#BlackGirlMagic: The Influence of Identity Expression on STEM Identity and Retention for Black Females in Undergraduate Research Experiences

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ABSTRACT

Terrell Roderick Morton: #BlackGirlMagic: The Influence of Identity Expression on STEM
Identity and Retention for Black Females in Undergraduate Research Experiences
(Under the direction of Eileen C. Parsons)

Research and reports promote targeted interventions such as the undergraduate
research experience to address issues with Black student retention and matriculation in
Science, Technology, Engineering, and Math (STEM). The effectiveness of these
interventions are purported to be their ability to foster strong associations between Black
students and STEM because of the resources and opportunities they provide (Hurtado et al.,
2009; Palmer et al., 2011; Pender et al., 2010; Merolla & Serpe, 2013). These interventions
tend to situate participants as being deficient and the targeted intervention must provide what
they lack. What is not fully investigated or understood are individual contributions, shaping
student persistence, that aid in STEM identity development and retention for these students.
Using Phenomenological Variant Ecological Systems Theory (Spencer, 2006), a framework
that considers individuals' strengths and the surrounding contexts, this study reveals the
influence of race, gender, and religious identity expression on STEM identity development
and retention for Black females participating in STEM undergraduate research experiences.
This study's findings offer useful insights for enhancing undergraduate research experiences,
addressing aspects such as STEM culture and student engagements with research mentors,
peers, professors, and projects.

I dedicate this work to my grandparents, the late Rev. Dr. Nilous M. Avery, I, Mrs. Christine

W. Avery, Mr. Felix Morton, II, and Mrs. Wadye G. Morton. Thank you for being the

foundation upon which I stand.

I am thankful for my friends who have loved and supported me throughout my life. I thank my Hill Street Family; my A&T Family; my BGMM Family; my fraternity brothers in Kappa Kappa Psi National Honorary Band Fraternity, Inc. and Omega Psi Phi Fraternity, Inc.; my Miami Family; and my UNC Family. Special thanks to Dr. Kenneth Ruff, Dr. Margaret Kanipes, Kiera Vargas, The Brothas, my Line brothers, La'Tisha Price, Nicole Williams, Todgi Dozier, Domonique Bulls, Mariah Murrell, Daphne Mills, Jessie Cain, Monica Faulkner, and Henry Willis. I am grateful for Dr. Cynthia Demetriou, Dr. Abigail Panter, Candice Powell, and the undergraduate retention family. I am also grateful for my ASPSA.

To my many little brothers and mentees that I have gathered along the way, I am thankful for you. You inspire me and motivate me to be better. To my students, thank you for being a source of encouragement and a daily reminder of the joy that comes with molding young minds. To my goddaughter, Kadence Agape Hudson, I love you. You represent #BlackGirlMagic in every way. To my study participants, I appreciate your willingness to share your story.

Lastly, I acknowledge my ancestors and all of my people who have fought tirelessly over the years to ensure that I had the opportunity to pursue a higher education. I am your WILDEST dream!

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LIST OF ABBREVIATIONS

STEM   Science Technology Engineering Mathematics

U.S.   United States

URE   Undergraduate Research Experience

PVEST   Phenomenological Variant Ecological Systems Theory

CRT   Critical Race Theory

Chapter 1: Introduction

Currently, the United States lags behind several of its competitor countries in science, technology, engineering, and mathematics (STEM) in secondary and postsecondary education. According to the Programme for International Student Assessment, an international assessment that examines mathematics and science competencies in 15-year-olds across 65 countries, the United States is ranked 27th out of 34 countries in mathematics literacy and 20th out of 34 countries in science literacy (Organisation for Economic Co-Operation and Development, 2012). In 2012, the United States (U.S.) produced nine percent of the overall first university degrees in science and engineering globally, compared to China at 33%, India at 23%, and the European Union at 21% (National Science Board, 2016). The U.S. also realized very little growth in science and engineering degree production from 2000 to 2012 compared to China's 300% growth (National Science Board, 2016).

Economic projections indicate that the U.S. needs to increase STEM graduation rates by 34% annually to meet the demands of the national science and technology sectors and maintain preeminence as a world leader in these areas (U.S. Department of Commerce Economics and Statistics Administration, 2011; President's Council of Advisors on Science and Technology, 2012). As a nation, the U.S. must also draw upon the minds and talents of all Americans –particularly those underrepresented in STEM – to promote inclusion and ensure that the country's STEM workforce represents the best and brightest (National Academy of Science, 2011). Given the importance of STEM careers on the economic

development and prosperity of the nation (U.S. Department of Commerce Economics and Statistics Administration, 2011) and the country's overall global economic standing (World Economic Forum, 2011), improving STEM engagement and participation in the U.S. is of paramount importance.

Since the 1960's, leaders in the U.S. have pushed and advocated for increased attention and focus on STEM education, achievement and advancement (Basile & Lopez, 2015). Their increased attention to STEM has been considered a response to Russia's launching of Sputnik and the country's fear of losing its stance as a global superpower (Basile & Lopez, 2015). Recognizing the many contributions that STEM afforded the nation, such as increased human capital, advanced global economic positioning, dominance and power over other countries, the U.S. increased its efforts in promoting and advancing STEM education for its citizens (Basile & Lopez, 2015).

As the country became informed of the state of STEM education within the U.S. and the lack of available human capital to achieve its goals, researchers and policy makers turned their efforts towards increasing the number of underrepresented individuals in STEM (Hurtado, Newman, Tran, & Chang, 2010; Palmer, Davis, Moore III, & Hilton, 2010). These numerically underrepresented students were students from non-white racial and ethnic backgrounds; students who embraced various cultures such as African American culture and some Asian or Latino cultures; and students of the female sex. The efforts put forth addressed areas that would improve underrepresented students' access, matriculation, and retention in STEM (Hurtado et al., 2010), with the expectation that these endeavors would make the U.S. more competitive in the global economic market (Perna, Gasman, Gary, Lundy-Wagner, &

Drezner, 2010; Hernandez, Schutz, Estrada, Woodcock, & Chance, 2013; Thiry, Laursen, & Hunter, 2011).

Although efforts were implemented to increase all underrepresented students' participation, retention, and matriculation in STEM, this research project focused specifically on Black[1] students in STEM at the postsecondary education level. Specifically, this study's primary objective is to develop a counter-story regarding Black females' retention in STEM, STEM identity, and undergraduate research experiences situated in the perspectives and stories of the participants. To uncover the counter-story, this study seeks to:

1. Characterize the perceptions of Black females' race, gender, and other salient identity in STEM undergraduate research experiences.

2. Gather the meaning they ascribe to their identity and how it informs their engagements with STEM.

3. Understand their perception of STEM and their undergraduate research experience.

4. Acknowledge their perceived associations as well as any predispositions to STEM to infer if STEM undergraduate research experiences are transformative experiences for them.

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[1] In the literature specific to Black students' matriculation and retention in STEM postsecondary education, the terms African American and Black are used interchangeably to reference individuals of African descent. Though I believe that these two words are distinct, one representing race and the other culture, when referencing or citing an author's work I use the terminology that is consistent with their literature. Within my own writing, however, I use Black as a racial designation for individuals who share African ancestry (Larkey, Hecht, & Martin, 1993; Smith, 1992) and African American as a cultural designation for individuals who share similar values, beliefs, and ideals rooted in the African heritage (Boykin, 1986; Larkey et al., 1993).

In this study, race is a socially constructed category that is used to classify or group people based on, "historically contingent, socially significant elements of their morphology and/or ancestry." (Haney López, 1994, p. 7). As well, gender encompasses a belief, acceptance, and practice of activities, roles and responsibilities that society assigns to a biological sex (Egan & Perry, 2001). Gender is contingent upon the individuals' "knowledge of membership…felt compatibility…felt pressure…attitudes" (Egan & Perry, 2001, p. 451).

Statement of Problem

Despite its popularity in educational research, student matriculation and retention in STEM is still a major concern within the U.S. (Chang, Sharkness, Hurtado, & Newman, 2014). Forty-eight percent of bachelor degree students and 69% of associate's degree students that were enrolled in a STEM major between 2003 and 2009 left STEM by 2009, with approximately one-half of those students leaving school altogether without earning a degree (Chen, 2013). In 2012, 71% of graduated high school students in the U.S. enrolled in a college or university (Organisation for Economic Co-operation and Development, 2014) and 45% of these students revealed that they intended to major in a STEM discipline (Eagan, Stolzenberg, Ramirez, Aragon, Suchard, & Hurtado, 2014); however, only 18% declared a STEM major (National Science Board, 2016). Not only is there a significant percentage of students who are STEM majors in college leaving STEM, but there are also very few students initially pursuing STEM majors when they first enter college, creating a cycle that perpetuates an increased reduction in STEM engagement, retention and matriculation over time.

In 2012, Black students had the lowest percentage college enrollment rate in a STEM discipline, at 13.8%, compared to their White (19.1%), Asian (27.1%), Hispanic (16.8%),

and other (17.7%) counterparts (National Science Board, 2016). Black students also had higher STEM attrition rates in both the bachelor and associate degree-seeking populations, as compared to other races and ethnicities (Chen, 2013). Although the overall college enrollment rates for Black students had increased from 11% to 13% over a 13-year period (2000-2013), the conferral rate of STEM bachelor degrees remained consistent at nine percent (National Science Board, 2016). Collectively, these statistics indicate an issue with STEM matriculation and retention both during the transition from secondary to postsecondary education, and during postsecondary studies. These statistics also disclose that despite any targeted efforts put forth, the on-going issues with STEM matriculation and retention in the U.S. dramatically affect Black students more than other racial and ethnic populations.

Purpose of the Study

The current trend in educational research surrounding STEM retention and matriculation is to focus on targeted efforts such as the undergraduate research experience, exploring the various affordances that environments of this nature provide its participants and how these affordances aid in their retention and matriculation. Arguments that promote those targeted efforts as being viable remedies for problems with STEM retention and matriculation tacitly proposition those experiences to be transformational for the participants. These studies often investigate underrepresented racial minoritized students from a deficit perspective. This is evident in research on students identified as underrepresented racial minorities – inclusive of Black students – as researchers claim that these students are able to "identify with the traits of being a scientist, and recognize themselves as a scientist as a result

of their research experience" (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009, p. 201). One particular construct noted in the research literature is STEM identity.

Research specific to STEM identity highlights the importance of factors such as competence, efficacy, confidence, performance and recognition (Adedokun, Bessenbacher, Parker, Kirkham, & Burgess, 2013; Carlone & Johnson, 2007; Hunter, Laursen, & Seymour, 2007; Hurtado et al., 2009; Perez, Cromley, & Kaplan, 2014; Seymour, Hunter, Laursen, & Deantoni, 2004; Thiry, Weston, Laursen, & Hunter, 2012). Not only is the environment in which a person experiences STEM important in helping to foster a STEM identity, but the perception of resources and support (both tangible and intangible) aid in the formation of a STEM identity (Carlone & Johnson, 2007; Lee, 2002; Merolla, Serpe, Stryker, & Schultz, 2012; Merolla & Serpe, 2013). For many researchers, structured undergraduate research experiences (programmatic efforts incorporating academic and financial support with supervised research) serve as a prime environment and experience where all the previously mentioned factors are operating (Pender, Marcotte, Sto Domingo, & Maton, 2010).

The undergraduate research experience is proposed as an optimal environment for the development of a STEM identity due to the resources it affords (National Academies of Science, Engineering, and Medicine, 2017). Undergraduate research experiences are reported to provide benefits and experiences that foster stronger associations between students and STEM, by promoting competence and confidence through increased STEM performance that leads to recognition as a STEM researcher by other STEM professionals (Adedokun et al.,2013; Hunter et al., 2007; Hurtado et al., 2009; Seymour et al., 2004). The undergraduate research experience is suggested to be a transformational site for Black students as indicated in the following statement: "academic enculturation through UREs may help to not only

shape students' learning but also shape their identity as a STEM researcher" (National Academies of Science, Engineering, and Medicine, 2017, p. 3-4).

Though undergraduate research experiences can establish associations with STEM and contribute towards students developing a STEM identity (Hurtado et al., 2009; Merolla & Serpe, 2013), the research literature does not consider students' predispositions to STEM or conceptualizations of their salient identities (e.g., race, gender) within the STEM undergraduate research social setting that can inform the development of their associations. Recognizing and understanding the influence of race, gender, and other salient identities within the STEM undergraduate research context is necessary to fully understand students' development of associations with STEM. It is important to understand the aforementioned constructs because identity, in general, is essentially the negotiation of self with society's value; it is developed over time as one transitions through different phases in life (French, Seidmen, Allen, & Aber, 2006; Miller, 2011). A STEM identity, specifically, is contingent upon factors like the recognition of self by self and others in STEM (Carlone & Johnson, 2007).

Furthermore, research indicates that perceived negative experiences in STEM due to a person's racial and ethnic identity moderates these students' expression of a STEM identity (Chang, Eagan, Lin, Hurtado, 2011). Chang and colleagues' (2011) study implies that a potential relationship exists between the students' racial and ethnic identity and their STEM identity, where occurrences that impact one indirectly influence the other. Using qualitative methodologies, my research project seeks to characterize the influence of Black females' racial, gender, and other salient identities and situates this influence in relation to the premise in the existent literature: the undergraduate research experience fosters the development of a

STEM identity. Additionally, the study examines the extent to which those identities, salient to the study participants, influence the students' retention and matriculation in STEM postsecondary education.

Retention is a term used to describe the enrollment behaviors and patterns of students within the postsecondary context (Berger & Lyon, 2005). Like retention, matriculation often refers to students' continued participation and engagement as they transition from one stage or phase in a particular process to the next (Brown, Morning, & Watkins, 2005; Merolla & Serpe, 2013). Given that both terms focus on students' prolonged engagement or participation within a specific entity, I use the label "continued participation" throughout the remainder of this research project to succinctly refer to retention and matriculation.

Black Student Retention, Matriculation, and Persistence

In educational research, retention is a term used to describe the enrollment behaviors and patterns of students within the postsecondary context (Berger & Lyon, 2005). Measures of retention can occur at four different levels: systematic, institutional, discipline specific, and course specific (Hagedorn, 2005). Systematic or system retention refers to retaining individuals within the higher education system as a whole. Institution retention refers to retention within a specific institution, and discipline or course specific retention looks at retention within a specific discipline or course (Hagedorn, 2005). Matriculation often refers to students' continued participation and engagement as they transition from one stage or phase in a particular process to the next (Brown et al., 2005; Merolla & Serpe, 2013). For the sake of this study, I operationalize retention and matriculation from a discipline-specific perspective, looking at efforts that assist Black females' retention and matriculation in STEM disciplines.

Retention and matriculation are traditionally viewed from an institutional or contextual lens; being contingent upon contextual affordances and restraints imposed on the individual engaged in the environment and the individual's own volition (Bowen, Chingos, & McPherson, 2009; Lang, 2001-2002; Lau, 2003). Research specific to Black student retention and matriculation in STEM fit within those two categories, context and individual. In their investigations, researchers delineate the influence or impact that the environment and the individual has on a student's continued participation and engagement in STEM within the postsecondary educational context. Environmental influences are measured in terms of the students' perception of support within the educational context (Carter, Mandell, & Maton, 2009; Thiry et al., 2011). Research measures individual influences in terms of student persistence (Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015).

Context-Related Literature. Three types of studies exist within the literature on environmental factors that influence or impact Black student retention and matriculation in STEM within the postsecondary educational context. These three types of studies either investigate a particular programmatic effort targeted to improve STEM retention and matriculation, investigate institutional effects on STEM retention and matriculation from pre-identified institution types, or identify successful factors in general that influence STEM retention and matriculation. Collectively, the resources afforded to the students and the influential people that students identify are two common factors found to significantly influence or impact Black student retention and matriculation (Thiry et al., 2011; Ong, Wright, Espinosa, & Orfield, 2011; Tsui, 2007).

