collins (2000) declares your sista is the listener most capable to afflict the invisibility constructed by Black women’s objectification. It seems that this holds true for Aletha and Aprille as they navigate their program.
In Aletha’s (4th year, Junior, Chemical Engineering) description of her ideal institution she states her interest in joining a sorority. Aletha is aware that sororities grant one access to sistahood on a larger scale. Specifically, Aletha was referring to Black sororities in her statement. Black sororities are well known in Black communities for the establishment of strong, lasting relationships among Black women across the nation. Aletha explains:

Aletha: Better interaction with the students. More of a family, like you said. I feel like my ideal undergraduate experience I wanted it to be a lot more fun, funner, that it is now. I wanted to join a sorority. I guess even to have that sister like comradery with people. Obviously, engineering doesn't provide that as much as that. And then just to feel like you find yourself. You find yourself growing instead of backsliding, and just dying and doubting yourself. I know engineering has created a whole bunch of doubt for me and just a lot of life questions. So, I detracted and tried to go forward.

(SC1 Audio, pp. 86-87)

Aletha acknowledges that the college of engineering lacks such companionship, but she believes this type of environment would alleviate feelings of regression and self-doubt that are inevitable given the academic climate.

Although Aletha and Aprille have successfully developed a supportive sistahood between them, the Eurocentric and masculine practices that permeate in undergraduate engineering and mathematics disciplines make this a nearly impossible task. Mae (3rd year, Junior, Chemical Engineering) describes individualistic practices infiltrate undergraduate engineering and mathematics disciplines, which simultaneously hinders the development of strong bonds among Black women. Mae proceeds to also make correlations between Black sororities and their effectiveness in fostering strong bonds among Black women. Mae continues:

Mae: I think we're all in our own lanes sometimes and it's kinda hard to just come out of it, especially when you're not forced to, like in a sorority. You're forced to hang out with your sisters, and stuff like that. When you're not forced to it, it's even harder to try to like, let me get out of my own zone for a second and go talk to someone else, and go converse with someone else.

(SC2 Audio, p. 14)
Mae makes the connection that sistahood must be a common goal or objective in the program if it will be successful (Perna et al., 2009). It is evident that Mae desires an environment that fosters and values a sense of sistahood, to develop a supportive peer culture that potentially strengthens Black women’s representation in engineering and mathematics disciplines (Perna et al., 2009).

**Sisterhood.** Erica (3rd year, Senior, General Mathematics) discussed a sisterhood bond that she shared with a White woman undergraduate mathematics major. Erica explains:

Erica: Also, my friend Tiffany who is a math major with me. She also is very supportive, and I can talk to her about anything that’s going on and she’s usually there to help me with the math as well but just in general talk to her about daily life and stuff like that. … I would say my friend Tiffany is invested in my success and I’m invested in hers because we have such a close relationship but everyone else that are in my courses and stuff I don’t feel as though they are invested in my success as well as much as they are in their own.

(LSC Audio, p. 13)

Erica developed a supportive lasting bond with another student in her program, Tiffany. Erica and Tiffany were able to take their courses together, discuss their course challenges, and engage in general discussions about life. Erica distinguishes the difference between her bond with Tiffany as opposed to her relationship with other mathematics majors in her program. Other mathematics majors are not invested in her student success unless they are working together to complete a specific assignment or test for a course. This sisterhood relationship between Erica and Tiffany positively influenced her academic persistence and overall well-being.

**Sista circle discussions support students’ awareness.** As the first sista circle concluded, the participants expressed feelings of liberation due to their participation in the sista circle unity getaway. On the first day of the getaway the participants shared their experiences with one another, independently, in the vision board collage, and over dinner during the first sista circle. After this experience on the first day, the participants highlighted being enlightened to their
experience as a shared experience. Specifically, Mae (3rd year, Junior, Chemical Engineering) expressed her realization that she was not alone.

Mae: Yeah, I think like you said, talking about it just makes it real. When you talk about it, it now exists, instead of not saying anything about it, and then people are going to be like, well this doesn't make sense, but when you actually converse about it and bring it out to open discussion, you really see what we call experience. We saw so many things that we each related to, and each other’s stories, it just shows how big of an impact whatever we experience has on all of us. This university has a big impact, and usually when I talk about ... My field and all that stuff, I don't get so melancholy, so somber, but when we were talking about it, I literally felt like, damn, where'd the joy go in the room, you know? Like, damn ... Tough. I could, you know ...

Researcher: You’re like, “can we go back over to the vision board collages?”

Aletha: Yeah.

Everyone: [laughter]

Mae: Damn, it just got real. We all, at one point, it was a moment of silence and we're just like, wow ... This is real, and it sucks because it's like, damn, does everybody experience this? Because, I didn't know we had it that bad until we started talking about it. Then, that's really ... That really sucks on its own thing, because once you start talking about it, it becomes more apparent, and then you're like, well, how do you change it? Then, that's a whole different discussion, which takes freaking forever.

Aletha: Yeah.

Mae: So, change can happen, but good God it takes forever. So, just to think about how Martin Luther King and all around it, and all that, and it finally made a change, I was like oh my God. It literally took a force of nature to change the whole country.

(SC1 Audio, pp. 96-97)

Mae attributed her enlightenment about her program structure to her participation in this safe space that allowed her an opportunity to share her experiences with other undergraduate engineering majors who have similar social identities. Prior to her participation in the sistar circle unity getaway, she was uncertain as to whether or not her experiences in her program were related to her social identity. However, after hearing the stories of other Black women
undergraduate engineering majors, she was assured that her experiences were classified as discriminatory and evidence of a toxic department culture. Mae concludes her statement with curiosity about the process towards change in engineering and mathematics fields.

It is relevant to note that as I struggled to recruit participants for this study, I sensed it was in part connected to my straightforward request for Black women as participants. However, this hunch was confirmed when one of the participants directly expressed a similar sentiment in her pre-interview. Mae (3rd year, Junior, Chemical Engineering) expressed her initial hesitation in participating in the study, which she attributed to a concern of being segregated from the larger group of engineering and mathematics majors just because she was a Black woman. As the researcher, I explained this misinterpretation was a deficit understanding (i.e. segregated as opposed to solidarity) of the intent of this study. Instead, my goal was to provide a safe space for the practice of our solidarity as Black women. I highlight this incident because labeling Black women’s relationships and solidarity as a ‘separatist’ practice, further dismantles our opportunities for sistahood, a comfortable environment with other Black women who share similar experiences and viewpoints (Browdy, 2017; Hill-Collins, 2000). It was evident to me that a White male supremacist ideology of separatism permeated the characterizations of Black women’s relationships in this predominantly White male space (Browdy, 2017; Hill-Collins, 2000). Black women must unapologetically embrace sistahood relationships because our solidarity is a daily practice of survival and coping with oppressive structures that surround us (Hill-Collins, 2000).

**Academic/Educational Opportunities**

A major theme in the study was academic opportunities as motivational tools, which include internships, research opportunities, and scholarships. These opportunities granted the
participants access to international research opportunities and insightful internships that allowed
them a firsthand experience with the workforce. As mentioned early in the study, participants do
not have access to many resources for academic opportunities within their department but have
been proactive in identifying opportunities independently that will enhance their undergraduate
experience. A primary advantage of engaging in these academic opportunities is that the
participants discovered the differences between their coursework and the requirements for
research and the workforce. Given the challenges and barriers presented to participants as they
navigate their undergraduate programs, participants embody the prove-them-wrong syndrome as
they pursue academic opportunities to enhance their experience and career. Prove-them-wrong
syndrome serves as a sub-category to this major theme and is defined as when students “work
harder in reaching their goals while, at the same time, ‘proving their critics wrong’ when they
doubt their ability to perform” (Moore, Madison-Colmore & Smith, 2003, p. 70).

When asked about the students in their engineering and mathematics courses investment
in their academic and professional success Aletha (4th year, Junior, Chemical Engineering) and
the other participants became struck by the question as if it was unreasonable or odd to ask.
Aletha explains that some peers will help you out with classwork but seeking out professional
experiences is something one must explore independently. In fact, academic opportunities help
foster the competitive nature of the department.

Aletha: Yeah, I think it's two-fold. Like, invested to a point, and so, yeah, they'll help you
out, and I'm grateful. [inaudible 00:17:51] is really cool. Like, he'll help us out
and get us farther than we were before, but as far as professional and stuff, it
kinda gets more competitive when professional. It's like people ... When you're
like, "I got an internship at this company," they'll be like, "Oh, good for you."
Just like that smile and stuff, so it's very competitive trying to get a job, and stuff.
Everyone's looking out for themselves for say, a career person, but invested to a
point, I'd say, to help each other out, but not to be successful, I guess. Just to get
through the program.
Mae: Together.

Aletha: Yeah. And then after that what you do with it is what you do with it, I guess.

Just some people really encourage you, like older chemical engineering people who are graduating this year, they encourage me to get through it and that I can, but that's all they give. So, invested to a point.

Mae: I agree.

(Sc2 Audio, pp. 6-7)

Students do not help each other identify and obtain professional opportunities. Students are invested in each other in order to complete their undergraduate program and to offer words of encouragement in some cases. However, this investment does not extend itself to career opportunities.

Mae (3rd year, Junior, Chemical Engineering) describes what motivates her to persist in her program of which she explicitly names extracurricular activities, specifically research opportunities as a primary source. Mae states that she struggles each day to remain motivated to complete her degree. However, lately when she gets down about school she thinks about the upcoming summer research opportunity she has in Greece.

Mae: I want to add, too. I never, like how you kind of said it, like you're more focused, but lately it's just more like ugh. I'm gonna say, it was just like that for me last semester. I just couldn't wait to get through with the semester, like ugh. I just couldn't stand school at that point. Even the research I was doing, I was like I still don't feel fulfilled. Why don't I feel fulfilled? I'm angry, 'cause I don't feel fulfilled.