The first group of studies investigates the effect of a particular programmatic effort offered to increase STEM engagement and retention for underrepresented students. Examples

of these programs include learning communities, the Meyerhoff Scholarship Program, the Minority Engineering Program, *TheScienceStudy*, and a K-12 Family Model (Freeman, Alston, & Winborne, 2008; Good, Haplin, & Haplin, 2001-2002). Researchers attempt to determine the overall success of the program offered, with students' perception of the program and their expressed intention to stay in STEM being the determining factors of success. The next group of studies looks at the institution that African American students attend and the particular components of the institution that influence STEM matriculation and retention (Burrell, Fleming, Fredericks, & Moore, 2015; Lundy-Wagner, 2013). This group mainly investigates Historically Black Colleges or Universities (HBCUs) to determine if the experiences of African American students at HBCUs differ from the experience of students at a Predominantly White Institution (PWI). The last group of studies seeks to identify successful factors that contribute to STEM retention through obtaining the students' perception of their STEM experience while in college (Gayles & Ampaw, 2014; Ong et al., 2011). This group does not pre-identify institutional differences before their study, but rather waits to determine the possibility of an institutional effect or influence on the basis of collected student responses.

Overall, determining what university efforts successfully attract and retain students in the STEM fields is the goal of this research. Researchers develop conjectures based on the student revelations of factors that they perceive to be most beneficial. As it pertains to the overall STEM environment, research suggests that the environment serves as a source of motivation and encouragement for African American students (Maton, Hrabowski III, & Schmitt, 2000). Students feel encouraged and motivated to continue in STEM because of the family-like structure created by the people, the particular services offered, and the

environmental messages and cues (Freeman et al., 2008; Good et al., 2001-2002; Ong et al., 2011). Program environments that successfully retain students are designed to help students learn STEM and develop associations with STEM through hands-on inquiry, peer support, collaboration, and mentoring (Stolle-McAllister, Sto. Domingo, & Carillo, 2011).

Likewise, studies that pre-identified institutional contexts and services, or studies that organically discovered influential institutional settings and services, suggest similar ideas regarding the influence of the environment (Brown et al., 2005; Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, & Gary, 2009). Researchers reveal that HBCUs produce more supportive and encouraging environments for African American students in STEM (Brown et al., 2005). The cooperative and collaborative culture that HBCUs provide scaffold the supportive and encouraging environments (Essien-Wood & Wood, 2013; Perna et al., 2009). These studies also suggest that institutional selectivity influences STEM matriculation, matriculation being determined by graduation rates: more selective institutions have higher STEM matriculation rates despite the fact that students' overall experience with STEM in more selective institutions is not the best due to perceived discrimination and racism on campus (Brown et al., 2005). Overall, the type of environment constructed has implications for African American students' continued participation in STEM, with supportive and collaborative environments being more favorable for student retention.

Creators of the supportive STEM programs or campus environments (i.e., faculty and staff) reported they intentionally developed conditions that would generate feelings of inclusiveness and support for the students. The construction of supportive environments is the administrators' attempt to provide a holistic approach to the students' development through the integration of academic, social, and emotional support (Kendricks & Arment,

2011; Maton et al., 2000). Holistic approaches are not only dependent on the people in the environment, but they also depend upon the services provided to the participants. Services rendered to the students are determining factors in the students' overall perception of the program and its ability to influence their retention in STEM.

A majority of the services offered by these particular programs or institutions that African American students find beneficial are undergraduate research experiences, peer tutoring, and clustered learning opportunities (Espinosa, 2011; Freeman et al., 2008; Thiry et al., 2011). Some programs, such as the Meyerhoff Scholars Program, offer these services in conjunction with financial aid and support for the students (Maton et al., 2000; Stolle-McAllister et al., 2011). These identified resources are beneficial in helping retain students by supporting the family-like structure and facilitating the development of associations with STEM through a complete immersion into the STEM community via active participation in research and conferences (Seymour et al., 2004; Tsui, 2007). Financial assistance is perceived as a valued resource as well, as it helps alleviate the stress and pressure that students face regarding paying for college (Stolle-McAllister et al., 2011). Financial support allows the students to be more engaged in the STEM environment rather than being disengaged in STEM because of having to work an off-campus job to pay for school (Stolle-McAllister et al., 2011).

Individual-Centric Literature. Individual influences on Black student retention and matriculation in postsecondary STEM are investigated as factors that contribute to the students' persistence in STEM. Persistence refers to the efforts of the individual to remain or succeed in a particular environment (Allen, 1999). Though different from retention and matriculation, student persistence relates to retention and matriculation given their centrality

to the same phenomenon of interest, which is student continued participation (Berger & Lyon, 2005). Relationships and self-efficacy (i.e., belief in one's capabilities to succeed) in STEM are two common factors found within the literature that investigates Black student persistence in STEM (Chang et al., 2014; McClain, 2014; Schultz, Hernandez, Woodcock, Estrada, Chance, Aguilar, & Serpe, 2011; Zhang & Barnett, 2015). These factors promote persistence by influencing Black students' interest in and association with STEM.

Relationships. Relationships established among Black students and their peers, faculty, and other university personnel are essential in helping Black students maintain and retain in STEM. Research demonstrates that these relationships develop during their collegiate experience, particularly within the STEM environment (Chang et al., 2014; Charleston, 2012; Palmer, Maramba, & Dancy II 2011). Non-college based relationships that are beneficial in helping Black students maintain and retain in STEM are relationships that these students have with their family, secondary school teachers and staff, friends, and other identified significant individuals. Specific studies demonstrate the relationships status between the Black students and other significant individuals (e.g., peer, mentor, family, community, etc.), and the influence these relationships have on the students' STEM persistence (Russell & Atwater, 2005; Zhang & Barnett, 2015). Overall, these relationships and their perceived benefits are best discussed by dividing them into two groups: school-based relationships and home-based relationships.

School-based relationships include the relationships between Black students and their peers, teachers, and other staff, that are established either during their secondary or postsecondary education process. Peer relations are most influential in providing motivation and encouragement to persist in STEM via collaboration or conversation, helping students

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learn the content necessary for success, as well as serving as companions (Freeman et al., 2008; Ong et al., 2011; Palmer et al., 2011). Peers may also act as competitors for Black students, being sources of encouragement when the competitors are also Black, or discouraging and detrimental to the ego, confidence, and sense of belonging when the competitors are non-Black (Harper, 2006; Hernandez et al., 2013; McClain, 2014). These types of peer relationships occur on both the secondary and postsecondary level, whereas in secondary education, peer influence has greater implications for students demonstrating a STEM interest (Charleston, 2012). On the postsecondary level, peer influence deals more with students' connection or association with STEM (Palmer et al., 2011).

Other staff relations found to be supportive and encouraging to the students are relationships established with individuals such as program personnel, campus administration, and school counselors. These identified persons serve as gatekeepers for access to STEM programming and services, pertinent knowledge, finances, and information that can help students continue and persist in STEM (Moore III, 2006; Zhang & Barnett, 2015). Teacher and faculty relationships are also crucial relationships for African American students regarding success in education in general (Brown, Kaney, & Johnson, 2014). Countless research studies demonstrate the effect of teacher relationships and expectations on student performance (Corprew III & Cunningham, 2011; Solórzano, 1997; Stewart, 2007-2008). Findings that reveal teacher expectations to have grave implications for student learning and engagement carry over to the STEM literature as well. Teacher relationships during the secondary education process shape African American students' pursuit of STEM (Charleston, 2012; Kane, 2016; Moore III, 2006; Russell & Atwater, 2005). Some studies suggest that these teachers convey lower expectations of African Americans; therefore,

creating a situation that does not foster strong associations with STEM for African American students (Burrell, Fleming, Fredericks, & Moore, 2015; Ong et al., 2011).

On the collegiate level, faculty attitudes can influence African American students' persistence in STEM (Beasley & Fischer, 2012; Chang et al., 2014). Negative attitudes towards African American students lead students to develop oppositional beliefs towards STEM (Beasley & Fischer, 2012; Chang et al., 2014). This is especially true when faculty attempt to weed out students in introductory STEM courses (Hurtado et al,2009). Faculty can also support the development of positive STEM associations for African American students as they serve as guides and mentors for the students, particularly for those who participate in undergraduate research (Adedokun, Zhang, Parker, Bessenbacher, Childress, & Burgess, 2012). Faculty may serve as nurturers, caregivers, or "extended parents," providing African American students with the necessary love, support, and guidance to overcome challenges and obstacles faced when engaged with STEM (Kendricks & Arment, 2011; Maton et al., 2000).

Home-based relationships provide similar benefits for African American students engaged with STEM. Family members are instrumental in introducing their children to STEM and keeping them motivated and encouraged to continue in STEM (Charleston, 2012; Moore III, 2006). This introduction and motivation occurs directly through messages of love or support, or vicariously by modeling STEM persistence as a successful member of the STEM community (Charleston, 2012; Moore III, 2006). Additionally, research shows that parental practices can influence African American students' goal orientations and overall academic engagement (Hill & Wang, 2015; Kim, 2015). Collectively, these studies suggest that home-based relationships can not only dictate student exposure to STEM but they also

can determine how students engage with STEM over time. Black families and Black communities also serve as protective mechanisms and factors for Black students in STEM, teaching lessons of self-worth, self-efficacy, and self-confidence (McGee & Spencer, 2013).

Overall, the type of relationships that Black students establish with people from school, home, or their larger community has implications for STEM retention and matriculation in postsecondary education by way of STEM interest and STEM associations. These relationships provide Black students with various forms of support and resources, as well as the motivation necessary to persist through the challenges and barriers surrounding STEM achievement and attainment. Additionally, these relationships assist Black students in developing stronger associations with STEM.

Self-efficacy. Self-efficacy is the degree to which an individual believes that they are capable of handling and addressing a specific task or goal (Bandura, 1989). Literature specific to Black student persistence in STEM suggests that self-efficacy is an outcome established from students' confidence, experience, and exposure in STEM (Hurtado et al., 2009; Moore III, 2006). Black students are able to develop confidence and obtain experience and exposure through their engagement and achievement in various STEM settings. Performance indicators and messages of support from significant individuals (i.e., STEM professionals, family, and community members) provide Black students with the opportunity to establish confidence within STEM as well as the belief that they have the necessary exposure and experience in STEM to feel efficacious (Griffith, 2010; Hunter et al., 2007; McClain, 2014; Schultz et al., 2011).

Performance indicators. Performance indicators, such as students' prior academic achievement, aid in the students' development of self-efficacy in STEM (Beasley & Fischer,

2012; Espinosa, 2011; Griffith, 2010) contributing to their persistence in STEM (Chang et al., 2014). Prior academic achievement refers to students' pre-college academic performance. Researchers investigating the influence of prior academic achievement for Black students reveal that it serves as a mediating factor for demographic effects or cultural influences on STEM persistence (Burrell et al., 2015; Chang et al., 2014; Gayles & Ampaw, 2014; McClain, 2014).

There are discrepancies within the research literature regarding which pre-college academic factor is most influential in Black students' persistence in STEM. Some research indicates SAT score as the only significant variable associated with STEM persistence (Chang et al., 2014) whereas other studies suggested high school GPA to be the only important pre-college indicator of STEM persistence (Espinosa, 2011). Others argue that it is the number of STEM-based advanced placement courses completed that has implications for STEM persistence beyond the sophomore year in college (Griffith, 2010). Despite differences in research findings of which factor is most important, high school preparation in its multifaceted forms moderates the relationship between race and STEM persistence, where race predicts lower STEM persistence for Black students compared to White and Asian Americans (Beasley & Fischer, 2012; Chang et al., 2014). High school preparation also moderates a gender effect on STEM participation; it has a greater influence on the STEM persistence of females in comparison to males (Gayles & Ampaw, 2014).

Black students' perception of their prior academic achievement also influences their confidence in STEM (McClain, 2014; Moore III, 2006). McClain (2014) found that students felt more efficacious and confident in their STEM abilities when they were able to demonstrate progress in their STEM academic achievement during high school. Their actual

scores in their STEM classes did not impact their desire to continue in STEM. It was the lessons of hard work, perseverance, and persistence demonstrated by their improvement in the courses, which helped them feel more confident in their abilities to succeed in STEM over the long haul (McClain, 2014). High academic achievement in high school informs Black students' confidence and decision to persist in STEM as high performance led students to believe that they had a high aptitude in STEM despite no initial interest in STEM or effort put forth to be successful in STEM (Moore III, 2006).

STEM exposure and experience obtained from prior academic achievements also influences Black students' persistence in STEM (Beasley & Fischer, 2012; Palmer et al., 2011; Moore III, 2006). Moore III (2006) found that continued experiences and exposure in STEM, for those students who had high aptitudes in STEM, gradually increased their interest in STEM, contributing to their persistence in STEM. Palmer et al. (2011) revealed that exposure and experience in STEM during elementary and secondary schooling increased Black students' awareness and efficacy in STEM, helping to foster a stronger association with STEM. Experience in STEM also brought about negative connotations for Black student persistence, as Beasley and Fischer (2012) show that Black students demonstrated higher measures of performance anxiety in their STEM experiences compared to other races. High performance anxiety resulted in higher attrition rates in STEM for Black students (Beasley & Fischer, 2012).

Messages of support. Supportive messages and cues from identified, significant individuals inform Black students' self-efficacy. Undergraduate research mentors that take on a master-apprentice type relationship with Black students help these students develop self-efficacy and self-confidence in STEM (Hunter et al., 2007). It is because of their guidance,

support, and teachings that Black students are able to garnish a better understanding of STEM, STEM careers, and STEM conceptual and procedural knowledge (Hunter et al, 2007; Hurtado et al., 2009). Likewise, supportive messages and cues from home and their home community assist Black students in developing self-efficacy in STEM, as these messages often teach the students how to handle and address challenges that may arise within STEM fields that are due to their race or racism (McGee & Spencer, 2013).

Research Questions

Educational research surrounding STEM retention and matriculation focus on the various affordances of targeted efforts such as the undergraduate research experience (Adedokun et al., 2012; Carter et al., 2009; Freeman et al., 2008; Good et al., 2001-2002; Hunter et al., 2007; Hurtado et al., 2009). Individual contributions to STEM retention and matriculation (i.e., student persistence), by way of these targeted efforts are not thoroughly investigated beyond factors deemed contributory to students' development of a STEM identity (Hurtado et al., 2009; Merolla & Serpe, 2013). Information gathered from the previously discussed studies are limited: they do not include students' predispositions to STEM or conceptualizations and understandings of their existent salient identities. Additionally, these studies investigate underrepresented racialized students from a deficit perspective.

To address the gap in the research literature regarding the influence of students' salient identities on STEM persistence, this qualitative research study investigated from an asset-based perspective the extent to which race, gender, and other salient identities influence the perceptions and experiences of Black undergraduate females participating in a structured undergraduate research program.

The following questions inform this research:

1.   How do Black female students participating in STEM undergraduate research
      programs conceptualize their race, gender, and other salient identities within
      their STEM experiences?

2.   How do Black females in STEM undergraduate research experiences position
      their race, gender, and other salient identities? Does their identity positioning
      inform their persistence in STEM? If so, how?

3.   How do Black females in STEM undergraduate research programs perceive
      STEM and their STEM undergraduate research experience? To what extent
      does their identity inform these perceptions?

4.   To what extent does Black females' conceptualization of their race, gender,
      and other salient identities inform their expressed association with STEM?

Answers to these research questions address gaps in the research literature concerning salient
identifiers, especially as they relate to STEM identity and the undergraduate research
experience. Additionally, the use of an asset-based perspective, specifically
Phenomenological Variant Ecological Systems Theory (PVEST) to discuss the findings,
offers an alternative perspective to what is pervasive in the existent research. This research
contributes to the growing literature regarding the importance of investigating and
understanding race, gender, and other identities influence on student retention. This research
also introduces to the postsecondary educational research settings the concept of studying
students' racial and cultural associations with STEM, a concept heavily researched in the K-
12 setting (Archer, Dewitt, & Osborne, 2015; Costa, 1995; Parsons & Carlone, 2013; Lee,
1999), but currently limited in the postsecondary educational setting.