But, now I look forward to the summer, 'cause I have the opportunity to go somewhere this summer, to Greece, and shadow doctors.

Aletha: Oh snap, that's awesome.

Mae: Thank you. So, every time I wake up, and I go to school, I'm always thinking about to do lists, to do lists, to do lists, so it is never a moment where I can just chill at school. I'm always going somewhere and doing something. So, in a way, that has helped my motivation, 'cause last semester, I was the same way. I was
like, I cannot wait to get this year over with. But now, it's kind of like the whole Greece thing, and then research is kind of picking up, so it's actually helping me want to actually do good, and me wanting to stay on campus all day, just to study and do whatever I have to do. I think the extracurriculars it's what's motivating. School focuses me, but the extracurriculars is what motivates me.

(SC1 Audio, p. 13)

Mae uses this research opportunity in Greece to keep her driven and motivated to work hard and thrive in her program while maintaining her focus. Also, seeing that Mae sought out this research opportunity independently, this action in itself combats the departmental climate and I think her desire to be proactive about her success is directly connected to her demonstration of prove-them-wrong syndrome. Another example of prove-them-wrong syndrome is evident in a discussion with Aprille (4th year, Junior, Chemical Engineering). Aprille spent a summer at Jackfruit University [an Ivy League school] for a research opportunity in which she created a drug delivery device. Aprille describes the experience of students devaluing the skillset and dedication it takes to obtain an Engineering degree.

Aprille: And then what kills me is when people try to downplay ... Because it does take a certain type of person to be an engineering major. You can't just be slacking off, you have to be working all the time basically. So that definitely does take a type of person. If people try to downplay that, for example that man at Tau Beta Pi, "Oh chemical engineering is not that diverse, ha ha ha." Or for example when my boyfriend was complimenting me about Jackfruit University [an Ivy League school], and this one girl that was there she was like, this white girl, "Oh so when did you graduate from Jackfruit University [an Ivy League school]?" And I was like, "Oh I didn't graduate from there, I just went there for a program." "Oh so he was lying?" And I like, "No, I just did a research program there." "Oh well what is your research on?" "Well I created a drug-delivery device." "Oh, okay." Turn the tables, "So what's your major?" "Oh, mass communications".

Researcher: (laughs) Not this face!

Aprille: Asking all these questions and I'm like, "Hmm so what do you even do?" Honestly. So, it's just hard to keep that sort of peace about yourself. Cause sometimes you just want to bug out.

Mae: Oh my god.

(SC1 Audio, p. 59-60)
Aprille’s remarks suggest that she interpreted this exchange as a *microinsult* (Yosso et al., 2009), based on the inquiring student’s assumption about Aprille’s academic merit. This incident is an example of a nonverbal racial microagression (Yosso et al., 2009).

When asked about motivators, Aletha (4th year, Junior, Chemical Engineering) stated that she is motivated to persist in her program based upon those who have invested in her. At the conclusion of her high school studies, Aletha received a scholarship award that has paid her entire college tuition expenses. As a result, Aletha feels completing her degree does not connect to a deep personal desire, but instead she feels indebted to those who have contributed to pay her tuition and fees and for that reason she is determined to succeed.

**Aletha:** I guess my motivation's pretty superficial, but that just tells you how much I need to find myself more, and really figure out what my purpose is, but I would say like scholarships. Someone invest in you, and the people that did, knowing their stories, they donate their own money, so I don't ever want to go to college and dropout because of that. So that's what motivates me to keep going and finish the degree whether I like it or not, or whether, Oh it's the right decision or not. Whatever. So, it's very simple and superficial, but that's what keeps me going because to let them down. Someone paid $30,000 ... It could be your parents, but for me, it wasn't my parents. It was different institution together that gave me the amount of money to go to college. Without that, I wouldn't even dare. I wouldn't want to. I would just work.

**Mae:** That's so superficial.

**Aletha:** Yeah, but it's like money ... It should be your drive to finish a degree. Like your passion for a degree. Because I see you, you have a passion for biomedical engineering and different things. Me that's not the stage that I'm at right now in order to get this degree. I'm gonna get it and stuff, but it's not really personal to me. So, I hope when I get to the stage of graduation I can be like, "okay. This is what I'm gonna do with it." And I know what I want to do, and this and this and this. So that it's more meaningful to myself and to others overall because of the impact you can do with it. But right now, I can't fail people who invested in me or gave me the opportunity to be here. Others could have had that same opportunity, so I'm not gonna let them down.

(SC1 Audio, pp. 84-85)
Aletha seems disconnected from positive thoughts that reflect the magnitude of her success and brilliance. Instead of basking in the joy of this phenomenal opportunity, Aletha carries feelings of distress due to the pressure of maintaining a standard of excellence to uphold her award. Although, her stress seems connected to a fear of failure, it is evident that Aletha is speaking from a place of empowerment because she is confident and determined to successfully persist in her undergraduate program through graduation. Mae (3rd year, Junior, Chemical Engineering) speaks up and challenges Aletha’s fearful thinking as she acknowledges how amazing the opportunity Aletha has been granted is. Mae goes on to assure Aletha that her worth exceeds this monetary award and she admires her for being a recipient of such a prestigious award. Mae continues,

Mae: It comes with a lot of pressure I feel like. I can just hear the pressure and all that. Having to want to please people in that sense because you are seen as an investment. They invest in you. It's a lot of pressure but I commend you, to be honest. From what I'm getting is you come from a background where to get an opportunity like that is once in a lifetime, you know what I’m saying. So, you got an opportunity like that, so I don't know if you should be so focused on trying not to let them down. If I were you I would be focused on just knowing that you are amazing. You stuck out enough to get an opportunity like that. Yeah, you don't want to step on people's toes, and you don't want to let them down, but girl, don't let yourself down because you did that. No one else did that but you. Yeah, they gave you the money but who earned it?


Mae: That's freaking amazing.

Researcher: Very true.

Aletha: Yeah. Thanks for that. Yeah. That's a different way to think about it. I think so far I've just been like, "okay. Gotta make sure I get the degree." Yeah. Yeah. Okay.

Mae: Outside looking in. My perspective on that is just like whoa. You're not worth $40,000. You're worth more than that. $40,000 off bat, that's huge. I wish I had something like that happen to me. I literally needed that much. Just the honor of having to say I got a scholarship or someone believes in me enough to pay my way through college, that's huge. That's huge. So, congrats.
Aletha: Thank you. (SC1 Audio, p. 85)

It serves relevance to acknowledge this moment of encouragement among participants and connect it to a benefit to being a participant in this study as they are providing peer mentorship and support to one another.

Through these academic opportunities participants were able to experience different career and research opportunities. The students often stated that these experiences were helpful because they showed them firsthand what they would be doing in the field. This was supportive knowledge and positively influenced students’ academic persistence because in those times where participants questioned whether or not their undergraduate major was worth the struggle, they used the future career as motivation to continue in their program.

Throughout this section of the chapter it is evident the participants have identified potential threats in the academic culture of their undergraduate engineering and mathematics programs. However, the participants use these threats as motivational tools towards persistence, as they refuse to fall victim to these threats (Larnell, Boston & Bragelman, 2014; McGee & Martin, 2011).

**Summary**

In this chapter I presented the major findings of this study that emerged from an analysis of the data obtained from pre- and post- interviews, the *sista circle* unity getaway, and the electronic post-*sista circle* reflection to provide qualitative findings about the characterization and perspectives of the experiences of Black women undergraduate engineering and mathematics majors at a PWI. I discussed the findings in three sections where I provided the 1) cause for concern in this study that is evident in the academic climate of their undergraduate engineering and mathematics programs, 2) identify the individual/personal effects this has on the participants
experience, and 3) the forms of resistance the participants constructed to survive and persist in this academic climate. Through these three sections I explained the eight major themes that emerged: a) access to caring professors, b) competitive isolating environment, c) variations in program expectations and reality, d) shift in academic self-concept, e) negotiation of alternatives to persistence, f) professional persona, g) sense of community and peer bonds, and h) academic opportunities as motivational tools. Together these themes shaped the undergraduate engineering and mathematics experiences of the participants in diverse ways.
CHAPTER FIVE:
SUMMARY, DISCUSSION AND IMPLICATIONS

I used Black feminist thought to guide this qualitative research study that sought to understand the experiences of Black women as they pursue undergraduate degrees in engineering or mathematics disciplines, at a predominantly white institution (PWI). I examined the characterizations, self-presentation and self-concept of the participants’ academic persistence and overall well-being in their undergraduate engineering and mathematics programs. Themes emerged about the Black women undergraduate engineering and mathematics major’s experiences, which allowed me to make meaning of the data. I conducted semi-structured face-to-face interviews with five participants and three of the participants also engaged in the *sista circles* conducted for this study. To recruit participants, I used listserv and direct email to professors and faculty in the corresponding engineering and mathematics departments. I ensured trustworthiness and rigor in this study through member checking.

I conducted an analysis of the interviews using open and axial coding (Creswell, 2014). Following an independent analysis of the data collected from research participants, eight major themes emerged: a) access to caring professors, b) competitive isolating environment, c) variations in program expectations and reality, d) shift in academic self-concept, e) negotiation of alternatives to persistence, f) professional persona, g) sense of community and peer bonds, and h) academic opportunities as motivational tools. Each of themes that arose helped me to understand the experiences and characterizations of the participants of this study.