Significance of Study

Research conducted to understand the impact and influence of efforts to increase the retention and matriculation of Black students in STEM (i.e., the undergraduate research experience) focus on the contributions that the research experience provides Black students and how those contributions inform their STEM identity (Adedokun et al., 2011; Hurtado et al., 2009). The literature contains very few studies that investigate the contributions of individual factors such as students' understanding and positioning of their racial, gender and other salient identities within STEM, in general, and undergraduate research experiences, in particular, thereby, creating a majoritarian narrative for underrepresented students. With respect to Black students, the majoritarian narrative is "colorblind" and excludes the influences and impacts of race and racism. The complexities of retaining traditionally underrepresented groups in STEM and the increasing demand for STEM professionals warrant the investigation of salient identifiers like race and gender.

My study investigated Black females' conceptualization of race, gender, and other salient identities within STEM experiences, including the undergraduate research experience, and their contribution to STEM persistence, retention, and matriculation. This study was unique in that it investigated students' identities and their influence on their persistence in the postsecondary STEM context (areas of research that are extremely limited in this body of literature). It also used a strengths-based approach, Phenomenological Variant Ecological Systems Theory (Spencer, 2006), to understand the influence of demographic variables and their associated experiences on STEM persistence, retention and matriculation in the undergraduate research context. This study gave voice to the students engaging in the experience, allowing them to share and possibly feel empowered by the potential strengths,

assets, and value that their traditionally marginalized identities afford them in their STEM persistence. This approach is different from the previous studies, which do not look at individual contributions to the research experience, but rather focus on how context shapes, molds, and transforms Black students into society's perception of a successful person in STEM.

Little is known about the strengths or assets that Black students bring into their research experiences that contribute to their STEM identity and decision to remain in STEM (Harper, 2009b, 2010). Understanding the value and influence of identifiers and experiences associated with them creates a different narrative from what is currently presented regarding Black females' perceptions and experiences during the undergraduate research experience. Furthermore, investigating the strength and power behind identifiers creates a socially just situation where Black females can feel empowered and valued within the STEM environment rather than marginalized or stereotyped (Chapman, 2013; Nicolas, Helms, Jernigan, Sass, Skrzypek, & DeSilva, 2008). Allowing students to open up about their past experiences and development to reveal how they have positively contributed to their understanding of themselves within the STEM context gives students a voice (Delgado, 1989). This information may prove useful to researchers and practitioners in re-conceptualizing influential constructs on STEM retention and matriculation, leading to the formation of optimal learning environments for STEM retention and matriculation.

My positionality impacts the overall project focus and the approaches I employ. My positionality is informed by the knowledge, experience, assumptions, and understanding of Black students' perceptions of and experiences in STEM undergraduate research programs

that I have gained over time through my own trajectory and experience as a Black male who studied the physical and biomedical sciences.

Positionality

Positionality is the perspective that a researcher brings into the research context; this perspective is based on the researcher's knowledge and experience of the world (Glesne, 2011). A researcher's positionality is influenced by their "fixed" personal characteristics (e.g., skin color, age, size, gender, etc.) and overall subjective stance based on ascribed (e.g., nationality and ancestry), or achieved characteristics, such as an individual's educational level, economic level, or institutional affiliation (Glesne, 2011). When conducting qualitative research, it is important for researchers to understand their positionality as it shapes their overall research design and perspective of the study. Scholars suggest researchers should examine themselves, their relations to others, and participate in engaged reflection with individuals from the population of interest, particularly when working with individuals from different races and cultures (Milner IV, 2007).

As a Black, African American male with a background in STEM, I readily identify with the participants of my proposed research study (Black, collegiate students in STEM). Throughout my educational career, I have had the opportunity to study at a HBCU and a public and private PWI. My personal and educational experience affords me an "insider's" perspective on the unique benefits and challenges associated with both types of institutions. Being a member of this population and knowledgeable of cultures and ways of being, my knowledge and experience informs my positioning and lens for my research. I view culture as, "symbolic forms through which people experience and express meaning" (Swidler, 1986, p. 273). It is an embodiment of a particular set of ideals, beliefs, and values that individuals

perform, utilize, and express. Lastly, critical race theory elucidates the underlying premises

of my positioning, informing how I perceive, interpret, and understand the research literature

and problem, in addition to the methodological approach I pursue.

Critical race theory. Critical Race Theory (CRT) is both a theoretical and

methodological framework that investigates and uncovers issues of oppression and power as

experienced by individuals from racialized groups (Harper, 2009a; Lynn & Dixson, 2013).

CRT acknowledges racism, pointing out how racist ideology is perpetuated throughout

society; and, how racism is maintained and promoted in social structures through their

policies, procedures, and practices (Lynn & Dixson, 2013). Parsons, Bulls, Atwater, Butler,

and Freeman (2016) define racism as:

> a hierarchical superior-inferior relationship among races that is established and
> maintained by power enacted through social and institutional practices
> (Bonilla-Silva, 1997). The hierarchical superior-inferior relationships are
> founded on perceived genetically-based differences, visible differences
> consciously and subconsciously believed to be linked to socially relevant
> abilities and characteristics (van den Berghe, 1967). These differences are
> considered a legitimate basis for the arrangement and positioning of groups in
> society (Byng, 2013).

CRT promotes racial-awareness and equity throughout society and its structures, challenging

researchers and practitioners to be more critical in their behaviors and actions to promote

socially just services and opportunities (Lynn & Dixson, 2013).

As a theory, CRT is comprised of several components, often identified as tenets.

These components focus on exposing race and racism embedded within American society,

dispelling any thoughts or myths associated with meritocracy and colorblindness, embracing

the concept of intersectional experiences, and empowering marginalized voices through

counter-narratives (Bell, 1992; Delgado, 1989; Gotanda, 1991, 2000; Ladson-Billings &

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Tate, 1995). CRT tenets and assumptions that inform my perspective, directly shaping this research study, are racial realism, the myth of colorblindness, and counter-storytelling.

Racial realism. One of the main tenets or constructs of CRT is that race and racism are endemic to American society (Bell, 1992). Critical analyses of the United States' governing documents and laws demonstrate that the concept of race is socially constructed (Gotanda, 1991; Haney López, 1994). Negative connotations of race stem from discriminatory and racist ideology that perpetuated and legalized the enslavement and marginalization of people from African descent based solely on morphology and ancestry (Haney López, 1994; Harris, 1993; Omi & Winant, 1994). In accepting and understanding the deep-rootedness of racism within American society, CRT suggests that individuals determined to improve society must work to combat racist and discriminatory ideologies and practices. Derrick Bell (1992) coined this belief as racial realism. Racial realism purports that racism is permanent and racial equality is not a realistic goal within the current structure; but rather than submit to an oppressive society or align with its ideals, people should resist and fight, with the hope of improving society. Having a racial realistic perspective, I recognize that race and racism are prevalent and present in all social structures, influencing my perspective on any information I ascertain regarding STEM retention and matriculation.

Myth of colorblindness. Colorblind approaches assume all things are equal when it comes to lived experiences and society. That is, it assumes racial neutrality as a goal and the ideal. Analyzing Supreme Court cases over the years, Gotanda (1991) reveals that a colorblind approach to law interpretation fails to connect the lived experiences of individuals to their assigned racial categorizations and corresponding meanings, as individuals of non-white races experience life differently based on their associated race. Gotanda (2000)

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therefore suggests that a colorblind approach disenfranchises non-white individuals, perpetuating social stratification in America based on race. Harris (1990), providing the historical context of the governing documents such as the Declaration of Independence, reveals that statements such as "We the people" do not include the voices and thoughts of individuals of color or women due to the white supremacist, patriarchal ideologies of the era. She also argues that "one voice" does not represent the people since individuals are not comprised of a single consciousness, but are made up of "multiple consciousness" or "multiple selves" that are products of intersecting identities and experiences (Harris, 1990). Her belief in intersectionality challenges the concept of colorblindness as she states that a colorblind approach creates an essentialist point of view regarding individuals and their capabilities or abilities (Harris, 1990).

Like Harris (1990) and others, I too believe that awareness of and embracing intersectionality and multiple consciousness generate a better understanding of people, their thought process and subsequent behaviors. Like Gotanda (1991) and Harris (1990), I also believe colorblindness does not exist. Due to the embeddedness of racism in the U.S, individuals see race, they either acknowledge it or not. Consequently, a race consciousness perspective is warranted when investigating human development and performance.

Counter-storytelling. Critical race methodology is a research approach grounded in CRT that situates race and racism in the research process, challenges traditional research paradigms, and focuses on the lived racialized, gendered, and classed experiences of people or color as a way to provide transformative solutions (Solórzano & Yosso, 2002). Situating race and racism in the research process, critical race methodology attempts to reveal and address majoritarian narratives created about people of color. These narratives are based on

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white privilege (Solórzano & Yosso, 2002). Majoritarian narratives portray the white, middle-class male as the norm and "good", with men and women of color and people in poverty stereotyped as being the "other" and "bad" (Solórzano & Yosso, 2002). To dispel such notions, critical race methodology uses counter-storytelling. Counter-storytelling elevates and validates the voices and experiences of people of color. I describe how I used counter-storytelling in chapter 3, the chapter on methodology.

The use of counter-storytelling reflects my positionality in two ways. First, counter-storytelling provides a methodological framing that allows me to address the dominant perspective constructed within the research literature regarding Black student retention, STEM identity, and undergraduate research experiences. In acknowledging the racism inherent within the dominant perspective – a racial realistic approach – counter-storytelling provides the outlet to explore the perceptions and experiences of Black females as a way to construct their narrative (Solórzano & Yosso, 2002).

Secondly, counter-storytelling is applicable to my decisions regarding how I choose to present the findings obtained for this study. Throughout my educational tenure, I have had the opportunity to learn about the trials and tribulations Black faculty in the academy face, particularly those who take a critical stance with their research agenda. Research literature demonstrates the inherent racism and bias that occurs within the academy regarding the scholarship created by Black scholars; this scholarship is challenged on the basis of Eurocentric epistemological norms (Bernal & Villalpando, 2002; Diggs, Garrison-Wade, Estrada, & Galindo, 2009).

As a Black male scholar-activist, I acknowledge both the struggle that Black scholars face because of institutionalized racism within the academy, and I push against what is

considered legitimate knowledge and traditional norms of presenting it. Embracing the ideologies of counter-storytelling, I choose to take an alternative approach to represent the study's findings. Alternative reporting styles allow researchers, "to work out and spotlight particular ironies or paradoxes inherent in particular positions and cultural conventions" (Coffey & Atkinson, 1996, p. 123). My representation of the study's findings is situated within my cultural resources (Bernal & Villalpando, 2002) of artistic expression. Situating the findings in my cultural resources, explicating them in an empirical manner while simultaneously challenging the norms of traditional presentation, is a form of transformational resistance – critiquing social oppression and seeking social justice reform (Solórzano & Bernal, 2001).

Summary. In agreement with scholars who call for a cultural, historical, and developmental understanding of African Americans in science education (Parsons, 2008), I believe that my identities and experiences serve as an asset for this research rather than an impediment that can lead to any biases. As a Black male educational researcher, studying STEM, I am cognizant of the perceptions and stereotypes constructed of Black students in STEM by educational researchers and STEM practitioners. This perspective is one in which Black students are often viewed from a deficit perspective. I have a vested interest in my selected population of study and am committed to disclosing their stories in full; producing as accurate of a representation of their experience as possible. CRT orients my research approach, provides the foundational premises from which I operate, as I strive to challenge current knowledge about the undergraduate research experience on Black student retention and matriculation on the basis that these perspectives do not incorporate an understanding of racism, race, and intersectional identities on Black student perceptions and experiences.

My upbringing, experiences, beliefs, and knowledge are the basis of my positionality. I believe that all individuals are both lovable and capable! I have a strong desire to not only address the oppression and injustice Black people have faced within the US, but I feel obligated to advocate and fight for change. Not just for my people, but for all people facing injustice and oppression. My positionality shapes this research proposal, informing my perspective on the problem, the existent research, my questions, and proposed method of inquiry.

Chapter One Summary and Dissertation Overview

Chapter one introduced the importance of STEM to the U.S. and the U.S. response to increase the human capital necessary to address STEM demands. Chapter one also provided a brief overview of the current state of STEM retention; it introduced the topic of the research, the statement of the problem, research questions, and the significance of the study. Chapter two contains the review of the related literature on undergraduate research experiences and literature on identity, relevant to the guiding research questions. Chapter two also introduces Phenomenological Variant Ecological Systems Theory (Spencer, 2006) (PVEST), the conceptual framework for positioning and discussing the study's findings. Chapter three presents the methodology and procedures used to collect and interpret data, the context of interest, and the research sample. I present the findings in chapter four and discuss them at length. Chapter five provides the implications of the study and future directions.

Chapter 2: URE and STEM Identity Development

Chapter two presents a review and critique of the literature on the undergraduate research experience, setting the stage for the counter-story regarding the perception and influence of race, gender, and other identity expression for Black females' STEM identity development and retention via undergraduate research experiences. Situating race and racism at the forefront of my synthesis and critique (Solórzano & Yosso, 2002), I uncover the limitations of the literature exposing the disseminated majoritarian narrative regarding Black students in STEM undergraduate research experiences. Theoretical and conceptual frameworks used within the varying studies promulgate the majoritarian narrative regarding the influence research experiences have on STEM retention and matriculation via STEM identity. Chapter two also introduces the conceptual framework for this study, Phenomenological Variant Ecological Systems Theory. I present Phenomenological Variant Ecological Systems Theory as the appropriate framework for producing the counter-story regarding Black females' perception and conceptualization of their race, gender, and other identities influence on their STEM identity and retention. I provide an overview of the theory, research using the theory, and the theory's stance on identity.

Undergraduate research experiences are reported to provide benefits and experiences that foster stronger associations between students and STEM (Adedokun et al.,2013; Hunter et al., 2007; Seymour et al., 2004). Stronger associations with STEM function to increase STEM graduation rates and the number of students that matriculate into STEM graduate

programs and careers (Carter et al., 2009; Lopatto 2004; National Academies of Science, Engineering, and Medicine, 2017; Thiry et al., 2012). Based on theoretical orientations, researchers position the undergraduate research experience to be a transformative context for Black students' identity. Undergraduate research experiences are presumed to be transformative for Black students as they address "race-based deficiencies" to incorporate aspects related to STEM (Marlone & Barabino, 2009; Hurtado et al., 2009) via the capital they provide, developing the necessary skills through immersive programs (immersion into STEM culture) that promote a STEM identity.

STEM Undergraduate Research Experience

The promises and the perils of undergraduate research experience[2] (URE) have been topics of national interest since 1998, with the release of the Boyer Commission report that called for research-based learning to occur in American colleges and universities (Pender et al., 2010). This report positioned URE to be beneficial in not only improving and enhancing students' learning through inquiry but also in ensuring more students matriculated to and through graduate programs (Pender et al., 2010). The Boyer Commission report specifically highlighted research-intensive universities, suggesting that all colleges and universities take

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[2] Within the literature, the definitions of URE vary. The definitions vary according to the type of research in which an individual can participate (e.g., academic, industry, government) and the duration of the research project (e.g., summer, academic semester, academic year). Deviations also exist with respect to the stage of higher education in which an individual participates (e.g., sophomore, junior, senior year of college), and the extent to which other services are offered in conjunction with research (Carter et al., 2009; Thiry et al., 2012). Despite the fact that these differences can determine the overall success and outcome of URE on continued STEM participation (O'Donnell, Botelho, Brown, González, & Head, 2015), for the sake of this review, all of the programmatic variations described encompass what I define as the undergraduate research experience. Although science, technology, engineering, and mathematics are distinct disciplines with unique challenges (Brown et al., 2005), for the sake of my review, I use STEM to represent all of these disciplines, their commonalities and distinctions.

on more creative approaches to teaching that "draws on the mode of inquiry that is fundamental to [research universities'] research and scholarly activities and their training of graduate students" (Katkins, 2003, p. 22). In response to this report, funding agencies and universities invested more efforts and resources to provide students with the opportunity to participate in URE, ushering in a wave of research to investigate the outcomes of this endeavor (Hunter et al., 2007).

As a result of the increased attention to undergraduate research, a large corpus of educational research literature exists regarding URE. To locate research on this information, I conducted a comprehensive investigation on terms such as undergraduate research (experience), STEM research, research programs, STEM retention, STEM matriculation, etc. I selected and reviewed more than 20 articles. The articles were published in peer-reviewed journals, with journal quality determined by their journal index or specificity (i.e., journals specific to STEM or STEM education). Articles whose authors are experts in the field (determined by frequent publication and citing on this topic) were included despite the type of the journal that published the study.

Research explores the overall benefits of URE (Seymour et al., 2004; Thiry et al., 2012), the predicted or surveyed outcomes of URE (Bauer & Bennett, 2003; Eagan Jr., Hurtado, Chang, Garcia, Herrera, & Garibay, 2013), and the experiences of those who have participated in URE (Craney, McKay, Mazzeo, Morris, Prigodich, & de Groot, 2011). Collectively, this work surmises that URE is useful in improving and influencing students' continued participation in STEM (Lopatto, 2004; Strayhorn, 2010b). It also suggests that participation in URE provides these students with an opportunity to develop associations with STEM (Harsh, Maltese, & Tai, 2011).

Benefits of URE

In investigating the overall benefits of URE, educational researchers have employed a variety of approaches to determine what participation affords students. Based on the literature, students who participate in URE report faculty mentorship, peer relationships, hands-on inquiry, and immersion within the STEM community as facilitating their continuation in STEM (Seymour et al., 2004). Research indicates each particular component benefits the students differently. Having a hands-on learning experience provides students with the opportunity to increase their conceptual and practical knowledge of the particular STEM discipline (Craney et al., 2011). Students report the relationships they establish with their faculty mentors, peers, and other members of the STEM community function to affirm their identity in STEM (Hurtado et al., 2009). Researchers have also determined the benefit of multi-year participation in URE, discovering that individuals who have multiple engagements in URE have higher-order conceptualizations in STEM and better critical thinking skills as compared to those who do not have multiple research experiences (Thiry et al., 2012).

Participating in URE affords individuals exposure to STEM careers and possibilities beyond their immediate STEM engagement (Adedokun et al., 2012; Thiry et al., 2011). URE immerses participants into STEM through their engagement in research projects and pertinent activities with their mentors and other lab members (Craney et al., 2011). Individuals are able to participate in lab meetings and travel to and present at conferences, where they meet and interact with STEM professionals (Adedokun et al., 2012). Interacting with STEM professionals in this manner affords the participants an opportunity to develop a stronger association with STEM as their competence in STEM is enhanced and their

recognition by others in STEM increases (Hurtado et al., 2009; Seymour et al.,2004; Tsui, 2007). UREs that contain additional resources such as financial support benefit students by helping alleviate the stress and pressure they may face regarding paying for college (Stolle-McAllister et al., 2011). To determine the impact of URE's benefits, researchers have investigated the overall outcomes of student engagement in URE.

Outcomes of URE

Studies interested in determining the outcomes of URE participation examine the educational and career trajectories of individuals who participated in URE and how those paths mirror or are different from persons who did not take part in URE. Researchers determined that students who participate in URE are more likely to be involved in a STEM graduate program or STEM career than individuals who do not (Bauer & Bennett, 2003; Carter et al., 2009; Lopatto 2004). Participation in URE leads to an increase in task and performance goals and a decrease in avoidance goals regarding continued participation in STEM (Hernandez et al., 2013). Researchers have developed models to determine the probability of intending to enroll in a STEM professional or graduate program; these models reveal participation in URE increases the probability of students continuing in STEM after their undergraduate education (Eagan Jr. et al., 2013; Pender et al., 2010). Eagan Jr. and colleagues (2013) also determined that faculty and graduate student interactions during the URE lead to increased graduate program attainment for the undergraduate students.

Experiences in URE

With respect to the students' experiences in URE, research reveals that participants of URE find the experience to be influential in developing a better understanding of the STEM discipline, its subsequent community, and potential careers that they could pursue (Adedokun

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et al., 2012; Bauer & Bennett, 2003; Hunter et al., 2007). Students describe their overall

perception of URE. They report differences in faculty treatment based on the race and gender

of the faculty (Frierson Jr., Hargrove, & Lewis, 1994), and express the belief that URE aids

in their personal and professional development because of the training they receive and the

expectations imposed on them (Thiry et al., 2011). Students also report that participating in

URE leads to an increased self-concept (i.e., overall confidence and belief in self) and self-

efficacy (i.e., belief in one's capabilities to succeed) in STEM, providing a transformative

experience that helps them develop a science or STEM identity (Hunter et al., 2007).

Summary

Synthesizing and interpreting their conclusions, URE contributes to continued

participation in STEM because it fosters STEM identity development, helping students

envision a possibility of long-term STEM engagement. Students who participate in URE are

more likely to continue in STEM because URE "increase[s] their confidence that they can

succeed in [STEM]" (Thiry et al., 2012, p. 270). Additionally, there is an increase in "student

perceptions of their abilities and confidence in conducting research [being] a critical link

between their acquisition of research skills and knowledge, and what they do with these

skills, including their aspirations for a research career" (Adedokun et al., 2013, p. 948). This

connection implies that URE influences continued participation in STEM via the formation

of a STEM identity. An individual's STEM identity is contingent upon their interest, their

self-efficacy and self-confidence as it relates to STEM, and their conceptual and practical

knowledge of their particular STEM discipline (Hurtado et al. 2009; Hunter et al., 2007;

Seymour et al., 2004). Identity development contributing to continued participation in STEM

is an inference based on the theory, model, or conceptual framework that the authors use to inform their thinking and study.

The Majoritarian Narrative: URE – STEM Identity Development Link and Theory

In educational research, theory is an analytic tool that is used to inform the researcher's perspective on "what is important and what is superficial" when it comes to the data obtained from the research study (Suppes, 1974, p. 4). Theory has the propensity to organize or "reorganize [a researcher's] way of thinking" (Suppes, 1974, p.4). Like theory, models and conceptual frameworks serve in this same capacity when it comes to investigating, interpreting, and understanding the data gathered (Gall, Gall, & Borg, 2003). Studies examining URE employ a variety of theoretical frameworks, conceptual frameworks, or models to analyze and interpret their findings. Social capital theory, social cognitive career theory, and sociocultural theory dominate the literature. These frameworks promulgate the majoritarian narrative regarding undergraduate research experiences transforming Black students; UREs promoting a STEM identity by incorporating aspects related to STEM to address "race-based deficiencies" via the capital they provide that develops research knowledge through STEM-immersive programs (Hunter et al., 2007; Hurtado et al., 2009; Marlone & Barabino, 2009; Seymour et al., 2004; Thiry et al., 2012).

STEM Identity

Research specific to STEM identity suggest a STEM identity to be strong associations or affiliations with STEM. These associations are exhibited by competence, efficacy, and confidence in STEM content and procedures; and confirmed by individuals' STEM performances and recognition of those performances from STEM professionals (Adedokun et al., 2013; Carlone & Johnson, 2007; Hunter et al., 2007; Hurtado et al., 2009; Perez et al.,

2014; Seymour et al., 2004; Thiry et al., 2012). Not only is the environment in which a person experiences and engages with STEM important in helping foster a STEM identity, but the perception of resources and support (both tangible and intangible) aid in the formation of a STEM identity (Carlone & Johnson, 2007; Lee, 2002; Merolla et al., 2012; Merolla & Serpe, 2013).

For many researchers, structured undergraduate research experiences (programmatic efforts that incorporate academic and financial support with supervised research) serve as a prime environment where students have access to all of these factors (Pender et al., 2010). UREs "enhance students' learning experiences and increase persistence during college, boost interest in STEM careers, and encourage pursuit of graduate education in STEM disciplines" (Pender et al., 2010, p. 4). As a result of their participation and engagement in the undergraduate research experience, studies suggest that students are more prone to retain, persist, and matriculate in STEM (Good et al., 2001-2002; Palmer et al., 2011; Tsui, 2007).

Within these particular studies using social capital theory, the authors are interested in determining the extent to which URE contributed to the students' success in continued participation, under the presumption that URE provides an added benefit or advantage over non-participation in URE and this advantage contributes to the development of a STEM identity (Bauer & Bennett, 2003; Carter et al., 2009). Other frameworks used are social learning theories, including social cognitive and sociocultural theories, and Carlone and Johnson's (2007) science identity framework. These studies are mostly qualitative studies taking a constructivist paradigmatic approach, using phenomenology to reveal the student experience (Hunter et al., 2007; Hurtado et al., 2009).

Social Capital Theory

Multiple versions of social capital theory exist. Social capital refers to the relationships, social networks, and interpersonal interactions between families, community members, peers, and other group members (Bourdieu, 1986). As a theoretical concept, social capital, "accepts the principle of rational or purposive action and attempts to show how that principle, in conjunction with particular social contexts, can account not only for the actions of individuals in particular contexts but also for the development of social organizations" (Coleman, 1988, p. S96). Most prevalent and pertinent to the URE research literature are Bourdieu's social capital theory (1986) and Coleman's social capital theory (1988). Researchers use social capital theory to suggest URE provides resources, tools, and knowledge that are an added benefit for continued participation in STEM (Jones, Barlow, & Villarejo, 2010; Lopatto, 2004; Strayhorn, 2010b), where individuals who participate in URE are more likely to remain in STEM post-college than people who do not (Bauer & Bennett, 2003, Craney et al., 2011; Lopatto, 2004, 2007).

Researchers also utilize social capital theory in their investigations of student experiences in URE. These studies expand upon the concept of URE being value added for continued participation. Researchers specifically highlight faculty mentor relationships, peer relationships, hands-on engagement, and complete immersion in the STEM context as specific types of capital afforded to individuals that participate in UREs (Frierson Jr. et al., 1994; Harsh, Maltese, & Tai, 2012; Seymour et al., 2004). Researchers suggest this specified capital functions to enhance or expand students' feelings and association with STEM, in addition to their understanding of STEM careers (Frierson Jr. et al., 1994; Harsh et al., 2012; Seymor et al., 2004). Students utilize this capital to create or enhance their associations with

STEM, developing a sense of self-confidence in their STEM academic ability, increasing their desire to remain in STEM (Craney et al., 2011; Seymour et al., 2004).

The acquisition of capital from participation in URE over not participating in URE (e.g., Bourdieu) and the transformative qualities of the various types of capital (e.g., Coleman) are frameworks used to infer how URE contributes to STEM retention. Social capital theory thus identifies specific components of URE that positively advances the students who participate in it (Frierson Jr. et al., 1994; Seymor et al., 2004). Additionally, social capital studies provide empirical evidence of URE contributing to continued participation in STEM (Lopatto, 2004, 2007).

Social Cognitive Career Theory

Social cognitive career theory is a theoretical framework that investigates the relationships between cognitive and interpersonal factors and internal and external influences on career behavior and choice among individuals (Lent, Brown, & Hackett, 2005). Derived from social cognitive theory,[3] the primary constructs associated with social cognitive career theory are self-efficacy (and the role it plays in determining behavior), outcome expectations, and personal goals. In social cognitive career theory, self-efficacy is seen as, "a dynamic set of beliefs that are specific to particular performance domains, and that interact in a complex way with other person, behavior, and environmental factors" (Lent et al., 2005, p. 262).

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[3] Social cognitive theory focuses on personal, environmental, and behavioral aspects that contribute to the internalized learning process (Bandura, 1989). It suggests individuals are both products of and contributors to their environment, and the capacity to which an individual can act on or influence their environment (agency), plays a role in shaping and determining a person's actions (Bandura, 1989). Social cognitive theory posits learning occurs through observation and social modeling and consciousness can overrule instinct in the decision-making process (Schunk, 2012).

Researchers employ social cognitive career theory to investigate the extent to which self-efficacy beliefs and self-confidence, obtained through participation in URE, serve as mediating factors to STEM career interest (Adedokun et al., 2013).

Researchers conclude that research skills obtained from participation in URE have both a direct and indirect effect on STEM career aspirations post-graduation (Adedokun, et al., 2013). Research self-efficacy – perceived confidence to successfully conduct scientific research (Adedokun, et al., 2013, p. 946) – positively relates to aspirations for STEM careers. Adedokun and colleagues also show a direct, positive relationship between research skills and research self-efficacy (2013), leading them to surmise that research self-efficacy mediates the indirect effect between research skills and aspirations for a STEM career. Efficacy and confidence – elements of a STEM identity (Carlone & Johnson, 2007; Hunter et al., 2007) – therefore, contribute to students' association with STEM, as they relate to and predict STEM career aspirations (Adedokun, et al., 2013).

Sociocultural Theory

Communities of practice, the zone of proximal development, and cognitive apprenticeship are the types of sociocultural theory[4] used in URE literature. A community of practice is a situative learning environment that focuses on the development of the individual and the reproduction of a particular community through a master-apprentice model (Lave, 1991). Learning is socially constructed as the learner changes their role or identity within the

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[4] Sociocultural theory, first developed by Russian psychologist Lev Vygotsky in the 1920's suggests that human activity takes place in a cultural context, is mediated by semiotic mechanisms, and that a genetic or developmental analysis provides the best understanding of these activities (John-Steiner & Mahn, 1996). Vygotsky (1978) proposed that learning was not only contextually specific, but it was also contingent upon the social actors within the context and the historical background of the culture of the individual; he also proposed that learning was a dialectic process that preceded development.

acting society through engagement in an activity with a teacher (Wegner, 2001). Research using this theory suggests that participation in URE is like participating in a community of practice. Students not only increase their knowledge and understanding of the research process and potential STEM careers, but are able to obtain concepts (e.g., knowledge or experience) that contributes to their desire to continue in STEM. Acquisition of knowledge and experience is due to their engagement with the context and key individuals within the context (Pender et al., 2010). This desire to continue is based on the students' ability to see his or herself as an active participant in the URE community or a "scientist" (Hunter et al., 2007).

The zone of proximal development and cognitive apprenticeship are concepts within sociocultural theory used to unpack how URE functions as a community of practice. The zone of proximal development is defined as the distance between the actual level of development that an individual can display without assistance and the level of development that a person can present with the help of an instructor or guide (Vygotsky, 1978). Cognitive Apprenticeship is the idea of learning factual and conceptual knowledge in a problem-solving context, through which an expert "master" models, coaches and scaffolds the novice towards the appropriate understanding (Collins, 2006). Use of these sociocultural theoretical components informed researchers on the influence of the experiences and perceptions of students in URE as well as the implications of any benefits proposed for continued participation in STEM (Hunter et al., 2007). Application of the zone of proximal development and cognitive apprenticeship suggests that within URE participants draw upon their affordances and their understanding of the influence of those affordances, to transition to a state of being that encompasses STEM and all its associations (Hunter et al., 2007).