Summary
The experience of pursuing an undergraduate engineering or mathematics degree can be a challenging experience, especially since this is a field practitioners, researchers and policy makers perceive as highly meritocratic (Martin, 2009; McGee & Bentley, 2017). Martin (2009) refers to this perception as the new racism, an insistent denial of evidence that illustrates the continuous existence of racism in order to diminish the current opportunities and life experiences of non-Whites. The participants of this study operate in the intersection of an engineering/mathematics identity and a socially constructed racial and gender identity. It was evident in this study that this intersectional identity directly influenced the way in which the participants experience their undergraduate engineering and mathematics programs. The challenges presented in this study integrated with structural racism, sexism and discrimination, possibly make the pursuit of and persistence in an undergraduate engineering and mathematics degree a distressing experience (McGee & Bentley, 2017; McGee & Martin, 2011; Perez Huber & Solórzano, 2014; Yosso et al., 2009). In this chapter, I will discuss the eight major themes that arose, organized by the research questions presented in this study. I follow with implications and suggestions to engineering and mathematics faculty, administrators and university personnel. I present these suggestions in an effort to enhance the experience, academic persistence and overall well-being of Black women enrolled in undergraduate engineering and mathematics disciplines at a PWI.

**Research Question: Experiences**

The research question that centered this study was: How do Black women in pursuit of engineering and mathematics degrees at PWIs characterize their experiences while enrolled in their respective undergraduate programs? The findings of this study provided evidence that the participants characterized challenges and barriers in their undergraduate engineering and
mathematics program experiences. Participants described the academic climate as intense, unwelcoming and uncaring, leaving them isolated and alienated within the university and their department. The participants attributed these experiences to the departmental culture, which they characterized as competitive and unsupportive with limited access to caring professors.

Participants characterized incidents with professors and students in the department as isolating, disrespectful, unwelcoming, devaluing, and provoking insecurity and invisibility. The participants highly regarded their ability to interact with professors but in return found most professors in their engineering and mathematics courses were unwilling to share their knowledge, wisdom and skillset in the field until students proved themselves worthy. This professional practice among professors of engineering and mathematics programs devalues and undermines ethics of care and personal accountability (Jones, Wilder & Osborne-Lampkin, 2013; Noddings, 2010), which have historically moved communities of color forward (Flowers, Scott, Riley & Palmer, 2015; Hill-Collins, 2000). Consequently, this professional practice demonstrates a clear acceptance of individual interest and separateness as the basis of student-professor relationships, the engineering and mathematics classroom, undergraduate programs and the university at large (Hill-Collins, 2000). Ultimately evading the potential for reciprocity that student-professor relationships produce and reproduces the hostile sociopolitical power structures that permeate the academic climate that surrounds them. Participants also characterized professors’ devotion to research, grants, and obtaining tenure, as a primary obligation that ranked above student needs. This popular practice in academia is an institutional microaggression because students needs fall inferior to professor obligations, which reiterates a lack of care within the academic culture of undergraduate engineering and mathematics programs. Professor involvement was essential to the participants’ experience (Flowers et al.,
2015; Johnson, 2012; Palmer & Maramba, 2012; Perna et al., 2009). The participants also highlighted the expectation for students to instantly recall previous and current knowledge learned within their engineering and mathematics programs. This expectation triggered self-doubt among participants because it forced students to define themselves in opposition to their classmates (Hill-Collins, 2000). This detachment among students in engineering and mathematics courses reproduced and emphasized the competitive environment within the classroom. Essentially, this diminishes the possibility of connectedness among students in engineering and mathematics disciplines, which has potential to provide the participants deeper, more meaningful self-definitions (Hill-Collins, 2000). Now I will discuss the participants’ interactions with fellow students.

Participants discussed their experiences with students in their engineering and mathematics departments. Most of the participants described being the only Black student in their engineering and mathematics courses and settings relative to their department. Two of the engineering participants took their engineering coursework together and developed a close bond. I define this bond as a sistahood, in which the participants function as a support system, friend, accountability partner, ally, and a reliable academic resource to one another. Although this sistahood bond had positive and supportive outcomes on their experiences, they characterized their classmates’ response to their sistahood as threatened. As a result, their classmates attempted to sabotage their academic progress by alienating the participants, being secretive and derogatory, which reinforced the discriminatory and competitive nature of the engineering classroom. In a discussion of settings within the department the engineering participants described a common space located in an open area within the college of engineering, designated for students to interact with one another and study. However, upon entering this common space
the participants characterized their experience as unwelcoming, intense, egotistic, unbearably awkward, and exclusive to predominantly White men students that are members of prominent engineering student organizations. These discriminatory occurrences often made the academic climate feel intense, unwelcoming, hostile and uncaring for the participants.

Participants also characterized their experiences in their programs as encouraging and discouraging. Participants characterized their experiences with peers outside of their engineering and mathematics disciplines and family as generally encouraging, although the participants expressed their systems of support were often disconnected from the engineering and mathematics programs (Shavers, 2010). The participants stated that the climate among peers within their programs was discouraging and only supportive when there was a common goal of completing a class assignment. Otherwise, the participants were rarely connected to their peers within their programs, with the exception of the two participants that established a sistahood, and Erica (3rd year, Senior, Mathematics) who sought out a sisterhood bond with a White woman that was a fellow student in her program. The two participants that developed a sistahood between them characterized their sistahood as encouraging (Browdy, 2017; Hill-Collins, 2000), since they had a common goal of high academic achievement in their engineering courses and successful completion of their undergraduate engineering degrees (Perna et al., 2009). Interactions with faculty were characterized as encouraging when professors were open, personable, genuinely interested, encouraging, cared about the students’ well-being and academic progress, provided advisement and guidance to support them in navigating their coursework and professional opportunities.

The participants discussed barriers and challenges related to academic trauma and structural oppression in their undergraduate program experiences (Mc Gee & Bentley, 2017;
McGee & Martin, 2011; Yosso et al., 2009). To combat these experiences, participants adapted to their environments through the development of methods to help them manage and resist their environment because they were determined to finish their undergraduate programs. Participants embodied a 1) professional persona 2) established a sistahood between them and 3) identified motivators as positive, reaffirming tools to support them in resisting the adverse environment. Participants developed a professional persona in order to respond to microaggressions and discriminatory interactions that occur. The participants were insistent on maintaining their professionalism in such instances. One of the participants discussed her source to develop a professional persona, in which she identified a parasocial mentor in popular culture who emulates characteristics of power, respect, success and intelligence and is a Black woman (Hamlet, 2015). The described professional persona is used to resist stereotype threat and reflect another perception that benefits the participant. This professional persona was used to hide parts of their identity to support them in navigating their program, while minimizing vulnerability.

Participants described this as a challenging and exhausting experience. Additionally, two of the participants in engineering developed a sistahood between them, which functioned as a form of resistance in their program. I characterize their sistahood as a revolutionary act because it opposes and resist the myth about women’s friendships, which is rooted in patriarchal ideologies that permeate our society (Browdy, 2017; hooks, 2000), and specifically engineering and mathematics disciplines (Leyva, 2017; McGee & Bentley, 2017; Rhoton, 2011). hooks (2000) stated the role of the male supremacist ideology in order to advocate for a liberated communal goal of sisterhood to strive towards a political solidarity among women:

Male supremacist ideology encourages women to believe we are valueless and obtain value only by relating to or bonding with men. We are taught that our
relationships with one another diminish rather than enrich our experience. We are taught that women are ‘natural’ enemies, that solidarity will never exist between us because we cannot, should not, and do not bond with one another. We have learned these lessons well. We must unlearn them if we are to build a sustained feminist movement. We must learn the true meaning and value of Sisterhood (p. 43).

The sistahood between the participants of this study challenges this master narrative because their bond is a display of self-valuation and value for one another’s individual identities as Black women engineering majors. It is evident that these Black women value and understand the true meaning of sistahood (hooks, 2000). Finally, the participants identified motivational tools to help them remain focused on their goal of academic persistence and degree completion. The participants identified professional opportunities for research and internships, scholarships, as well as their families, church family, organizations and themselves as motivational tools.

The findings of this study suggest that the Black women undergraduate engineering and mathematics majors at a PWI who participated in this study had a range of experiences that were overall characterized as supportive or a barrier to their experience as students. The participants were reactive to the academic climate of their respective programs and identified opportunities for affirmation and support as they navigated their undergraduate engineering and mathematics programs. Now I will make connections between students’ experiences and their academic persistence.

**Research Sub-Question 1: Academic Persistence**

The first research sub-question was: How have those experiences shaped their academic persistence? The findings of this study suggest that participants’ experiences as Black women
engineering and mathematics majors at a PWI, shaped their academic persistence. The participants characterized their experience as intense, unwelcoming and uncaring, which made the participants feel as if they did not belong. This threatening environment hindered the participants' academic persistence. In the previous section I described the participants characterization of their experiences as encouraging and discouraging, which shaped their academic persistence. Sense of belonging has been commonly cited as a positive influencer towards Black women in undergraduate programs academic persistence and overall well-being (Johnson, 2012; Palmer & Maramba, 2012; Strayhorn, 2015). Sense of belonging refers to feelings that members matter to one another and the group, a person’s perceived indispensability with in a system, an individuals’ sense of identification in relation to a group (which yields an affective response), and a students’ sense of being accepted, valued, and cared about in academic spaces (Strayhorn, 2015, p. 49). Ethics of care, sense of mattering, and the development of peer bonds and sense of community are essential elements to students sense of belonging (Johnson, 2012; Palmer & Maramba, 2012; Strayhorn, 2015). The findings of this study suggest that sense of belonging positively influenced the participants’ academic persistence when present. The participants of this study also used academic opportunities as motivational tools as a significant contributor to their academic persistence.

**Access to caring professors.** The participants highlighted the urgency for professors with strong teaching skills in Engineering and Mathematics courses. The participants reiterated the liability of engineers and mathematicians as they contribute significantly to economical solutions across the world that keeps our society functioning. Therefore, talented teachers are
necessary to train and prepare the next generation of engineers and mathematicians while reinforcing their confidence to develop students as self-assured professionals.

The participants in this study encountered professors that often triggered their insecurity and display uncertainty about the academic potential as engineering and mathematics majors. Instead, caring professors should be interested in encouraging students’ academic success. Perna et al. (2009) found professors who encourage academic success start by assuming all students in engineering and mathematics courses can achieve and consciously work to ensure students share this belief about their engineering and mathematics ability. Professors have the power to positively influence students’ self-esteem and self-confidence, which could create a positive classroom environment and reinforce students’ contributions to the common welfare of the college (Perna et al., 2009; Yosso et al., 2009).