Science Identity Framework

Heidi Carlone and Angela Johnson (2007) introduced the science identity framework in 2007 as a part of their research study that investigated the science experiences of successful women of color. Science identity as an analytic framework was developed on their understanding of the limitations of the literature to explain the experiences of women of color in science, and their belief of the science community being a community of practice (Carlone & Johnson, 2007). According to their framework, science identity is based on three main, interacting components: performance, recognition, and competence, with these components being influenced by an individual's race, gender and ethnic identity (Carlone & Johnson, 2007). A science identity is socially constructed. This construction involves the "local meanings of an activity of phenomenon and global context that enable and constrain those meanings" (Carlone & Johnson, 2007, p. 1192). Carlone and Johnson use this framework to understand the various forms of a science identity an individual may express (altruistic, disrupted, or research) within the science context, but also the process that leads to the development of those said identities

Hurtado and colleagues (2009) used this particular framework to examine the benefits and challenges that underrepresented racial minorities experience in URE as a way to determine how these benefits and challenges contributed to students' formation and solidification of a science identity. In revealing the benefits afforded to identity production and confirmation, they found that participation in URE contributed to students feeling like they were becoming scientists, influencing their desire to continue in STEM (Hurtado et al., 2009). The authors highlighted specific factors such as faculty, peer, and other relations as being essential for identity construction, in addition to competence established and autonomy

in research gained (Hurtado et al., 2009). With identity being the focal point of this framework, this framework supports the inference of UREs facilitating STEM identity by demonstrating the way in which STEM identity is conceptualized and operationalized within URE.

Limitations of URE Theoretical Orientation

Application of sociocultural theories in the URE literature in addition to social cognitive career theory and social capital theories provide a comprehensive perspective of URE, specifically its influence upon the continued participation in STEM through the development of a STEM identity. Whereas social capital theory points out the affordances of URE and their long-term outcome (Bennett & Bauer, 2003; Frierson Jr. et al., 1995; Lopatto, 2004, 2007), and social cognitive career theory reveals how the participants interpret affordances and their connection to STEM careers (Adedokun et al., 2013), sociocultural theory uncovers the application of the developed understanding and corresponding affordances. Collectively, application of these four frameworks, including the science identity framework previously discussed, positions URE to be a context for and influential in identity transformation that facilitates continued STEM participation.

Findings garnished from studies utilizing social cognitive career theory or sociocultural theory reveal the importance of individuals developing self-efficacy in STEM by way of building confidence and competence in STEM (Adedokun, et al., 2013; Hunter et al., 2007; Pender et al., 2010). Data obtained from research informed by social capital theory highlight the importance, influence, and impact of the STEM environment and exposure to STEM on individuals' persistence (Frierson Jr. et al., 1994; Harsh et al., 2012; Hurtado et al., 2009). What is missing from this research is information regarding the impact and influence

students' predispositions to STEM and social identifiers have on their exposure, experience, and development of confidence and competence. More specifically, few URE studies consider the impact and influence of constructs such as race and culture, despite the implications of race and culture on research involving underrepresented groups and the various theoretical orientations utilized within the URE studies.

Although the science identity framework promotes inclusion of race in the construction of a science identity, the authors position race to be more influential regarding STEM professionals' recognition of people of color as scientist more so than how race influences the individuals' self-recognition as a scientist (Carlone & Johnson, 2007). Believing that other people's perception of race hold more weight than individual's perception of race creates a perspective where external validation outweighs internal validation. Maintaining this perspective ignores intrinsically regulated motivation an individual may express that stems from their perception and understanding of their race. Likewise, situating individuals' race within the context of other people's perceptions gives those other people the power to determine the conceptualization of race within that context. Others maintaining the power to dictate the meaning behind an individuals' race provides an avenue for a deficit perspective to emerge when considering Black race because of the systematic and institutionalized oppression that paints Black as inferior (Banton, 2005; Bell, 1992; Crenshaw, 1988; Omi, & Winant, 1994).

Exclusion of Race. The impact and influence of an individual's race on their STEM engagement, identity development, and continued participation in STEM is missing from the theoretical orientations used in URE research. Race is a socially constructed category used to classify or group people based on, "historically contingent, socially significant elements of

their morphology and/or ancestry." (Haney López, 1994, p. 7). One's race influences how they perceive the world and how the world perceives them (Sellers, Copeland-Linder, Martin, & Lewis, 2006). Despite the fact that all of these previously reviewed studies identify various racial groups involved in their research, the researchers do not acknowledge the effects of race on the students' STEM identity or the extent to which race influences the students' continued participation in STEM.

Racial identity expression. Racial identity expression is the extent to which an individual performs or exudes specific behaviors, beliefs, and ideas that are in relation to their understanding of and connection with a specific racial group (DeCuir-Gunby, 2009; Marsh, 2013; Stewart, 2015). Racial groups, in these instances, refer to a collective of individuals established on biologically and socially based associations and ancestry (DeCuir-Gunby, 2009), including phenotype, morphology, and socialized behaviors and practices (Lee & Ahn, 2013; Stewart, 2015). Researchers and scholars discuss the positives and negatives of racial identification. For example, on one hand, racial identification can serve as a protective measure for Black students in troubling learning environments (Chavous, 2000); on the other hand, race can also be the reason students display a disassociation with academic achievement (Fordham & Ogbu, 1986). How one perceives race and associates with one's racial group based on that perception has an impact on the individual's self-identification and the individual's worldview and all its accompaniments.

Positive associations from race. Racial identity expression can serve as a protective mechanism against detrimental psychological processes for Black students when these students maintain a positive belief of themselves, racially, and pride in their race (Chavous, 2000; Chavous, Bernat, Schmeelk-Cone, Caldwell, Kohn-Wood, & Zimmerman, 2003; Hurd,

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Sellers, Cogburn, Butler-Barnes, & Zimmerman, 2012; Sellers et al., 2006). Black racial identity relates to resilience, academic achievement, and improved educational outcomes for Black students (Chavous et al., 2003; Zirkel & Johnson, 2016). Students who embrace and express their race from a more historical understanding are more likely to incorporate academic success into their racial identity and positively engage in school (Nasir, McLaughlin, & Jones, 2009).

In contexts where there are very few Black individuals present, Hurd and colleagues (2013) reveal that individuals with a high private regard – positive personal belief and pride in their race – exhibit fewer depression symptoms over time. Despite the onset of discriminatory experiences, Black adolescents with high race centrality – exuding strong racial connection with the Black race – hold positive attitudes towards Black individuals and demonstrate high positive psychological well-being, buffering these students from discriminatory experiences (Sellers et al., 2006).

Negative associations with race. Negative associations with race manifest as a result of racism, perception of isolation, and stereotypes (Beasley & Fischer, 2012; Carter & Forsyth, 2010; Marlone & Barabino, 2009). Researchers have found that Black people experience an onset of prejudice – in the form of racism – due to their race, with Black women being more likely to experience institutional and cultural racism than Black men (Carter & Reynolds, 2011). In experiencing racism, African Americans are more likely to exhibit feelings of anger, low self-esteem, depression and increased anxiety (Swim, Hyers, Cohem, Fitzgerald, & Bylsma, 2003; Yip, Seaton, & Sellers, 2006). In majority white spaces where Black individuals perceive themselves to be the "only one," a Black racial identity can lead to feelings of isolation, marginalization, and undervaluing (Marlone & Barabino, 2009).

In this particular study, students' racial identity was externally regulated, where the context was not perceived to be supportive, leading to negative psychological well-being (Marlone & Barabino, 2009).

Lastly, stereotypes – common and often overly simplified presumptions of an individual or group based on limited knowledge and understanding of that individual or group – produce negative associations with race. Stereotypes can negatively influence Black students' connection with white faculty at PWIs, leading to academic behaviors detrimental for their performance such as not seeking academic assistance from the faculty when needed (Guiffrida & Douthit, 2010). Researchers suggest that stereotypes influence Black students' disassociation with academic achievement as Black students resist academic achievement as a way to fit in with other Black students given the presumption that high academic achievement is associated with acting "White" (Fordham & Ogbu, 1986). Stereotypes can also lead to higher attrition rates in STEM for Black students, given stereotype threat, a performance-decreasing fear of confirming negative stereotypes (Steele, 1997), and Black students exhibiting higher group performance anxiety (Beasley & Fischer, 2012).

Intersection of race and gender identity expression. Given the focus of this research study on Black females, it is important to discuss concepts related to race and gender identity expression such as intersectionality. This section provides an overview of intersectionality, highlighting the distinctive point of view of Black females.

A majority of what is understood regarding the impact and influence of intersecting identities stems from research and literature that explore and define the unique experiences of being a Black woman. Kimberlé Crenshaw's (1991) concept of intersectionality, bell hooks' (1981) *Ain't I a Woman* and Patricia Hill Collins' (2000) *Black Feminist Thought* serve as

seminal pieces and ideas in the field of studying and theorizing intersecting identities. These notions stressed the importance of recognizing and understanding the impact multiple identities have on an individual's perceptions of and experiences in the world. Navigating social climates and negotiating the expression and understanding of self within those climates is contingent upon the unique experience imposed on and lived by the individual that is based on their multiple identities.

Collins (2000), Crenshaw (1991), and hooks' (1981) investigation of the Black women's collective experience highlight the uniqueness that comes with expressing two identities, race and gender. These authors purport that understanding the experience of Black women requires an individual to recognize sexism found within opposing racism, racism that is inherent in feminism, and the awkward positioning placed upon Black women by both of these concepts when they are investigated in isolation (Collins, 2000; Crenshaw, 1989; hooks, 1990). A racial or gender-based approach to oppression alone leaves out or ignores Black women, creating a system where Black women are "othered" and positioned at the bottom of the social hierarchy (hooks, 1990). Investigating issues of oppression and discrimination from a single-axis framework favors and privileges Black male and White female experiences, erasing the unique experience of being both Black and a woman (Crenshaw, 1989). In acknowledging the oppression faced by Black women, these scholars and others called for a framework that described, defined, and empowered Black women, based on the idea that their experience was unique due to their expression of multiple identities.

Crenshaw's intersectionality acknowledges and examines both the presence and importance of multiple identities' combined, unique influence on an individual's perception

and experience. Intersectionality was named to "denote the various ways in which race and gender interact to shape the multiple dimensions of Black women's [experiences]" (Crenshaw, 1991, p. 1244). Intersectionality is more than a summative approach for looking at two or more identities (Crenshaw, 1989); it requires multiple identities to be conceptualized from a blended perspective where the perceptions and experiences of one identity are uniquely tied to and related to the perceptions and experiences associated with the other. Evidence of the uniqueness in multiple identity expression is presented by Crenshaw as she explains the Black woman experience in relation to issues of racism and sex-based discrimination in the law and politics (Crenshaw, 1989; 1991).

Strength, empowerment, and resistance in relation to the dominating narratives of Black women are constructs researchers conceptualized when exploring intersectionality and identity expression (Collins & Blige, 2016). These constructs come from Black women's understandings garnished and lived experiences in their work and family context, where they are able to observe the hypocrisy between what society states to be true and what reality demonstrates regarding their positioning and influence (Collins, 2000). An intersectional identity is contingent upon the social context in which individuals are operating, but defined by what those individuals wish for others to see and know (Collings, 2000). Their decision to choose what is displayed is a way to promote self-preservation, to address the inconsistencies of society's concepts and reality, and to maintain a high sense of self-concept, value, and pride within themselves (Collins, 2000; hooks, 1990).

Studies investigating race and gender identity expression delineate differences in experience and identity expression for Black females (Oyserman, Harrison, & Bybee, 2001; Plummer, 1995) or highlight the intersection of race and gender in various endeavors

(Buckley & Carter, 2005; Harper, 2006, 2009b; Marsh, 2013; Tate & Linn, 2005; Wade, 1996). For example, Marsh (2013) finds Black females are more likely to accommodate rather than assimilate in contexts where White race and norms are valued, maintaining a sense of their Black racial identity while engaging in the environment. Additionally, race and gender expression provides Black females with the agency to determine their circumstances and outcomes in high school (Marsh, 2013).

Summary. Racial identity expression relates to a plethora of positive and negative factors including stress, self-esteem, academic efficacy, and delinquency (Oyserman et al., 2001). Racial identity can serve as a protective factor when it comes to experiences of racism and discrimination (Chavous, 2000; Chavous et al., 2003; Hurd et al., 2012; Sellers et al., 2006). Racial identity expression can also perpetuate racist and discriminatory experiences that lead to negative and detrimental emotions and behaviors such as anger, isolation, attrition and lack of engagement (Beasley & Fischer, 2012; Fordham & Ogbu, 1986; Swim et al.,2003; Yip et al., 2006). Race also negatively influences continued participation in STEM and STEM identity when considered in light of science and the U.S. racial history, where science was used to promote racist ideology and messages of inferiority regarding people of color (Brown & Mutegi, 2010; Green, 2014). Ignoring race and what is associated with it (e.g., racism, culture, ethnicity) severely disadvantages students from non-white racial backgrounds and ignores any strengths or assets they may have because of their race (Harper, 2010; Parsons, Rhodes, & Brown, 2011; Zuniga, Olson, & Winter, 2005). Ignoring race also removes racism and its effects from any analyses regarding Black students, STEM identity and retention, as race and racism are perpetually linked (Bonilla-Silva, 1997, 2014).

Exclusion of Culture. Like race, the analyses provided by the theoretical orientations used in URE and STEM identity literature also leaves out culture and its influences. As it pertains to students from marginalized backgrounds, specifically non-white racial and ethnic groups, years of research suggest that the culture of STEM is oppositional to or different from African American and Latinx cultures (Carlone & Johnson, 2012; Lee, 1999). STEM is perceived to perpetuate Western, Euro-American cultural norms (Aikenhead, 1996; Cobern & Aikenhead, 1998) where autonomy, competitiveness, and individual achievement are delineating variables of success (Anderson, 1988; Boykin, 1986; Lewis, 2004). Culture, being "symbolic forms through which people experience and express meaning" (Swidler, 1986, p. 273), is not only an entity that an individual can take on, but it is a way in which an individual comes to understand and perform life.

In STEM research literature, students who do not embrace these Western, Euro-American cultural norms associate with STEM differently (Costa, 1995) and either assimilate to, or accommodate STEM norms to be successful (Aikenhead, 2001; Cobern & Aikenhead, 1998). Assimilation, also referred to as acculturation or cultural imperialism, is defined as students abandoning their cultural beliefs, values, and ways of knowing to adopt what the culture of STEM dictates regarding specific values, beliefs and ways of knowing (Aikenhead, 1996; Cobern & Aikenhead, 1998). Assimilation is perceived as a threat to non-Western cultures (Cobern & Aikenhead, 1998). Accommodation refers to adapting to or adopting the ideals and beliefs of the external environment, as a way to create a consistency between an individuals' internal understanding and their external reality (Schunk, 2012).

Using the two previously described views of assimilation and accommodation, an individual that chooses to assimilate, completely abandons their cultural associations to

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embrace STEM culture. An individual who chooses to accommodate, adapts or adopts elements of STEM culture as they make sense in their current engagement in STEM at that immediate moment in time, but does not necessarily abandon all of their cultural associations that may differ from STEM culture.

Facing instances of opposition due to culture and other societal beliefs, African American and Latinx students experience higher cases of anxiety in STEM and leave STEM at higher rates, despite their greater interest in STEM fields as compared to other groups (Beasley & Fischer, 2012). Culture, therefore, is an important and necessary concept to consider when studying STEM engagement, matriculation, and retention of students from various backgrounds.

The impact and influence of culture was missing from the analyses conducted in the URE literature. Culture is an important part of sociocultural theory; culture is believed to have grave implications for learning and development (Vygotsky, 1978). Culture contributes to the transformation that occurs during the learning process as it influences both the tools used to learn and the individual's identity in the negotiating and learning process (Nasir & Hand, 2006). Culture is a source of capital (Bourdieu, 1986) and it influences the interaction between persons, their environment, and their behavior within social cognitive theory (Schunk, 2012). Without information on the culture of the URE environment, the culture of STEM and the culture of the individuals engaged, a limited understanding of how URE contributes to STEM identity and the very premise that URE fosters the development of a STEM identity are questionable for traditionally underrepresented groups in STEM. Including culture is of particular importance given that STEM researchers acknowledge the

need for a more cultural analysis of STEM education because of culture's significant influence on the individual and their learning (Parsons & Carlone, 2013).

Race and Culture as Mutually Exclusive. In addition to dismissing culture and race, researchers often conflate the two in the study of African Americans and other Blacks (e.g., Haitian Americans, Jamaican Americans). In instances where Black or African American student populations were of interest to the researchers (Carter et al., 2009; Chang et al., 2009; Hurtado, et al. 2009), despite the fact that the constructs Black and African American have different meanings and implications (Boykin, 1986; Larkey et al., 1993), they were used interchangeably to represent the same population of people. Using Black and African American interchangeably within research suggests that race and culture are the same and have the same implications. Black race and African American culture are not the same; they are not homogenous groups (Jones & Campbell, 2011). Maintaining a homogenous perspective of persons engaged in STEM perpetuates stereotypes associated with non-dominant populations (Seiler, 2013) reinforcing a system that promotes STEM attrition (Beasley & Fischer, 2012) rather than STEM persistence. Maintaining a homogenous perspective also shows apathy regarding a racial and cultural effect on continued STEM participation (Basile & Lopez, 2015). However, systematic groupings of individuals, where groups are based on shared demographics, with an understanding of heterogeneity within these groupings (e.g., understanding the differences between Black students and African American students) can address issues pertaining to the group on an institutional, widespread level. Recognition of this fact requires researchers to delineate racial, ethnic and cultural nuances that may have implications for STEM identity and continued STEM participation

while also looking intersectionally at the combined influence of race, ethnicity, and culture on continued STEM participation via STEM identity development.

Though the term underrepresented racial minority may be appropriate to recognize commonalities among marginalized individuals of non-White racial backgrounds, failure to acknowledge the differences in experience based on racial, ethnic, gender, and other types of categories silences the unique experiences and perceptions of the individuals within those groups. Even within marginalized groups, differences in STEM persistence and experience occur based on implications from intersecting identities (Atwater, 2000; Espinosa, 2011; Strayhorn, 2010a). Failure to acknowledge the unique experiences of individuals and intersecting identities in URE studies results in misinformation regarding STEM identity formation of an individual. One way to consider unique experiences of individuals even if the group is the unit of analysis is to include prior information, perceptions, and feelings regarding STEM associated with said identities in the study.

Summary. Because URE studies fail to incorporate demographic and intersecting components in their analyses, their claims about URE's contribution to continued participation in STEM via the development of a STEM identity are limited. Not including demographic influences allows for deficit-oriented analyses of the individuals and a "savior complex" interpretation of URE's success, as it becomes solely attributed to the context the individual engaged (Brown, 2013).

The exclusion of race and culture, and the interchangeable use of each in the theoretical frameworks utilized in URE research promote the idea of assimilation and accommodation to STEM culture and norms through URE rather than recognizing the strengths and assets that individuals bring into the context that aid in their development and

continued participation in STEM. A critical, inclusive perspective that promotes a comprehensive understanding of the context and the individual is necessary to avoid deficit-oriented and assimilation promoting perspectives. Spencer's Phenomenological Variant Ecological Systems Theory provides that critical, inclusive perspective.

Phenomenological Variant Ecological Systems Theory

Phenomenological Variant Ecological Systems Theory (PVEST) is a framework designed to study the influence and outcomes of identifying characteristics and experiences on an individuals' perceptions and behavioral responses to their environment and its subsequent challenges (Spencer, 2006). Margaret Spencer devised PVEST in the early 1990's to study strength and resilience in identity formation and development for African American youth (Spencer, Dupree, & Hartmann, 1997). As a theory, PVEST incorporates perception and self-appraisal (e.g., self-evaluation) under the weight of social, cultural, and historical influences (Department of Corrective Human Development, 2014). PVEST allows for a "self-appraisal and meaning-making processes, as a dynamic system, within the various contexts of development" to be studied in conjunction with how perception influences development (Swanson, Spencer, Dell'Angelo, Harpalani, Spencer, 2002, p. 75). PVEST also delineates potential pathways that individuals take depending on the obstacles they face, the sources of support or hindrance present, and the corresponding choices made.

PVEST is an identity focused-cultural ecology framework, that incorporates phenomenology to capture the essence and meaning behind the individuals' experience through their perspective (Spencer, 2006). PVEST is based on Bronfenbrenner's ecological

systems theory[5] (Bronfenbrenner, 1977), incorporating the influence of the ecosystem on human identity development (Spencer, Fegley, & Harpalani, 2003). Incorporation of the ecological framework allows for a better understanding and interpretation of individuals' identity development by considering the influences of context, history, and society (Bronfenbrenner, 1977).

Five components make up PVEST (see Figure 1): net vulnerability level (risk factors), stress engagement, reactive coping methods, emergent identities (stable coping mechanisms), and life stage outcomes (Spencer et al., 1997). All five factors operate in a bidirectional, recursive process (Spencer et al., 1997). Net vulnerability are factors that a person is either born with (i.e., race, gender, physical characteristics), born into, or acquire (i.e., socioeconomic status, language, culture), that are viewed and valued differently by society (Spencer, 2006). A perceived difference in the value associated with these varying characteristics present differences in the types of engagements individuals encounter during development, some factors being perceived as risk while others are perceived as protective. Stress engagement is the actual circumstances or incidents that a person faces due to their risk factors (Spencer, 2006).

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[5] Bronfenbrenner's (1977) ecological systems theory is a framework for studying human development as a process of progressively complex reciprocal interactions between people and their varying social and structural environments. These interactions can occur in five different systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem. Microsystems involve patterns of activities, social roles, and relationships that occur at a face-to-face level. Mesosystems include linkages between two or more settings that have a direct influence on the individual such as home and school. The exosystem is similar to the mesosystem except it involves one setting that has direct control and one setting that has an indirect influence (i.e., home and parents' work). Macrosystems (e.g., belief systems of a society) include the overarching principles of the micro-, meso-, and exosystem. The chronosystem involves measuring the consistency or change of these concepts across the lifespan of an individual.

Figure 1. Phenomenological Variant Ecological Systems Theory
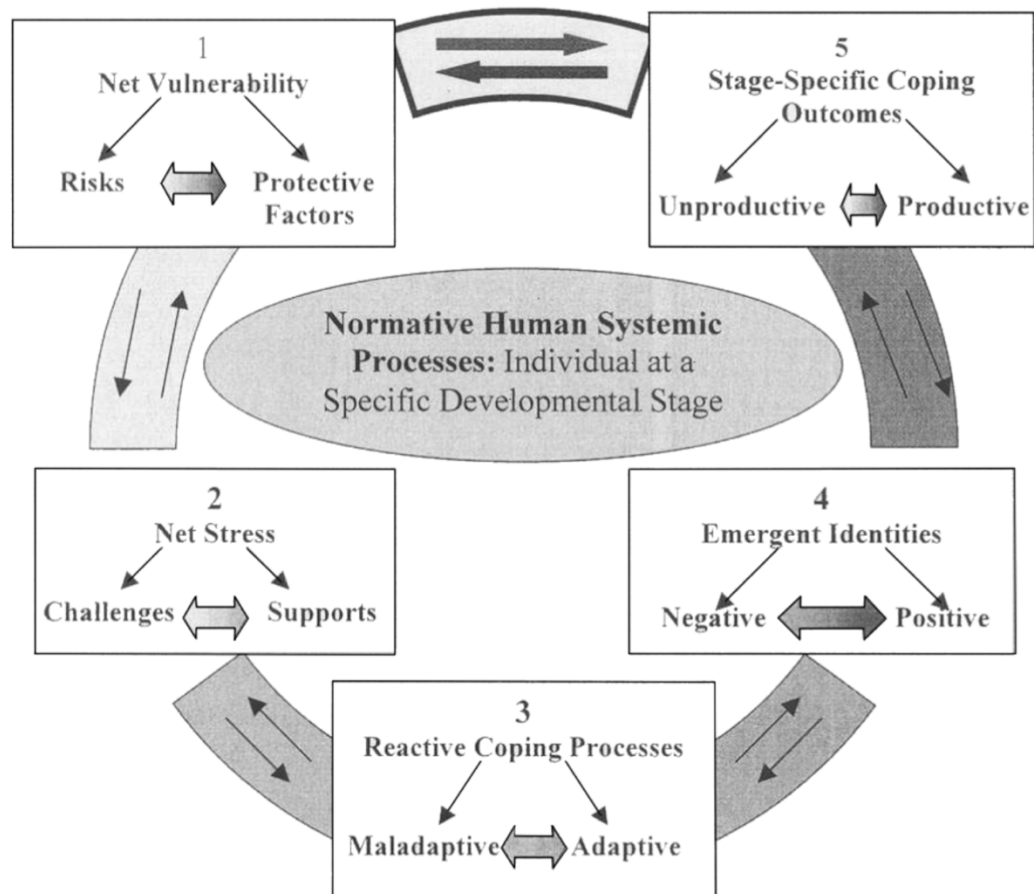
Figure 1. Conceptual model of Phenomenological Variant Ecological Systems Theory. Adopted from "Understanding hypermasculinity in context: A theory-driven analysis of urban adolescent males' coping responses" by M.B. Spencer, S. Fegley, V. Harpalani, & G. Seaton, 2004, *Research in Human Development, 1*(4)*,* p. 232. Copyright 2004 Lawrence Erlbaum Associates, Inc.

These situations often take place within the individuals' immediate context, where they face a dilemma that is a juxtaposition between a risk and the availability of supportive measures. Coping responses are the cognitive and behavioral decisions individuals enact as a response to their stress engagement (Spencer, 2006). Per PVEST, coping responses are either

maladaptive or adaptive, with maladaptive responses being negative or harmful for identity development and adaptive responses being positive for identity development. As individuals encounter the same types of stress engagements over and over again and generate the same coping mechanism each time, PVEST proposes that these recurring coping mechanisms become stable coping mechanisms or emerging identities (Spencer, 2006).

Learning outcomes are the overall intended effect generated by engaging in the process of identity development, though they too have an influence on the individuals' experience as demonstrated by the cyclical, bidirectional nature of the theory. PVEST's inclusion of phenomenology accounts for a person's agency in the shaping of their environment and behavior. Its incorporation of ecology allows for an understanding of how the social, cultural, political and historical issues of the context shape the perceptions and experiences of the individual (Spencer, 2006). As a theory, PVEST values intersectionality and purports that the experience of a person cannot be determined by one demographic variable alone, with identity development being a product of the perception of the individuals' intersecting experience and their self-appraisal along the way (Swanson, Cunningham, & Spencer 2003). Within PVEST, despite the fact that learning plays a significant role in identity development for the individual, it is not the only psychological process of interest.

Reflection, comparison, and negotiation are other psychological processes that occur at the most fundamental level of PVEST (Lee, Spencer, & Harpalani, 2003). These concepts arise as the individual reflects over their experiences during stress engagements, compares and contrast their experiences with their perceptions of their environment, and negotiates how to handle or address the dissonance presented to them (Swanson et al., 2002). It is

through the process of negotiation, along with the influence of mediating variables, where individuals can determine what behaviors they subsequently express. This process occurs in iterations, with people learning from their experience and process forming a stable emergent identity (Spencer, 2006). Beyond feelings of self-efficacy and self-confidence, established through the self-appraisal process that occurs, individuals also utilize other interpersonal skills and agency to aid in their developed identities and the learned outcomes they display.

Research using PVEST

Research that showed the relationships between experience, outcome, and identity formation solidified PVEST as a theoretical perspective (Spencer et al., 1997). Studies using PVEST researched the construction of academic identity development among African American students, determining the extent to which the perception of their environment influenced their academic outcome, identity formation, and specific mediators of identity (Cunningham, Hurley, Foney, & Hayes, 2002; McGee & Pearman II, 2014, 2015; Seaton, 2010; Spencer, 2005; Spencer et al., 1997; Spencer et al., 2003; Swanson et al., 2003). Middle school and high school aged African American students, male and female, were the primary population of interest, with surveys and self-reports used to analyze correlations and relationships between varying environmental components, perceptions of those factors and the types of coping responses generated. One study incorporated Latino and European American students as it investigated the influence of perceived discrimination on peer victimization (Seaton, Neblett Jr., Cole, & Prinstein, 2013). Another study focused on college age students, investigating the relationship between their identity expression, imposter syndrome and mental health issues (McClain, Beasley, Jones, Awosogba, Jackson, & Cokley, 2016).

Older studies using PVEST delineated gender differences regarding the influence of perception and experience of incidents that affect coping strategies (Cunningham et al., 2002; Seaton, 2010; Spencer et al., 2003). Gender correlated with the effect of parental monitoring on mediating high-risk environmental stressors and grade point average (GPA), indicating a relationship exists between the two variables for girls (Cunningham et al., 2002). Females show higher depressive symptoms regarding self-esteem and perceived racial inequity than males (Seaton, 2010), with peer groups being a more important source of support necessary to aid in coping and identity formation for females in middle and high school age youth (Spencer et al., 2003).

More recent scholarship using PVEST reveal the importance of race socialization, racial and ethnic identity, and culture on the development of positive and successful math identities, academic expectations, and mental health outcomes for African American students of all ages (McClain et al., 2016; McGee & Pearman II, 2014, 2015; Trask-Tate, Cunningham, & Francois, 2014). Use of PVEST in these studies allowed researchers to develop a better understanding of how race, culture, and ethnicity are influential in students' identity development. PVEST also allowed researchers to discover that factors they initially thought to be detrimental, such as "street smarts or acting hard" were actually protective for these students, granting them the ability to continue their education and succeed academically (McGee & Pearman II, 2015).

Identity in PVEST

 As a theory, PVEST integrates multiple perspectives such as a developmental perspective, a CRT perspective, and an ecological perspective (Spencer, 2006). Identity and identity development are mainly viewed from a developmental perspective, though a

sociological perspective is also included (Spencer, 2006). Developmental psychologist view identity as "the understanding and acceptance of both the self and one's society" (Miller, 2011 p.148). Identity is conceptualized from a global perspective and developed in stages (Jensen, 2003). A developmental perspective of identity is evident in PVEST as Spencer (2006) writes "the framework provides enhanced understanding of foundational processes and stage-specific outcomes of diverse groups and individuals" (p. 831).

Evidence of a social psychological perspective to identity exists within the PVEST as well. A social psychological point of view describes identity as being the expression of different behaviors that reflect the various social affiliations a person maintains (Merolla & Serpe, 2013). Spencer (2006) defines the identity process stage of PVEST as "either the product of basic temperament and/or particular socialization experiences" (p. 832). Within PVEST, identity development incorporates innate traits and negotiations between self and the social context, where those negotiations are developed and refined as individuals matriculate through various stages in life. Like Spencer, I too take a combined approach when viewing identity and identity development.

I believe that identity development incorporates both a developmental life-phase process and the negotiation of self to society with respect to the various roles a person may play. As a person matriculates through time, and their experiences differ, I believe that their subsequent identities are informed by their previous identities developed in past phases. An examination of the URE literature showed an absence of these elements supporting identity and identity development from either a developmental or social psychological perspective. In light of this study's focus on predispositions and perceptions; on social identifiers important to study participants; and conceptualization of their identifiers in relation to their experience

and behaviors, PVEST provides the appropriate framework when investigating the influence of identity expression on STEM identity and retention for Black females, helping to construct their counter-story.

Developing a Counter-Story: PVEST in URE

PVEST provides a framework for understanding the extent to which demographic variables such as race, gender, and other salient identities like culture, and socioeconomic status impact and influence STEM matriculation, retention, and persistence through the undergraduate research experience and STEM identity development. PVEST allows for a thorough investigation of the environment (i.e., research, institutional, and overall discipline's culture) and an understanding of the extent to which it influences students' decision to persist and maintain in STEM, as well as the extent to which their values and norms are enacted in the undergraduate research environment.