**Sense of community and peer bonds.** Develop a fictive kinship within the department so that students can develop a sense of belonging in their program (Browdy, 2017). This family-oriented department environment the participants described is a method of resistance because it challenges the competitive norms that exist within this academic climate (Hill-Collins, 2000). The development of this inclusive environment would also be supportive to students’ academic persistence.

**Negotiation of alternatives to persistence.** The participants characterized the course structure and curricula as discouraging to their academic persistence because it functions to identify those students who are “underprepared or unmotivated” (Geisinger & Raman, 2013; Perna et al., 2009). This deficit evaluation of students’ academic performance, reveals evidence of “weeding out”, a common practice embedded in engineering and mathematics coursework (Borum & Walker, 2012; Geisinger & Raman, 2013; Perna et al., 2009).
found professors can oppose this common practice through the reconceptualization of engineering and mathematics courses to serve as “gateways” to more advanced engineering and mathematics coursework. This shift in professors’ conception of students’ academic performance has the potential to positively influence academic persistence of students in engineering and mathematics disciplines.

**Academic opportunities as motivational tools.** Some participants used academic opportunities as motivational tools and remained focused on forthcoming opportunities they had been selected for. In the case of Aletha her scholarship supported her persistence but negatively impacted her overall well-being because it triggered impostors’ syndrome. In what follows, I make connections between participants’ experiences and their overall well-being.

**Research Sub-Question 2: Overall well-being**

The second research sub-question was: How have those experiences shaped their overall well-being? In this section I discuss the participants development of a professional persona, access to caring professors, and a shift in their academic self-concept. I highlight these major themes that arose in this study because they were supported me in understanding the experiences that shaped the participants overall well-being.

**Professional persona.** The participants developed a professional persona, which functioned to dismantle existing power arrangements in their respective engineering and mathematics programs. To protect themselves against the degrading assault of race and gender oppression in their engineering and mathematics disciplines, all of the participants described the need to conform to the “superstrong” Black woman stereotype through the development of a professional persona (Hill-Collins, 2000; Harris-Perry, 2011; McGee & Bentley, 2017). Harris-Perry (2011) defined this controlling image as a self-sacrificial figure that displays “dogged
strength to keep from being torn asunder”, which reveals emotional and political consequences (p. 179). It is important to note that Black women encounter these controlling images as ideologies created to provide meaning to our everyday experiences as opposed to existing as disembodied representative messages (Hill-Collins, 2000). The participant Mae referenced a parasocial mentor in the popular culture television series Scandal, from which she valued the powerful and assertive presence of the character Olivia Pope to support her in navigating the academic climate of her program. Olivia Pope directly links to the controlling image of the superstrong Black woman stereotype. Furthermore, the superstrong Black woman is often viewed as a necessity and positive trait, but she too embodies the myth that Black women are emotionally and mentally invulnerable (Harris-Perry, 2011; McGee & Bentley, 2017).

Essentially, the negotiation of a professional persona by Black woman undergraduate engineering and mathematics major, attest to them as strong-willed resisters. Although this process is a positive survival tactic, the participants seemed exhausted by having to negotiate their identity and contribute negatively to the participants overall well-being.

Also, as participants discussed the development of a professional persona they placed emphasis on respect, which illustrates the significance of self-valuation (Hill-Collins, 2000). In a society that lacks accountability for the respect of Black women, Black women have long ingrained in one another the possession of self-respect and require the respect of others (Hill-Collins, 2000). This understanding aligns with the participants of this study and their development of a professional persona, a survival tactic used to obtain the respect of others and be liberated in their self-respect as they navigate the hostile academic climate in their engineering and mathematics programs. It was evident that “The right to be Black and female

**Access to caring professors.** Good advisement has the potential to serve as a motivational tool for students when present because it opposes the complexity of the coursework students’ encounter in their programs. Strong advisement and support on behalf of the department helps students to develop their self-esteem and self-confidence (Perna et al., 2009), which combats feelings of self-doubt and inferiority that arise and seem unpreventable, given the academic climate of undergraduate engineering and mathematics disciplines.

**Shift in academic self-concept.** The cultural climate that was evident in their engineering and mathematics programs were characterized as a survival-of-the-fittest approach (McGee & Bentley, 2017). However, this triggered impostors’ syndrome in the participants as they developed a fear of failure because they did not want to be the cause of their own failure (Neureiter & Traut-Mattausch, 2016). McGee and Bentley (2017) stated that this mindset places the responsibility of underrepresented status on Black students, which generates stereotypic assumptions about Black students in STEM disciplines.

**Discussion and Implications**

Resilient behavior was evident in the participants’ development of a professional persona, a survival mechanism that supported them in navigating the hostile academic climate of the undergraduate engineering and mathematics programs. Although the participants’ responses to the academic climate may be classified as resiliency, it is important to consider that resilience can mask race-related trauma (McGee & Bentley, 2017). Specifically, Hill-Collins (2000) links controlling images of the “superstrong” Black woman (e.g. mammy image and Black mothers) to societies praise of Black women’s resiliency. She emphasizes that too often these same women
must sustain an inferior ranking of their own needs, to those of everyone else (Hill-Collins, 2000). McGee and Bentley (2017) offer, educational leaders acknowledgment of the presence of (masked) trauma yields opportunities for critical support and training that appeals to students’ overall well-being and holistic success.

Perez Huber & Solórzano (2014) list potential responses to microaggressions, which included engagement in counterspaces, locations outside of or within the educational institution that provide opportunities for an oppressed population to develop strategies for empowerment, healing, and building a sense of community.

The objective in this paper is not to highlight a few discriminatory incidents or bad individuals in hopes of creating a fair and equitable field. This perspective leads to what Martin (2009) refers to as a false conclusion. Instead, this study seeks to go beyond the good and bad intentions of individual Whites and men, and call explicit awareness to Whiteness and masculinity, which functions to privilege these individuals as experts/masters of knowledge that is valued in engineering and mathematics fields (Martin, 2009).

The participants in this study are academically persistent, high achieving students who have “made a way out of no way” (Hill-Collins, 2000), despite the institutional and structural barriers that function against their academic success. Possibly the participants are conscious of the power of self-definition. Hill-Collins (2000) states:

By persisting in the journey toward self-definition, as individuals, we are changed. When linked to group action, our individual struggles gain new meaning. Because our actions as individuals change the world from one in which we merely exist to one over which we have some control, they enable us to see everyday life as being in process and therefore amenable to change (p. 121).
This quote speaks to the participants of this study and how their collective experiences can function as an agent of change. Based on Hill-Collins (2000) I suggest the participants remain focused on their individual self-definition because it is through this intersectional identity as a Black woman undergraduate engineering or mathematics major that they become changed. Specifically, in this study, I have linked the individual struggles and barriers of the participants as a form of united action, to acquire new meaning of their individual experiences. The participants’ individual actions provide them agency to change their engineering and mathematics programs from a program in which they merely exist, to one where they have some control. This empowers the participants to conceptualize their everyday experience as undergraduate engineering and mathematics majors as a form of progression, thus amendable to change (Hill-Collins, 2000). Ultimately, there is power in their self-definition.

Finally, as it relates to the introduction of this study, I sought to explore the collective “voice” of Black women undergraduate engineering and mathematics majors. It is through the maturation of the participants’ self-definition they become united for a quest from “silence to language to individual and group action”, inevitably liberating the collective “voice” of Black women as undergraduate engineering and mathematics majors (Hill-Collins, 2000, p. 120). The participants of this study used their language, self-definitions and self-valuations to persist in their oppressive, marginalizing and silencing undergraduate engineering and mathematics programs (Browdy, 2017).

Limitations

In this study three of the participants attended the Sista Circle Unity Getaway and were all engineering majors. The two participants that were unable to attend the getaway were the only two mathematics majors that participated in this study. Therefore, in this study I was limited in
my understanding of the experience of participating in a *sista circle* as an undergraduate mathematics major. This study was unable to explore this dynamic, however future researchers should consider using *sista circle* methodology to explore the experiences of Black women in undergraduate mathematics disciplines.

Of the five participants in this study, I had the pleasure of working with one of the engineering majors and one of the mathematics majors during my time as a Program Director and Developer for the Future Engineers Program. This experience allowed me to develop a mentorship relationship with these two participants prior to their participation in this study. A limitation to this study is that the remaining three participants did not have the chance to meet me in-person until the day they arrived at my home for the Pre-*Sista Circle* Unity Getaway Interview. I did not have a personal relationship with these three participants prior to their participation in the study, which could have influenced their comfortability with me since they did not know me personally.

In my request for participants in this study, I specified that I was looking for women who identify as Black, African American and/or members of the African Diaspora. Although my request reflects a diverse group of Black women and the participants in this study had a variety of ethnic backgrounds, their cultural identity was the same because it aligned with the African American experience. As a result, this study was limited in its ability to explore the experiences of Black women who are culturally diverse. For example, Black women who do not identify by their race may instead identify with their nationality, which is rooted in different historical backgrounds with different colonizers and could significantly alter the *sista circle* dialogue that occurred. Therefore, if I were to remove the criteria of Black or African American women and only request African women or women who identify as members of the African Diaspora, might
the students that expressed interest in participating in this study have been different? A limitation to this study is that if a student rejected the term Black women or one of the terms listed, it may have influenced them to opt out of the study.

Another limitation in this study was that I did not use the student organization outlets to speak publicly about my study in hopes of recruiting more participants. In the recruitment process I sent emails to request participants from several student-led organizations at the selected university. In the majority of the organizations I reached out to, the president of the organization assured me via email that the population of participants I was requesting were not active members of their organization. In most of the engineering and mathematics organizations they mentioned not having any Black women as members. Similarly, in many of the Black student organizations they mentioned not having any students who were engineering and mathematics majors. Although these organizations were limited in resources to support the request of this study, the presidents of these organizations were willing to share my request for participants with their organization. For the few organizations that did have the requested population as active student participants (e.g. the National Society of Black Engineers) it would have been beneficial if I had requested to speak publicly at one of their meetings to recruit participants. This would have provided an outlet for me to engage with potential participants and provide a chance for them to assess my energy to determine whether or not they would be interested in exploring this study with me. Also, this would have provided a platform for students to learn more about the study and raise any questions or concerns that would inform their understanding of this research.

Recommendations

Now I will discuss recommendations for practice to support faculty and administration in improving current trends and common practices discussed in this study. Administrators should
consider the development of outlets for undergraduate engineering and mathematics majors to fellowship and develop lasting friendships with other students in their program. In these spaces, activities should be implemented to support and guide students through the process of engaging with one another in hopes of structuring strong bonds that will have the potential to provide personal and academic support to students (Ashford, Wilson, King & Nyachae, 2017). In the development of such interventions, the structure of activities and overall implementation of the event and/or program should be well designed and supported with relevant literature. The literature explored should take into consideration the specific needs of the diverse population of the students at the hosting institution.

Teacher development workshops should be developed to support professors of undergraduate engineering and mathematics courses. Such workshops should provide professors with recent literature that can inform them on current, relevant teaching practices to support them in structuring, facilitating and disseminating course content. Ideally teacher educators with engineering education and/or mathematics education backgrounds whose teaching experience is concentrated in undergraduate engineering and/or mathematics courses would lead, develop, and structure the curriculum for such workshops.

Additionally, teacher development workshops should engage professors of undergraduate engineering and mathematics courses in discourse that explores literature on norms of masculinity, whiteness and elitism that persist in undergraduate engineering and mathematics disciplines. By heightening the professors’ awareness of the hegemonic structures that control the common practices and policies embedded in undergraduate engineering and mathematics disciplines, it will support professors in the development of a critical consciousness necessary to develop a more inclusive environment for students. An inclusive environment supports the goal
of developing a sense of community among students since it opposes traditions of isolation that were evident in the characterizations of the participants in this study (Johnson, 2012; Palmer & Maramba, 2012; Strayhorn, 2015).

Also, since care was a characteristic the participants found as essential to their undergraduate engineering and mathematics program experience, teacher development workshops should explore literature on ethics of care, personal accountability, and the value of reciprocity in student-professor relationships (Flowers, Scott, Riley & Palmer, 2015; Jones, Wilder & Osborne-Lampkin, 2013; Noddings, 2010; Hill-Collins, 2000). This body of literature has the potential to prompt conversations about how professors can develop and strengthen these characteristics in authentic ways in order to support students.

Administrators and program faculty need to consider the development of outlets for professors to engage with undergraduate engineering and mathematics majors on a personal level. The participants in this study emphasized their desire to access their professors’ knowledge and passion for their respective field. In this study I found those professors who granted students access to a more personal and authentic side of their identity, inspired the participants. This relationship enabled the participant to consider the professor as a reliable resource for their academic advisement in their undergraduate program. An environment that values student-professor relationships and opportunities for mentorship yields the potential for students to develop bonds that exceed the classroom and carry over into their future endeavors as career professionals, graduate students and beyond.
REFERENCES


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APPENDIX A:

IRB APPROVAL LETTER

1/6/2017

Jessica Wilson
Teaching and Learning
17831 Tropical Cove Drive
Tampa, FL 33647

RE: Expedited Approval for Initial Review
IRB#: Pro0027536
Title: Voices of Black Women Undergraduate Engineering and Mathematics Majors

Study Approval Period: 1/5/2017 to 1/5/2018

Dear Ms. Wilson:

On 1/5/2017, the Institutional Review Board (IRB) reviewed and APPROVED the above application and all documents contained within, including those outlined below.

Approved Item(s):
Protocol Document(s):
[Insert dissertation study protocol PDF]

Consent/Assent Document(s)*: **Online Consent forms are un stamped
[Insert consent form PDF]

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s). **Online Consent forms are un stamped

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:
(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your study qualifies for a waiver of the requirements for the documentation of informed consent for an online consent form as outlined in the federal regulations at 45CFR46.117(c) which states that an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

[Signature]

John Schinka, Ph.D., Chairperson
USF Institutional Review Board
APPENDIX B:
RECRUITMENT EMAIL

RECRUITMENT E-MAIL MESSAGE
Subject Line: Female Undergraduate Engineering and Mathematics Students Needed/Selection Yields Resort Stay and Food

Dear Undergraduate Student,

Hello! I hope this email finds you well. We understand that Engineering/Mathematics program coursework can leave you with a very busy schedule!

We are conducting a research study (Pro# 00027536) at the University entitled: Voices of Black Women in Undergraduate Engineering and Mathematics Majors. This qualitative study aims to understand the undergraduate student experiences of Black women junior and senior Engineering and Mathematics students while enrolled in their programs at predominantly white institutions (PWIs) through interviews and a Sista Circle Unity Getaway (a platform for group interviews). The Sista Circle Unity Getaway will be an excellent opportunity for selected participants to bond and build relationships with one another. It is our hope that participants will develop a support system among each other that will carry on with you when you return to campus.

As for the time commitment for this study, interviews will last between 45 to 60 minutes. The pre-interview will occur Wednesday, January 4th-Tuesday, January 10th. The Sista Circle Unity Getaway will begin at 12pm Saturday, January 14th-12pm Sunday, January 15th at a local resort, which will last 24 hours. Through the questions presented in this study, I seek to understand the experiences of Black women in undergraduate Engineering and Mathematics programs.

To be selected, you must be a Black woman undergraduate Engineering or Mathematics student enrolled at the University, and you must identify as African American or Black (African Diaspora). If selected for participation in the study, you will be invited to participate in a 1-night, 2-day Sista Circle Unity Getaway. A three-course dinner will be provided the first night, and a continental breakfast will be provided the morning of the second day. Immediately after the getaway you will receive an electronic reflection to reflect upon your experience at the Sista Circle Unity Getaway. This reflection will take 15-20 minutes and will occur during January-February 2017. Finally, you will receive a $10 Barnes and Noble gift card for completing the member checking of aggregate themes. This post-interview will occur during late-January and early-February 2017. If you withdraw from the study before completing the member checking you will receive a $5 gift card.
Confidentiality will be protected per IRB and ethical guidelines, and you will have the right to withdraw from participation at any time without penalty.

If you are interested in participating, please contact Jessica Alyce Wilson privately at jwilson17@mail.usf.edu. You will then receive a form requesting your permission to participate in the screening document (that will be completed online), which will allow you to complete the screening document. In the case you are eligible for the study, you will then receive a detailed information sheet. By expressing interest in this study, you are not committing to participate.

This study serves a significant purpose in understanding the relationships and experiences of Black women as undergraduate students enrolled in Engineering and Mathematics programs at PWIs. For more information about the study or to participate, please contact Jessica Alyce Wilson.

We hope you choose to participate in this important study to contribute your unique story.

Sincerely,

Jessica Alyce Wilson  
Doctoral Candidate, Researcher  
University of South Florida  
jwilson17@mail.usf.edu

Eugenia Vomvoridi-Ivanovic, Ph.D.  
Doctoral Advisor  
Assistant Professor, Mathematics Education  
University of South Florida  
eugeniav@usf.edu
APPENDIX C:
SCREENING: INFORMED CONSENT

Informed Consent to Participate in Research
Information to Consider Before Taking Part in this Research Study

Pro # 00027536

Researchers at the University of South Florida (USF) study many topics. To do this, we need the help of people who agree to take part in a research study. This form tells you about this research study. We are asking you to take part in a research study that is called: Voices of Black Women in Undergraduate Engineering and Mathematics Majors. The person who is in charge of this research study is Jessica Wilson. This person is called the Principal Investigator.

Purpose of the Study

We are conducting a research study to understand the experiences of Black women as they pursue undergraduate degrees in Engineering or Mathematics disciplines at a predominantly white institution.

Why are you being asked to take part?

We are asking you to take part in this research study because you classify as a Black woman currently enrolled at the USF as an Engineering or Mathematics major.

Study Procedures

Before you can enroll in the study, we need you to respond to a few questions to determine if you meet certain requirements to participate. All information that you provide during this process will be confidential. You may refuse to respond to any questions and not complete the survey at anytime.

If you take part in this study, you will be asked to:

- Complete a Demographic survey prior to the Pre-interview. This survey will be completed online and will be sent to you via email. This survey will take 5-10 minutes to complete.
- Participate in a Pre-Interview between January 4-January 10, 2017. The interview will last 45-60 minutes. The Pre-Interview will be conducted at Jessica Wilson’s home.
- Participate in a Sista Circle Unity Getaway from Saturday, January 14th-Sunday, January 15th 2017. The Getaway will last 24 hours beginning and ending at 12pm each day. The Getaway will take place at the Hotel Resort.
- Complete a Vision Board Collage during the Getaway. A picture will be taken of your Vision Board Collage. This information will not be identifiable.
Complete a Post Reflection after the Getaway. The Post Reflection is electronic and will be emailed to you in January-February 2017. The post reflection will take 15-20 minutes to complete.

Complete a Post-Interview that will be conducted at Jessica Wilson’s home during January-February 2017. This interview will take 30-45 minutes.

During the Sista Circle Unity Getaway we will have two sista circles. The first will take place during dinner and the second will occur during breakfast. Each sista circle will be audio and video recorded. Also, The Pre-Interview and Post-Interview will be audio recorded. The PI and research team will have access to the recordings. This information will not be identifiable. The tapes will be maintained for 5 years after the Final Report is submitted to the IRB. When that time comes we will delete and dispose of all recordings. The total time commitment will be approximately 27 hours.