PVEST incorporates many components that allow for a comprehensive investigation and understanding of the context, the individual, and the situations at hand that contribute to the creation and development of an individuals' identity (STEM identity), its long-term outcomes (continued participation), and the influence of the individual's racial and intersecting identities. Applying PVEST to URE allows for a comprehensive study and understanding of the context, individual, and research that students participate in and encounter. Its use can not only highlight the influence of personal characteristics and culture on identity development but can allow for a revelation of various mediating factors and psychological processes that individuals use or draw upon to develop their STEM identity when faced with different choices (Spencer, 2006). PVEST is a transformative approach, which allows a researcher to understand identity development over time (Spencer, 2005).

PVEST provides a strengths-based approach towards understanding choice and human development (McGee & Pearman II, 2015). Researchers' application of the theory in URE allows for identifying and understanding racial, cultural, gender, or SES-based strengths and assets that individuals bring into the research environment. Additionally, it enables researchers to understand how these constructs influence students' continued participation in STEM. No other theory or framework presented thus far acknowledges any strengths or assets that a racial, ethnic, cultural, gender or SES identity may bring. PVEST is an appropriate framework to utilize when investigating URE's contribution to continued participation in STEM of traditionally underrepresented groups as it considers the previously listed constructs, preventing the creation of a deficit research-oriented perspective that is all too common when researching Black students (Harper, 2010).

Additionally, PVEST allows for an exploratory process to occur, potentially revealing significant demographics or identities, mediators and psychological processes under-researched in URE literature. PVEST incorporates the necessary components that allow for an understanding of the immediate context and the larger hierarchal structures and their impact on the individual, their choices, and perceptions (Spencer et al., 1997). Focusing on the context specifically addresses retention and matriculation as it reveals institutional and structural barriers and support for the students (Lau, 2003), and their impact on students' racial and intersecting identity expressions. Coupling the PVEST focus on context with phenomenology provides researchers the opportunity to understand individual aspects, such as perseverance and persistence, how they influence retention and matriculation, and retention and matriculation influence them (Harper, 2009b). I use a phenomenological

approach in this study as described in chapter three and use PVEST in chapter four to discuss

the study's findings.

Chapter 3: Research Design

As shown in the literature review, there is a need for more research investigating the influence of the undergraduate research experience for Black students, Black females specifically, and the extent to which students' various identities, outside experiences, and perceptions shape and inform their positioning in STEM. In particular, there is a need to understand racial identity expressions in STEM. A strengths-based approach (Spencer, 2006) reframes the student narratives shared, eliminating the possibility of developing a deficit perspective regarding Black student engagement and participation in research experiences. This approach differs from the dominant approach used in the literature regarding the effects and influence of the undergraduate research experience, as previous studies seemingly position the research experience to be a transformational opportunity assimilating Black students into STEM. Within this chapter, I present the methodology of my research study. I present the research questions and the research design. I also discuss the research paradigm, research methodologies, research methods, and research ethics.

I used a qualitative approach to gain an understanding of Black females' perceptions and experiences of the undergraduate research experience. More specifically, I sought to understand the extent to which identifiers such as race, gender, other salient identifiers, and the subsequent experiences attached to those identifiers influence Black females' understanding of themselves within STEM undergraduate research experiences and their perception of URE. These questions guided the study:

1. How do Black female students participating in STEM undergraduate research programs conceptualize their race, gender, and other salient identities within their STEM experiences?

2. How do Black females in STEM undergraduate research experiences position their race, gender, and other salient identities? Does their identity positioning inform their persistence in STEM? If so, how?

3. How do Black females in STEM undergraduate research programs perceive STEM and their STEM undergraduate research experience? To what extent does their identity inform these perceptions?

4. To what extent does Black females' conceptualization of their race, gender, and other salient identities inform their association with STEM?

Given the structure of my research questions and my overall interest in the students' perception and understanding of their identity and experience, a qualitative research approach was most fitting for this study.

Research Design

Research designs are plans of actions that encompass a range of structures, from broad assumptions to detailed procedures for data collection and analysis (Creswell, 2009). In conducting educational research, it is important for researchers to delineate the specific research design utilized within their studies. The research design situates a particular study within the context of the researcher's overall philosophical worldview in addition to the strategies of inquiry (methodologies) and specific research methods (Creswell, 2009). The specific research problem of interest as well as the researcher's point of view and personal experiences influence research designs (Creswell, 2009).

Situating a study within an overall philosophical worldview allows the reader to better comprehend the purpose of the study and develop a better understanding and interpretation of its results. Creswell (2009) defines a philosophical worldview as "a general orientation about the world and the nature of research that a researcher holds" (p. 6). His notation of "worldview" is similar in meaning to what others describe as a paradigm with epistemological and ontological elements (Creswell, 2009). Beyond epistemology and ontology, Guba and Lincoln (2005) include axiology, a philosophical branch that involves the researcher's ethics, appeal and faith as part of the overall research paradigm or worldview. Four types of research paradigms or worldviews are most common in educational research: postpositivist, constructivist, transformative, and pragmatic (Mertens, 2010). In this study, I situate a qualitative, phenomenological strategy of inquiry within a transformative worldview. My positionality (previously noted in Chapter 1), research problem of interest, and research population informed my decision to take a transformative paradigmatic approach for this research study.

Transformative Paradigm

A transformative paradigmatic approach is one in which the research is situated within social justice. A transformative paradigm acknowledges the "meaning-making" of a constructivist approach, but extends beyond it by strategically positioning the researcher to be on the same level of power as the participants in a combined effort to initiate social change (Mertens, 2010). Transformative paradigms:

1. Place central importance on the lives and experiences of the diverse groups that, traditionally, have been marginalized.
2. Analyze how and why inequities based on gender, race or ethnicity, disability, sexual orientation, and socioeconomic classes are reflected in asymmetric power relationships.

3. Examine how the results of social inquiry on inequities are linked to political and social action.
4. Use transformative theory to develop the program theory and research approach (Mertens, 2010).

The transformative paradigmatic approach arose as a response to critical scholars challenging the nature of other epistemologies, suggesting that they may be inherently bias and discriminatory against marginalized populations (Mertens, 2010; Scheurich & Young, 1997).

Epistemologically, investigating the relationship between the knower and what is known, transformative paradigms require the researcher to have an interactive link with their participants (Mertens, 2007). Knowledge is determined not only through the research focus, but also from the relationships and collaboration established between the researcher and the research participants (Mertens, 2010). Cultural lenses and power dynamics, their effects on the relationship between the knower and what is known, also shape the meaning of knowledge (Mertens, 2007, 2010). Cultural lenses and power dynamics help determine what is considered legitimate knowledge, where history too plays a role in what is determined as knowledge (Mertens, 2007, 2010). To determine what the participants consider legitimate knowledge, I employed a variety of qualitative methods (interviews, journals, and observations) to uncover not only the experiences of the participants, but the various elements that mold their experience.

Specific constructs of interest in this study included, but were not limited to, the influence of race and gender on their perceptions of STEM and their undergraduate research experiences. Race, gender, and other salient identities are social constructs used to classify individuals. Investigating the influence of these constructs incorporates culture and power dynamics, as these social constructs shape lived experiences and understandings of what is

known to be real or true for the Black females who participated in this study (Rogoff, 2003). As a Black male with a STEM background, I too share similar understandings and experiences regarding what is considered legitimate knowledge in STEM fields. I worked collaboratively with the participants to uncover their truths.

Ontologically, questioning the nature of reality, a transformative paradigm exerts that multiple realities exist, are socially constructed, and are explicitly defined by social, political, cultural, economic, ethnic, racial, gender, age, and disability values (Mertens, 2007). Rather than embrace the dominant and pervasive perspective regarding Black female engagement in STEM, often situating race as deficient or an obstacle to success (Harper, 2010), this research project embraced a phenomenological approach, characterizing the lived experiences of the individual participants. Through phenomenology, the very nature of reality is contingent upon the perceptions, feelings, and beliefs of the individual operating within a specified context. This research project specifically investigated the extent to which Black females' race, gender, and other salient identifies influence and shape their experiences and outcomes, as noted by the research questions.

Transformative paradigms employ quantitative, qualitative or mixed methods, but require methods be adjusted for cultural complexity and power issues (Mertens, 2007). Axiologically, transformative paradigms push for respect, beneficence, and justice (Mertens, 2007). I chose to employ a qualitative strategy of inquiry due to its use in exploring and understanding any meaning humans create and assign to a specific social instance or event and the ease to which qualitative strategies can be used to align with the underpinnings of the transformative paradigm (Creswell, 2009).

Qualitative Strategies of Inquiry (Methodologies)

Qualitative strategies function as an orientation used to explore individuals, processes and events, or shared behaviors of a specific group of interest (Creswell, 2009). As a mode of inquiry, these specific approaches are used throughout the research process that focus on "data collection, analysis, and writing" (Creswell, 2009, p. 176). Given my CRT informed positionality discussed in chapter one and interest in exploring race and gender identity expression, I centralized counter-storytelling as a method in this study. I used counter-storytelling to capture the perceptions and experiences of Black females in STEM undergraduate research experiences, specifically focusing on their positioning and perception of their race, gender, and other identities in STEM experiences as well as their potential influences on STEM identity and retention. In addition to using counter-storytelling to capture the views of the study participants, I also use counter-storytelling as an organizational tool to juxtapose the stories of Black females in STEM undergraduate research experiences to the narrative of Black student retention and STEM identity found in the STEM undergraduate research literature.

Counter-storytelling is a tool used in critical race methodology to give voice to traditionally silenced and marginalized people (Cook & Dixson, 2013). Counter-storytelling exposes, critiques, and challenges the dominant narrative, as a way to "further the struggle for racial reform" (Solórzano & Yosso, 2002, p. 32). Beyond challenging the dominant discourse, counter-storytelling strengthens survival and promotes social and cultural resistance (Hubain, Allen, Harris, & Linder, 2016). There are many forms of counter-stories. Composite counter-stories are narratives to portray a collective.

Compositing allows for the development of a narrative that adequately captures the reports and experiences of the individual participants as a collective, one goal of the guiding

research questions, and reduces the instances in which any unique characteristics or identifiers inadvertently compromise an individual's anonymity (Hubain et al., 2016). This study's composite narrative is developed from data obtained from different individuals' raced, gendered, and classed experiences (Solórzano & Yosso, 2002), demonstrating a shared history with racism, discrimination, and White supremacy among people of color (Cook & Dixson, 2013).

To provide the counter-story for Black females in STEM undergraduate research experiences, I used phenomenology to ascertain their perceptions and understanding of their race, gender, and other identity within STEM URE spaces.

Phenomenology. As a qualitative strategy of inquiry, phenomenological research is where the researcher reveals "the essence of human experiences about a phenomenon as described by participants" (Creswell, 2009, p. 12). A phenomenological point of view takes into consideration the concept that human behavior is a result of a specific incident or phenomenon, rather than an occurrence that is objective or external to the individual experiencing the event (Sloan & Bowe, 2014). Two major approaches to phenomenology exist, descriptive and hermeneutics (interpretative) (Sloan & Bowe, 2014). Descriptive phenomenology focuses on the what of the experience – noema – and how it is experienced – noesis (Sloan & Bowe, 2014). Descriptive phenomenology traditionally seeks to only identify aspects of an experienced phenomenon without further exploration, embracing the thoughts that the observer can "transcend the phenomenon and meaning," taking an objective stance to what is revealed and presented (Sloan & Bowe, 2014, p. 1294). Hermeneutics extends the identification piece to include the interpretation by the observer, but also recognizes that by being within the research setting, the observer is operating within the

phenomenon and contributing to its essence (Sloan & Bowe, 2014). I used a hermeneutic phenomenological perspective, acknowledging my presence within the research project and my role in co-constructing knowledge as a means to highlight under identified messages within the dominant narrative of Black racial identity in STEM retention and matriculation.

Although phenomenological research is typically classified under a constructivist paradigm (Mertens, 2010), layering phenomenology with a critical race methodology informed by CRT situated my research in a transformative point of view. CRT seeks to: explore race, expose racism embedded within American society, dispel any thoughts or myths associated with meritocracy and colorblindness, embrace the concept of intersectional experiences, and empower marginalized voices through counter-narratives (Bell, 1992; Delgado, 1989; Gotanda, 1991; Ladson-Billings & Tate, 1995). A critical race perspective, therefore, attempts to address this psychological, physical, social, and economic oppression experienced by people of color by focusing on the impact and influence of race on the formation and continuation of the United States. My research was transformative as I attempted to uncover the extent to which the associated power dynamics of marginalized identities (i.e., race and gender) shape the experiences and perceptions of Black females operating within an environment (i.e., STEM) where the understood culture is one in which their various identities are believed to be invaluable and insufficient for success.

The ontological and epistemological stances of this study also align with the transformative paradigm. Ontologically, this project characterized the lived experiences of Black females within STEM undergraduate research programs, exposing what they understand to be reality and how they operate within their realities, emphasizing the power and influence of social constructs such as race, gender, and other identities on their

experience (Mertens, 2010). Epistemologically, this project focused on what the participants believe to be true regarding their knowledge and expertise developed within STEM and STEM URE, again focusing on how their knowledge relates to their salient identities. To obtain their views and understandings, I chose to employ phenomenological methodologies, enhanced by my critical race informed positionality, to create stories regarding the perception and experiences of Black females that counter what is pervasive in the existent literature on Black females' retention and matriculation in STEM.

Research Methods

Qualitative methods prompt a detailed focus of a specific phenomenon of interest (Creswell, 2012). The methods of a qualitative approach are typically inductive by nature, where multiple sources of data are collected over a certain period and are subjected to on-going analysis (Gall et al., 2003). Qualitative research usually occurs within the natural setting of the research participants and seeks to answer the questions of "how and why" (Luttrell, 2010). Explicit theoretical lenses or orientations also inform qualitative research. Qualitative researchers are deemed an instrument, and therefore in need of disclosing their positionality and perspective (Greenback, 2003). As a nonparticipant observer (Creswell, 2012) or observer-participant (Glesne, 2011), I was centrally located within the research through conducting observations and interviews, providing reflections of the data from a personal and professional point of view.

This research study took an in-depth look at the perceptions and experiences of Black female students participating in a STEM undergraduate research experience. I utilized a case study methodological approach where individual participants served as multiple cases for this study, as case studies are meant to address the research questions of "how" and "why"

(Baxter & Jack, 2008). Case studies allow researchers to delve into phenomena of interest within a specified context (Baxter & Jack, 2008). The use of multiple data sources within each case ensures the area of interest can be thoroughly explored by revealing and interpreting multiple aspects of the specific phenomenon (Baxter & Jack, 2008). Case studies thus complement phenomenological methodologies as they provide the avenue and means to fully investigate individuals' lived experience either in isolation or within a collective, situating the researcher within the context so that an accurate depiction of the participant's truth can be revealed (Baxter & Jack, 2008; Sloan & Bowe, 2014).

Numerous types of case studies exist (Stake, 1995; Yin, 2003). For this project, I used an instrumental case study across multiple instances. The primary purpose of an instrumental case study is to develop a deeper understanding of a concept, issue, or theory, in lieu of a specific case (e.g., individual, organization). I employed an instrumental case study because a primary goal of the study was to expose and understand the extent to which marginalized identities are enacted in the research context and their subsequent influence on STEM retention and matriculation. To ensure that the cases are reasonable within scope (Baxter & Jack, 2008), there are several contingences in which I bound the cases. For this research project, cases consisted of individuals who identify as Black female undergraduate students majoring in STEM, are enrolled in a structured STEM research program that provides financial assistance and STEM discipline specific-research opportunities during the 2016-2017 academic year, and who had the opportunity to participate in at least one supervised research project while participating in the program. Participants involved in the study attended two different institutions of higher education.