Alternatives / Voluntary Participation / Withdrawal
You have the alternative to choose not to participate in this research study. If you are unable to attend the Sista Circle Unity Getaway for the entire 24 hour time period, then I will invite you to complete a one-on-one interview that I will conduct. In this interview you will be asked the same set of questions provided during the Sista Circle Unity Getaway. However, this data will not be used for the purpose of this research study.

You should only take part in this study if you want to volunteer; you are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Your decision to participate will not affect your student status, course grade, recommendations, or access to future courses or training programs.

Benefits and Risks
The benefit of participating in this research study is the opportunity to develop strong bonds with other Black women to develop a social network of support as undergraduate students in Engineering and Mathematics disciplines. The risk to participating in this research study include:

The questions included in this study will cause you to reflect on your experiences as an undergraduate student at USF. It is possible that it will cause you to experience discomfort during the interviews and/or sista circles.

The sista circles are a group interview. So you will have to share some of your experiences as an undergraduate student at USF with the other participants.

Breach of confidentiality. You are responding online, so it is possible, although unlikely that unauthorized individuals could gain access to your responses because you are responding online.

This research is considered to be minimal risk.

Compensation
You will be compensated with a $10 Barnes and Noble Gift Card if you complete all the scheduled study visits. If you withdraw for any reason from the study before completion you will be paid with a $5 Barnes and Noble Gift Card.
**Privacy and Confidentiality**

We must keep your study records as confidential as possible. It is possible, although unlikely, that unauthorized individuals could gain access to your responses because you are responding online.

Certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are: Principal Investigator, advising professor. The University of South Florida Institutional Review Board (IRB).

It is possible, although unlikely, that unauthorized individuals could gain access to your responses. Confidentiality will be maintained to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet. However, your participation in this online survey involves risks similar to a person’s everyday use of the Internet. If you complete and submit an anonymous survey and later request your data be withdrawn, this may or may not be possible as the researcher may be unable to extract anonymous data from the database.

**Contact Information**

If you have any questions about your rights as a research participant, please contact the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu. If you have questions regarding the research, please contact the Principal Investigator at 248-225-8051 or by email at jwilson17@mail.usf.edu.

We may publish what we learn from this study. If we do, we will not let anyone know your name. We will not publish anything else that would let people know who you are. You can print a copy of this consent form for your records.

I freely give my consent to take part in this study. I understand that by proceeding with this survey that I am agreeing to take part in research and I am 18 years of age or older.

https://goo.gl/forms/T5LII21foChpunsF2
APPENDIX D:
INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Study ID: Pro00027536 Date Approved: 1/5/2017

Informed Consent to Participate in Research Involving Minimal Risk

Pro # 00027536

You are being asked to take part in a research study. Research studies include only people who choose to take part. This document is called an informed consent form. Please read this information carefully and take your time making your decision. Ask the researcher or study staff to discuss this consent form with you, please ask him/her to explain any words or information you do not clearly understand. The nature of the study, risks, inconveniences, discomforts, and other important information about the study are listed below.

We are asking you to take part in a research study called:

Voices of Black Women in Undergraduate Engineering and Mathematics Majors

The person who is in charge of this research study is Jessica Wilson. This person is called the Principal Investigator. However, other research staff may be involved and can act on behalf of the person in charge. She is being guided in this research by Eugenia Vomvoridi-Ivanovic, Ph.D.

The research will be conducted at

Jessica Wilson’s home
17831 Tropical Cove Dr.
Tampa FL 33647

And

Twins Inn & Apartments
12520 Gulf Blvd
Treasure Island, FL 33706

Purpose of the study

To understand the experiences of Black women as they pursue undergraduate degrees in Engineering or Mathematics disciplines at a predominantly white institution. This study will engage participants in one-on-one interviews conducted by Jessica Wilson. Also, participants will have the opportunity to participate in a Sista Circle Unity Getaway hosted by Jessica Wilson, which will be a 2-day, 1-night resort stay where participants get to know each other and engage as a group about your experiences in your undergraduate degree programs at USF.
Why are you being asked to take part?

We are asking you to take part in this research study because you classify as a Black woman currently enrolled at the USF as an Engineering or Mathematics major. Also, you are a junior or senior in your program, with a 3.0 GPA or higher.

**Study Procedures:**

If you take part in this study, you will be asked to:

- Complete a Demographic survey prior to the Pre-interview. This survey will be completed online and will be sent to you via email. This survey will take 5-10 minutes to complete.
- Participate in a Pre-Interview between January 4-January 10, 2017. The interview will last 45-60 minutes. The Pre-Interview will be conducted at Jessica Wilson’s home.
- Participate in a Sista Circle Unity Getaway from Saturday, January 14th-Sunday, January 15th, 2017. The Getaway will last 24 hours beginning and ending at 12pm each day. The Getaway will take place at the Hotel Resort.
- Complete a Vision Board Collage during the Getaway. A picture will be taken of your Vision Board Collage. This information will not be identifiable.
- Complete a Post Reflection after the Getaway. The Post Reflection is electronic and will be emailed to you in January-February 2017. The post reflection will take 15-20 minutes to complete.
- Complete a Post-Interview that will be conducted at Jessica Wilson’s home during January-February 2017. This interview will take 30-45 minutes.
- During the Sista Circle Unity Getaway we will have two sista circles. The first will take place during dinner and the second will occur during breakfast. Each sista circle will be audio and video recorded. Also, The Pre-Interview and Post-Interview will be audio recorded. The PI and research team will have access to the recordings. This information will not be identifiable. The tapes will be maintained for 5 years after the Final Report is submitted to the IRB. When that time comes we will delete and dispose of all recordings.
- The total time commitment will be approximately 27 hours.

Please identify your authorization of audio and video recordings during this process:

<table>
<thead>
<tr>
<th>Permission to record audio</th>
<th>[Yes]</th>
<th>[No]</th>
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<tbody>
<tr>
<td>Permission to record video</td>
<td>[Yes]</td>
<td>[No]</td>
</tr>
</tbody>
</table>

**Total Number of Participants**

About 4-6 individuals will take part in this study at USF.

**Alternatives / Voluntary Participation / Withdrawal**

Alternatives to participating in the study include: If you are unable to attend the Sista Circle Unity Getaway for the entire 24 hour time period, then I will invite you to complete a one-on-one interview that I will conduct. In this interview you will be asked the same set of questions provided during the Sista Circle Unity Getaway. However, this data will not be used for the purpose of this research study.
You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study.

Benefits
The potential benefits of participating in this research study include:

Through this study I anticipate that participants will have the opportunity to develop strong bonds with other Black women to develop a social network of support as undergraduate students in Engineering and Mathematics disciplines.

Risks or Discomfort
The following risks may occur:

- The questions included in this study will cause you to reflect on your experiences as an undergraduate student at USF. It is possible that it will cause you to experience discomfort during the interviews and/or sister circles.
- The sister circles are a group interview. So you will have to share some of your experiences as an undergraduate student at USF with the other participants.

Compensation
You will be compensated with a $10 Barnes and Noble Gift Card if you complete all the scheduled study visits. If you withdraw for any reason from the study before completion you will be paid with a $5 Barnes and Noble Gift Card.

Costs
It will not cost you anything to take part in the study.

Privacy and Confidentiality
We will keep your study records private and confidential. Certain people may need to see your study records. Anyone who looks at your records must keep them confidential. These individuals include:

- The research team, including the Principal Investigator and all other research staff.
- Certain government and university people who need to know more about the study, and individuals who provide oversight to ensure that we are doing the study in the right way.
- Any agency of the federal, state, or local government that regulates this research. This includes the Food and Drug Administration (FDA) and the Office for Human Research Protection (OHRP).
- The USF Institutional Review Board (IRB) and related staff who have oversight responsibilities for this study, including staff in USF Research Integrity and Compliance.

We may publish what we learn from this study. If we do, we will not include your name. We will not publish anything that would let people know who you are.
You can get the answers to your questions, concerns, or complaints
If you have any questions, concerns or complaints about this study, or experience an unanticipated problem, call Jessica Wilson at 248-225-8051.
If you have questions about your rights as a participant in this study, or have complaints, concerns or issues you want to discuss with someone outside the research, call the USF IRB at (813) 974-5638 or contact by email at RSCT-IRB@usf.edu.

Consent to Take Part in this Research Study
And Authorization to Collect, Use and Share Your Health Information for Research
I freely give my consent to take part in this study. I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

________________________________________________________________________
Signature of Person Taking Part in Study                      Date

________________________________________________________________________
Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent
I have carefully explained to the person taking part in the study what he or she can expect from their participation. I confirm that this research subject speaks the language that was used to explain this research and is receiving an informed consent form in their primary language. This research subject has provided legally effective informed consent.

________________________________________________________________________
Signature of Person obtaining Informed Consent                      Date

________________________________________________________________________
Printed Name of Person Obtaining Informed Consent
APPENDIX E:
PARTICIPANT SCREENING SURVEY

Participant Screening Survey (Part 1)

Instructions: Please answer the following questions to determine if you are eligible for participation in this study. You must be a Black woman undergraduate student enrolled at USF as a junior or senior, and identify as African American or Black (African Diaspora). You must also be 16 years of age or older. Please contact Jessica Alyce Wilson at jwilson17@mail.usf.edu if you have any questions. Thank you!
* Required

1. Name *

2. Please identify a pseudonym. (This is a fictitious NAME that will be used to identify you if you are selected as a participant in this study. Selecting a pseudonym helps me to maintain your privacy in this study. Please make note of the name you select as you will need it in the near future.) *

3. Age *

4. Major *
Mark only one oval.

- Engineering discipline
- Mathematics
- Other: ________________________________

5. Enrollment status in your Engineering/Mathematics program *
Mark only one oval.

- Junior
- Senior
- Other: ________________________________
6. GPA *
   Mark only one oval.
   
   ○ 3.0 or higher
   ○ 2.5-2.99
   ○ Below a 2.49

7. Email Address *

   .....................................................................................................

8. Telephone Number *

   .....................................................................................................

9. Mailing Address *

   .....................................................................................................

10. I am a Black woman undergraduate student that identifies as African American and/or Black (African Diaspora) *
    Mark only one oval.
    
    ○ Yes
    ○ No

11. The Pre-Interview will be conducted between Wednesday, January 4th-Tuesday, January 10th. Please list the DATES you will NOT be available. (MM/DD/YY) *

    .....................................................................................................
    .....................................................................................................
    .....................................................................................................
    .....................................................................................................
    .....................................................................................................

12. For the Pre-Interview identify a TIME that fits your schedule (please allow 60 minutes). *

    Example: 8:30 AM
13. **The Sista Circle Unity Getaway will last 24 hours from Saturday, January 14th- Sunday, January 15th. Starting 12p on Saturday and concluding on 12p on Sunday. All participants are required to be in attendance the ENTIRE 24 hours.**
Mark only one oval.

- [ ] I will be available during this time period.
- [ ] I will not be available during this time period, but I can adjust my schedule to ensure that I will be available the entire 24 hour period.
- [ ] I will not be available during this time period.

14. **This study relies on snowball sampling in addition to the listserv as a recruitment method. Please list other Black women undergraduate Engineering/Mathematics students enrolled at USF who may like to participate. Include their NAME and EMAIL ADDRESS. They will only be told that you referred them; no other information about your participation will be shared. You are NOT required to list anyone to remain eligible to participate in this study.**

- [ ]
- [ ]
- [ ]
- [ ]
- [ ]

15. **Thank you! The researcher will contact you soon to verify the date and time of your interview. Before the data collection portion of the in-person interview, you will have an opportunity to ask questions and consent to participate in the study. If you have questions before then, please contact Jessica Alyce Wilson (Principle Investigator) at jwilson17@mail.usf.edu.**
Mark only one oval.

- [ ] I understand.
APPENDIX F:
DEMOGRAPHIC SURVEY

Demographic Survey

Instructions: Please respond to the following questions. This step must be completed before your interview can be scheduled. Please email Jessica Alyce Wilson at jwilson17@mail.usf.edu if you have any questions.

* Required

1. Pseudonym (Please enter the fictitious name you selected during the screening survey.) *

2. What racial and/or ethnicity group do you identify with? *

3. What is your age? *

4. What is your gender? *

5. Where are you from? (City, State, Country) *

6. Where were you born? (City, State, Country) *

7. Where is your family from? (family heritage) (City, State, Country) *

8. Where did you reside growing up? (City, State, Country) *

https://docs.google.com/forms/d/1x0BZVwz0GALCRCQGJUC89tNYhXKuvVZ_bxYQgKs4/pinfoform
9. How would you describe your socioeconomic status? *  
Mark only one oval.  
☐ lower-class  
☐ working-class  
☐ middle-class  
☐ upper-class  
☐ Other: __________________________________________

10. Are you a transfer student? If your answer is YES, please select "other". In the space provided tell me: Where did you attend college? *  
Mark only one oval.  
☐ No  
☐ Other: __________________________________________

11. What is your major? *  
_____________________________________________

12. Do you have a minor? If your answer is YES, please select "other". In the space provided tell me: What is your minor? *  
Mark only one oval.  
☐ No  
☐ Other: __________________________________________

13. When did you start your Bachelors program? (Semester and Year) *  
_____________________________________________

14. What is your classification? *  
Mark only one oval.  
☐ Junior  
☐ Senior  
☐ Other: __________________________________________

15. When do you plan to graduate? (Semester and Year) *  
_____________________________________________
16. Have you attended your program continuously? *
   Mark only one oval.
   ○ Yes
   ○ No
   ○ Other: 

17. How would you describe your program advisor’s race/ethnicity? *

18. How would you describe your program advisor’s gender? *

19. What is your program advisor’s status? *
   Mark only one oval.
   ○ Assistant Professor
   ○ Associate Professor
   ○ Full Professor
   ○ Other: 

20. Where did you attend school for your K-12 education? (City, State, Country) *

21. What is the school district in which you received your K-12 education? *

22. What was your high school GPA? *

23. What is your undergraduate GPA? *
24. Were you involved in any Science, Technology, Engineering and/or Mathematics (STEM) initiative opportunities or programs during high school? *
Mark only one oval.

☐ Yes
☐ No

25. Have you been involved in any STEM initiative opportunities or programs during undergrad? *
Mark only one oval.

☐ Yes
☐ No
☐ Other: ..............................................................

26. Were you involved in extracurricular activities in high school? *
Mark only one oval.

☐ Yes
☐ No
☐ Other: ..............................................................

27. Have you been involved in extracurricular activities in undergrad? *
Mark only one oval.

☐ Yes
☐ No
☐ Other: ..............................................................

28. Are you a first generation college student? *
Mark only one oval.

☐ Yes
☐ No
☐ Other: ..............................................................

29. Do you have siblings? *
Mark only one oval.

☐ Yes
☐ No
☐ Other: ..............................................................
## APPENDIX G:

**PARTICIPANT INFORMATION LOG**

<table>
<thead>
<tr>
<th>Participant “Name”</th>
<th>Received Signed Consent Form</th>
<th>Response to Verbal Consent</th>
<th>Hidden Figures Pseudonym (Black Women STEM professionals)</th>
<th>Highlights about Hidden Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Jadea</td>
<td>YES</td>
<td>Agreed</td>
<td>Aprille J. Ericsson-Jackson, Ph.D.</td>
<td>First woman to receive Ph.D. in Mechanical engineering from Howard University. First woman to receive a Ph.D. in engineering at NASA Goddard Space Flight Center.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Employer:</strong> NASA Goddard Space Flight Center</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Title:</strong> Aerospace Engineer, Technologist, Project and Program Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Employer:</strong> NASA Astronaut Corps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Title:</strong> Former Science Mission Specialist AND Establisher of the Jemison Group</td>
</tr>
</tbody>
</table>
3. **Lovely**

   YES  
   Agreed

   Aletha Maybank, M.D.

   Specializes in preventive medicine, health injustice and inequities, food and fitness, maternal and child health, cancer, HIV/AIDS and community health.

   *Employer*: New York City Department of Health Mental Hygiene

   *Title*: Assistant Commissioner AND a Founding Board Member of the Artemis Medical Society

4. **Lacey**

   YES  
   Agreed

   Erica N. Walker, Ed.D.

   Teacher, learner and mathematics educational researcher. Her research explores positive outlooks on mathematics teaching and learning. Her work often explores students of color in mathematics context.

   *Employer*: Teachers College, Columbia University

   *Title*: Professor of Mathematics Education

5. **ACM**

   YES  
   Agreed

   Katherine Johnson

   American physicist, space scientist and mathematician. Recognized in the popular film *Hidden Figures* for her contributions NASA none as one of their “human computers”.

   *Employer*: NASA
APPENDIX H:
SISTA CIRCLE UNITY GETAWAY ITINERARY

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
<th>Contact</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 4, 2017</td>
<td>12:00 PM</td>
<td>Pick-Up at the University</td>
<td>Student Center</td>
<td>Jessica Wilson</td>
<td>248-225-8051</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jessica will pick up participants at the Employee parking lot behind the Arts building, near the Student Center. Please be prepared with luggage in hand.</td>
</tr>
<tr>
<td></td>
<td>12:30 PM</td>
<td>Leave the University</td>
<td>Drive to Treasure Island</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1:15 PM</td>
<td>Arrive at Hotel</td>
<td>Twins Inn &amp; Apartments</td>
<td>727-360-7420</td>
<td>Please pay in your room and be ready to start promptly at 2 pm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12920 Gulf Blvd</td>
<td></td>
<td>Refreshments: Snacks/Appetizers will be accessible throughout your stay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Treasure Island FL 33706</td>
<td></td>
<td>Water, juice and lemonade will also be provided.</td>
</tr>
<tr>
<td></td>
<td>2:00 PM</td>
<td>Ice Breaker: Hidden Figures Activity</td>
<td></td>
<td></td>
<td>Directions: Participants will introduce themselves and present their selection for the Hidden Figures Activity. Questions: What is her significant contribution to the field of Engineering/Mathematics? Where is she from and what is her family background? Why did you select her as the person you wanted to present? Recorded: Ice Breaker will be audio recorded.</td>
</tr>
<tr>
<td></td>
<td>2:40 PM</td>
<td>Vision Board Activity</td>
<td></td>
<td></td>
<td>Directions: Using the materials provided develop a collage that is representative of who you are today. Jessica will need a picture of your vision board once you complete it. Recorded: Vision Board will be audio recorded.</td>
</tr>
<tr>
<td></td>
<td>3:30 PM</td>
<td>Presentation of Vision Boards</td>
<td></td>
<td></td>
<td>Directions: Please provide a brief synopsis describing your intent in developing your poster. Also, what does this board tell us about you? What do you want us to take away? Recorded: Presentations will be audio recorded. Please take 5 pictures of your poster board using Jessica’s cell phone or pad.</td>
</tr>
<tr>
<td></td>
<td>4:15 PM</td>
<td>Break</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5:30 PM</td>
<td>Dinner and Sista Circle Chat</td>
<td>Diving Room Table</td>
<td></td>
<td>Directions: The purpose of this activity is to engage the participants in a sisterly discussion about your experiences as undergraduate students in your respective programs at your institution. The dialogue will be lead by Jessica. You will be provided a 10 minute break during this portion. Recorded: Discussions will be audio and video recorded.</td>
</tr>
<tr>
<td></td>
<td>8:00 PM</td>
<td>Break for the evening</td>
<td></td>
<td></td>
<td>Dinner: Chicken, Greens, Coles, Rolls, Corn Bread, Lemonade, and Water. Optional activity: Movie, walk on the beach, etc… Enjoy Dessert: Ice Cream, chocolate, cookies, and fruit.</td>
</tr>
<tr>
<td>Feb 5, 2017</td>
<td>8:00 AM</td>
<td>Breakfast and Sista Circle Chat</td>
<td>Diving Room Table</td>
<td></td>
<td>Directions: The purpose of this activity is to engage the participants in a sisterly discussion about your experiences related to your academic persistence and overall well-being. Recorded: Discussions will be audio and video recorded.</td>
</tr>
<tr>
<td></td>
<td>10:30 AM</td>
<td>Breakfast</td>
<td>Diving Room Table</td>
<td></td>
<td>Breakfast: Continental Breakfast: Bagels, muffins, fresh fruit, juice and water.</td>
</tr>
<tr>
<td></td>
<td>11:00 AM</td>
<td>Load the Car</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11:15 AM</td>
<td>Head to the University</td>
<td>Drive to City</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12:00 PM</td>
<td>Drop-Off at the University</td>
<td>Student Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb 6, 2017</td>
<td>12:00 PM</td>
<td>Electronic Reflection</td>
<td></td>
<td></td>
<td>Email: <a href="mailto:jwilson17@mail.ufl.edu">jwilson17@mail.ufl.edu</a> You will receive an email with a link to complete an electronic reflection. This reflection will allow you to reflect on your time during the sista circle getaway and will take 10-15 minutes. Please complete your reflection by Monday. February 13th, also, you will be able to schedule your final interview for Wednesday, February 22nd or Thursday, March 7th (giving 30-45 minutes). You will receive your phone call once you complete the final interview.</td>
</tr>
</tbody>
</table>
APPENDIX I:

PRE-SISTA CIRCLE UNITY GETAWAY INTERVIEW PROTOCOL

The pre-interview and Sista Circle protocols have been adapted from (Shavers, 2010).

Researcher statement: You will have an opportunity to share your perception of self and how others perceive you in your academic and personal experiences. You will also be asked to share a typical day as an Engineering/Mathematics major. But first I want to ask a few follow-up questions from the Demographic survey you completed.

Follow-up Demographic List
1. You mentioned that you are from _____ and your family is from _____. Tell me more about the community you grew up in.
2. You also, mentioned that you attended K-12 schools in___________. Would you define the space as a majority or minority space? What is the SES household makeup of the school?
3. You mentioned that you transferred from ______________. What influenced you to transfer? (OPTIONAL)
4. You mentioned that you were involved in STEM initiative programs in high school. Undergrad. Please share more about the experience and your involvement? (OPTIONAL)
5. You mentioned your involvement in extracurricular activities in high school. Undergrad. Please share more about your involvement in extracurricular activities. While in undergrad, did or do you hold any leadership positions? (OPTIONAL)
6. You mentioned that you (are, are NOT) a first-generation college student. What is your mother or fathers highest level of education? What are their current professions?
7. You mentioned that you have siblings. Have your siblings completed their K-12 education? Please explain. If so, did your siblings attend college? Please explain. (OPTIONAL)

Personal perception Interview Portion
1. Tell me about yourself. What characteristics, strengths and weaknesses, do you have that make you who you are?
2. How do you think others describe you in general at the University? Advisor? Undergraduate peers? Engineering/Mathematics peers? Other faculty?
3. What would you like for these individuals (i.e., advisor, undergraduate peers, Engineering/Mathematics peers, and other faculty) to say about you? Why? Anyone else?
4. Describe a typical day for you as an Engineering/Mathematics major.
Researcher statement: As we transition you will now have an opportunity to discuss your experiences in social networks on campus, particularly with other women.

5. What are your current social networks of support as an Engineering/Mathematics major?
6. Do you have networks of support as an undergraduate student that are exclusive to Black women on campus? Black students in Engineering/Mathematics on campus? Black women in Engineering/Mathematics on campus? To what extent do you participate in these social networks?
7. Do you find it easy to develop strong, supportive bonds with other Black women on campus? Black women in Engineering/Mathematics majors? Explain.
8. What is your role (or contribution) when you are in a space dominated by Black women? How do other Black women perceive you when you are in a space dominated by Black women?
9. Are there times you feel as though you benefit and/or suffer from being in these spaces? If so, explain.
10. Do you have any reservations with Black women? Explain.
APPENDIX J:

SISTA CIRCLE #1: DINNER

Theme: Undergraduate Experiences

Researcher statement: The objective of today’s sista circle is to provide an opportunity for me to understand your experiences as undergraduate student at the University enrolled in an Engineering or Mathematics program. In the beginning you will have an opportunity to share the differences in how you might represent yourself in public and private places, your experiences enrolling and being a student in your academic program, and we will close with questions about your motivation.

1. How different are you in public (i.e. on campus, church, social media, local store) compared to in your personal life?
2. How do you present yourself in your undergraduate courses (non-Engineering/Mathematics courses)?
   a. How is that different from the way you present yourself in your Engineering/Mathematics courses?
   b. How is that different from the way you present yourself in your personal life? Is this a conscious decision? Please explain.
   c. What are the advantages and disadvantages of presenting yourself differently in one context from another context?

Researcher statement: Now I would like to transition the conversation to learn more about your individual programs and your decision to select the University as your institution, as well as Engineering or Mathematics as an undergraduate major.

3. Tell me about your experience as an Engineering/Mathematics major?
   a. What made you decide to come to the University?
   b. What made you decide to major in Engineering/Mathematics (i.e., teachers, counselors, family members or friend, program, organization, others)?
   c. What messages did you receive from these individuals once you decided to major in Engineering/Mathematics and after you made your decision to attend the University?
   d. Do you feel comfortable ask questions in class? Going to office hours?
4. When did you first think about majoring in Engineering/Mathematics?
   e. How did you envision that experience of being an Engineering/Mathematics major?
   f. How does that match up with what you are actually experiencing?
5. What Black Woman Engineering/Mathematics professional inspires or influences you? If not, who has is an Engineering/Mathematics professional that has inspired you? How have they inspired or influenced you?

6. What motivates you to stay in your major?

7. What would your ideal undergraduate experience be?
   a. In what ways do you think your experience, as an Engineering/Mathematics major and/or undergraduate student, would be different if you were in this “ideal space”?

Researcher statement: So as we come to a close for this evening:

8. Is there anything else you would like to share?
APPENDIX K:

SISTA CIRCLE #2: BREAKFAST

**Theme:** Academic Persistence and Overall Well-being

*Researcher statement:* The objective of today’s *sista circle* is to provide an opportunity for me to understand your academic persistence and overall well-being as an undergraduate student in an Engineering or Mathematics program. You will have an opportunity to share your support systems, challenges and barriers, and discuss the advice you would give other Black women.

1. Do you have someone or a group of individuals to share your emotions? Describe those relationships and the benefits of those relationships, specifically as an undergraduate student and the distinction as an Engineering/Mathematics major.
2. Do you think other students in your Engineering/Mathematics courses are invested in your academic and professional success? What does the “investment” look like? Please explain.
3. What are your interactions with other Black women Engineering/Mathematics majors?
4. What challenges/barriers have you faced in your Engineering/Mathematics courses? How do you overcome them?
5. What advice would you give to other Black women considering enrollment in an undergraduate program in general and as an Engineering/Mathematics major at the University in particular? How might this advice differ if the applicant was from a different demographic group?
6. What would you say to professors or Deans at the University if they inquire about your undergraduate Engineering/Mathematics experience at the institution?
7. Based on what you know about this study and the previous questions asked, is there anything else you would like to share regarding your experience as a Black Woman Engineering/Mathematics major at a PWI?
APPENDIX L:

PARTICIPANTS VISION BOARD COLLAGE

1. Aprille’s Vision Board
2. Mae’s Vision Board
3. Aletha’s Vision Board

*Front Side:*
NOTES TO SELF

STRETCH

\text{\textit{strecth}}

\text{verb}

1. TO REACH BEYOND YOUR COMFORT ZONE INTO YOUR FULL POTENTIAL

BY CHARLENE R. JACKSON

It is believed that giraffes didn’t always have long necks. In fact, one of their closest relatives is theelope, a short, horse-looking animal with white-striped legs that stands around 5 feet tall. So how did giraffes get their height and neck bones? By evolving beyond their roots. According to Disney’s Animal Kingdom, giraffes likely developed longer necks over time in response to competing for food in the savannah. The age didn’t face such conditions in the rainforest and didn’t grow over time. This month we challenge you to leave your comfort zone and reach for the higher ground. Google CoO Tandeha Jackson Warner knows all about the art of stretching. She has a stopping on in The Warner Project, her annual conference for entrepreneurs. The stretch is the distance between your comfort zone and your dream,” she says. “Take it on the other side of the age and remember to keep pushing beyond it.

Back Side:
APPENDIX M:
ELECTRONIC POST SISTA-CIRCLE REFLECTION

Sista Circle Unity Getaway Reflection

Instructions: Please provide a paragraph style response to the following questions. Please contact Jessica Alyce Wilson at jwilson17@mail.ucf.edu if you have any questions. Thank you!

* Required

1. Pseudonym (Please enter the fictitious name you selected during the screening survey.) *

2. How did you feel discussing your experiences with a group of fellow students? Please explain. *

3. What moment during the Sista Circle Unity Getaway stands out the most to you? Please explain why. *

4. Did you identify with a story that was shared by a another person at the Sista Circle Unity Getaway? Please explain. *

https://docs.google.com/forms/d/18f9e9f9b7c0UCu8khvyQbGtDvNMq5zh3YNhBQ4C1gprintform
5. Was there anything that happened during the Sista Circle Unity Getaway that caused you to experience discomfort or feel discouraged? Please explain. *


6. Was there anything that happened during the Sista Circle Unity Getaway that made you feel excited or accomplished? *


7. Is there anything else that you would like to share? *


https://docs.google.com/forms/d/16Fgnof9Vc2GUh57huMuYD6rGVmJGq6h3RYnBDP4C1g/printform