Research context. This research project took place at two distinct locations; both are public institutions of higher learning located within the Southeast region of the United States. Shakur University, a pseudonym for the first institution, is located in a city that has a population of about 290,000 people. The racial demographics of the city is approximately 48.5% White, 40% Black or African American, 4.7% Asian, 3.9% Multiracial, 2.8% Other, and 0.2% Native American. The U.S. government classifies Shakur University as a Historically Black College or University (HBCU). It serves a student body consisting of 78% African American, 12% White, 1.8% Hispanic, 1.2& Asian, and 0.007% International students. Shakur University has a first-year to second-year retention rate of 80%, a 15:1 student to faculty ratio, and offers a total of 78 degrees with 146 concentrations. Shakur University has a 48.3% four-year graduation rate for Black students.

Hurston University, a pseudonym for the second institution, is located in a city that has a total population of approximately 60,000 people. The racial demographic of the city is 69% White, 13.6% Asian, 8.8% Black, 5.3% Hispanic, 2.2% two or more races, 1% Other, 0.3% American Indian, 0.1% Native Hawaiian or Pacific Islander. Hurston University is considered a Predominantly White Institution (PWI), servicing 62.8% White, 12.4% Asian, 8.1% Black or African American, 7.1% Hispanic, 5.1% two or more races, 3.7% Other, 0.5% American Indian, and 0.3% Native Hawaiian or Pacific Islander. Hurston has a 13:1 student to faculty ratio, offers over 75 majors and minors, 68 doctoral programs and 113 master's programs. Hurston has an 82.6% four-year graduation rate for Black students and a 96.4% first-year to second-year retention rate for Black students.

Participants. Participants of this study attend either Shakur University or Hurston University and are a part of an institutionally sponsored program that promotes STEM

engagement and matriculation via undergraduate research. Both programs offer financial aid, academic support, advising and mentoring, exposure to STEM, and undergraduate research experience. Students participate in these programs via cohorts, building a sense of community among each group. As a member of either program, the students are awarded a merit-based scholarship each year ($10,000 for the program at Hurston and the cost of attendance or $10,000 at Shakur), paid for the duration of their time in the program, and are expected to maintain at least a 3.0 GPA on a 4.0 scale. Students of the programs are expected to major in a STEM field and have aspirations for obtaining a Ph.D. or MD/Ph.D. within a STEM area post-undergraduate graduation.

Study participants, identified by pseudonyms, varied regarding their classification (First-Year, Second-Year, Third-Year, Fourth-Year) age (ranging from 18 to 25), and cohort within their respective program (see Table 1). Participation in this study was voluntary. All individuals that fit the specific criteria (enrolled at Shakur or Hurston and a member of their respective research program) were eligible to participate.

In phenomenological studies, qualitative scholars suggest that at least six participants should be sufficient in "discerning the essence of experiences" (Sandelowski, 1995, p. 182). The number of participants should be sufficient to represent various factors related to the phenomenon of interest (Sandelowsi, 1995). I recruited 10 participants, five from each institution to participate in this research study. These individuals ranged in their classification, major, prior STEM experiences, and research experiences pursued. Researchers investigating UREs have utilized participants who varied with regards to their demographics and experiences, based on their research foci of interest (National Academies of Science, Engineering, and Medicine, 2017). The most consistent categories investigated

among their participants are students' race or ethnicity (e.g., underrepresented minority or White), classification, major, and type of research program (e.g., university, industry, etc.). Given my goal of exposing and understanding marginalized identities within STEM URE, I attempted to maximize the variation among these students' majors, research experiences, classifications, and prior STEM experiences while focusing on the core concepts of identities most salient to them and the overall influence of these identities on experience (Gall et al., 2003; Stake, 1995).

Table 1

Research Study Participants

Name	School	Classification	Major
Buttercup	Shakur	First-Year	Physics + Electrical Engineering
Ginnette	Shakur	First-Year	Chemistry
Lexi	Shakur	Fourth-Year	Mathematics-Secondary Education & Physics
May	Shakur	Third-Year	Chemistry
Nicole	Shakur	Second-Year	Chemistry
Teresa	Hurston	Third-Year	Environmental Health Science (Public Health)
Sunshine	Hurston	Third-Year	Biology (Public Health)
Charlotte	Hurston	Fourth-Year	Biology + Women & Gender Studies
Sara	Hurston	Third-Year	Biology + Chemistry
Jenny	Hurston	Third-Year	Biology + Latin

Note. Majors listed in parentheses represent the reported majors those participants are interested in exploring after changing their majors.

Data sources. Scholars suggest three key elements of data collection for case studies: multiple data sources, the formation of a case study database, and sustaining a chain of evidence (Yin, 2003). Multiple data sources allow for a richer description of the case in addition to adding to the rigor of qualitative research. Multiple data sources promote triangulation, the process of collecting multiple sources of data and using the different sources to validate findings (Gall et al., 2003), helping ensure trustworthiness of the data and process and reduce researchers' biases. There is variation in terms of how qualitative researchers view and interpret trustworthiness and subsequently bias that range from seeking to show the research is credible and plausible to specifically focusing on advancing a social agenda and provide cultural criticism (Glesne, 2011).

A case study database involves organizing and documenting the collected data (Yin, 2003). To maintain a database, I created an excel file that included from whom information was obtained, what information was obtained (observation, interview, or journal prompt), when the information was obtained (date), where the participant was located (institution or context), and how the data were stored (location on the secure server and file name). A chain of evidence helps researchers ensure that individual and aggregate research-site evidence are incorporated and adequately reported in the final analysis of the project (Yin, 1982). The chain of evidence encompasses any guides used to collect data (e.g., observations, interviews, and journal prompts), the researcher's notes created throughout the process, and the analytical narratives derived (Yin, 1982).

Given the function of transformative paradigms to promote collaboration among the researcher and participants in considering what is reality and knowledge (Mertens, 2007, 2010) and the nature of hermeneutics phenomenology that situates the researcher within the

context (Sloan & Bowe, 2014), my presence as a researcher and positionality both directly

and indirectly influenced the knowledge generated from this research project. As a

contributor to the phenomena of interest and knowledge construction process, the

interpretations and conclusions represent, to some extent, my positioning and understanding

(Mertens, 2010; Sloan & Bowe, 2014). I did, however, collect multiple sources of data to

ensure I reported what was taking place as accurately as possible, given my goal of

addressing a social issue within the context of STEM undergraduate research programs

(Mertens, 2010).

I obtained data[6] via observations, interviews, and responses to electronic journal

prompts, ascertaining information regarding the students' perceptions and experiences. I

created and maintained a database for my case studies making data management easier and

making the links between data collection and data analyses more evident.

Observations. Observations are processes in which the researcher can obtain firsthand

information by observing or viewing the research context (Creswell, 2012). It affords the

researcher an opportunity to record data in real-time, allowing the researcher to study

participants' behaviors and interactions. As an observer, the researcher can take on one of

two roles, a participant observer or a nonparticipant observer (Creswell, 2012). A participant

observer is one who takes an active part in the research setting that they observe, assuming

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[6] Data collection occurred in two phases that corresponded to the umbrella project affiliated
with this study. Part of the data, one interview, three journal prompts, and one observation
from Shakur University was collected at the initial approval of the umbrella study (IRB 16-
1559). The remaining data, collected from both Shakur and Hurston were obtained after
dissertation committee approval was granted for this sub-study, hallmarked by different
research foci, though still a part of the same IRB approved-umbrella study. Each data set
contained the same sources of data: observations, interviews, and journal prompts from the
same participants. This study focused on a subset, Black females, of the overall sample of
students in the umbrella research study.

the role of an "insider" (Creswell, 2012). A nonparticipant observer does the opposite, visiting the site and recording notes without becoming involved with the activities (Creswell, 2012). Glesne (2011) challenges these definitions and terms, suggesting that all observers actively engage the observed context with a variation in the activity level. Observations can aid in developing a unique story behind the phenomena or area of interest (Stake, 1995).

Observations can provide a thorough understanding of the research setting, its participants, and the events taking place; and offer a description receptive to one or more of the five senses (Glesne, 2011). For this study, I used observations to gather evidence of the students' identity performance within their STEM URE context. I conducted observations using a protocol that I designed to focus on the participants' engagement with their activity and others within their research space (see Appendix A). The protocol describes the context, re-creating the essence of the room through words, and the people present. Additionally, the protocol describes the interactions that the participants have, both with their project and with others, any role that they take during the interactions, and other people's response to their role. Observations were taken over an hour to an hour and a half and provided sufficient time to observe students' engagements in their context, their roles, as well as other people's responses to them. Though no specific number of observations collected is advised, scholars suggest conducting multiple observations over time to ascertain the greatest understanding of the research site (Creswell, 2012). For this study, I used one observation per participant given my focus being on the overall constructs – race and gender identity performance in STEM and its influence. I examined these observations across the ten individual cases, as suggested in instrumental case studies (Stake, 1995).

Observations took place at the participants' respective institutions, URE specific events including coursework, program-specific meetings, and research activities. I took field notes in addition to completing the observation protocol to cover information not readily included in the protocol. My field notes were descriptive, refraining from interpretation and judgment while collecting the data (Glesne, 2011). I maintained a researcher's diary, capturing my thoughts, opinions, behaviors and emotions about the event observed. Observations, in addition to the field notes, informed my understanding of the meanings behind the identities students shared, as I took note of how these participants maneuvered in their URE setting, who they interacted with and how.

Interviews. Interviews are a source of data that allows the participants to share their voice. An example of an interview includes the researcher asking the participant open-ended questions while recording their answers (Creswell, 2012). Though multiple types of question-based interviews exist (one-on-one, focus group, telephone, email, etc.) for the purpose of this study, I conducted one-on-one interviews in a face-to-face setting. Face-to-face interviews allowed me to probe for additional information on particular responses, to note body language, and to ensure that no voice was silenced by others – as can occur in focus groups (Glesne, 2011). I conducted two interviews as part of the research study. Those interviews were approximately one hour, containing no more than 30 questions (see Appendices B1-2).

The two interviews contained questions regarding the students' background experiences in STEM, their undergraduate research experience, and their thoughts and beliefs on how the URE experience has influenced their goals, aspirations, and understanding of STEM. I conducted all the interviews and recorded them. I used an external transcription

service, Rev.com, to transcribe verbatim the interviews. After receiving the transcripts, I listened to the audio files and read over the transcripts to correct any typographical or substantive errors.

The interviews were semi-structured, having order and purpose to the question while allowing for probing and spontaneous questioning to occur. Questions during the second interview were informed by conducted observations and journal prompts completed by the participants. Interviews took place in private settings on the participants' respective campus, either Hurston or Shakur University.

Journal prompts. Creswell (2012) considers personal journals to be a document or artifact. Documents provide a rich source of text data for qualitative research (Creswell, 2012). I employed journal prompts, a total of five, in this study (see Appendix C). The prompts obtained more information about the participant and their experiences that they might not feel comfortable sharing aloud.

I sent journal prompts approximately once a month to the individual participants by way of email. The email included a secure link for them to upload their typed documents to a secure server. I asked participants to be as thorough as possible in their responses but they determined the overall length of their response. I used these prompts in conjunction with the observation and interviews to identify students' predispositions, salient identities, and characteristics and behaviors. The journal prompts informed my understanding of the various identities that students declare, the source or foundation of those developed identities, the extent to which the students perceive their identities as strengths or assets for their persistence in STEM, and their overall perceptions of STEM and their URE.

Data analysis. Denzin and Lincoln (1994) suggest that a qualitative researcher is a bricoleur, employing a variety of strategies and methods to collect and analyze their data. There are numerous ways for researchers to analyze qualitative data (Dey, 1993; Huberman & Miles, 1994; Tesch, 1990; Wolcott, 1994). At its most simplistic form, Coffey and Atkinson (1996) suggest that qualitative data analysis "deals with meaningful talk and action" (p. 5). For the purpose of this research project, I used Coffey and Atkinson's (1996) *Making Sense of Qualitative Data* to guide my data analysis process, understanding that this text provides a variety of styles that informed how I described, analyzed, and interpreted the data obtained.

Qualitative data analysis is not a distinct stage of the research process, rather an on-going reflexive activity that informs future data collection and writing (Coffey & Atkinson, 1996). Using an open-coding process (Corbin & Strauss, 1990), I coded and categorized existent study data, while simultaneously collecting additional data at both Shakur and Hurston. Analyzing data while also obtaining new data allowed me to explore concepts in the second interviews that emerged from the participants' previous accounts.

For each individual case, I read over the existing transcripts, observational data obtained from protocols and field notes, and prompts sequentially (i.e., journal prompt one before journal prompt two, interview one before interview two, etc.) and in their entirety. After reviewing the data in its entirety, I used open, inductive coding (Corbin & Strauss, 1990) to create a list of codes that described what was occurring within the first round of interview data collected. I used the qualitative software HyperRESEARCH to conduct all data coding. After completing an initial round of coding, I re-coded the interview data in addition to the first round of journal prompts to solidify my codes. After establishing the

codes, I separated and reviewed all of the documents by case, first round of interviews and first round of journal prompts, comparing and contrasting each individual case's codes to generate categories that represented the overall conglomerate of cases.

Categories consisted of broad labels that encompass a variety of different, related codes. Categories, in essence, further assisted with the organizing, management, and retrieval process of the meaningful pieces of the data (Coffey & Atkinson, 1996). I applied all codes and categories developed from the existing data to newly acquired data. I also used a deductive coding process to generate new codes from the newly acquired data. These new codes captured commonalities that appeared both saliently and consistently within and across the cases. Like before, for the newly acquired data I coded within the first round of data collected, first, to generate any new codes, followed by coding the remaining data. I then compared the codes across all of cases to develop additional categories. After collecting, coding and categorizing all of the data, I reflected over the categories in relation to the research literature, questions, and conceptual framework to develop themes.

Themes represent my ideas and understandings of the interrelated codes and categories, linking the obtained data with the existent research, conceptual framework, research questions, and research design (Coffey & Atkinson, 1996). I used the codes and categories of the total data set – both existing and newly acquired data – to devise emergent themes (see Table 2). The developed themes, founded on codes and categories, served as a portion of the analysis process. Additionally, I looked for examples of contrast, paradoxes, and irregularities as a way to complete the analysis of the data, the culminating process of theorizing and presenting meaning (Coffey & Atkinson, 1996).

Rigor

Displaying rigor is a way in which qualitative researchers can substantiate and legitimize their findings. Morse, Barrett, Mayan, Olson, and Spires (2002) state that, "without rigor, research is worthless, becomes fiction, and losses its utility" (p. 14). Rigor is the process of exhibiting truth value, applicability, consistency, and neutrality as a way to show that research is meaningful (Guba 1981). Rejecting the terminology of validity and reliability to determine rigor, Guba (1981) suggested the concept of "trustworthiness" as a way to substantiate and legitimize the research conducted.

Trustworthiness. Establishing trustworthiness is an important step in the qualitative research process (Baxter & Jack, 2008; Creswell, 2009, 2012). Determining the accuracy of the findings should be an on-going, continuous process, in alignment with the data collection and analysis process (Creswell, 2009). Given the interpretive nature of qualitative research, establishing trustworthiness of the data is necessary to demonstrate validity (Creswell, 2012). Guba (1981) suggests four criteria that should be satisfied to establish trustworthiness within natural inquiry (qualitative research): credibility, dependability, confirmability, and transferability.

Credibility is the accuracy and adequate representation of the findings, reflecting what occurred within the setting (Lincoln & Guba, 1985). To establish credibility, I conducted member checks (see Appendix E), allowing the participants to review the interpretation of the data, and I triangulated findings using the different data sources (Gall et al., 2003). Additionally, given the structure of my research questions and the questions listed in the interview protocol, a significant portion of interview number two functioned to corroborate reports presented in interview one. Triangulation is the process of collecting

multiple sources of data to validate findings (Gall et al., 2003). For the purpose of this study, I triangulated observations, interviews, and journal prompts to establish credibility.

Given the transformative paradigm and my desire to disclose the students' input, I described and presented the data in as close to its original state as possible. Using the participants' own words to define, describe, and explain the data enhanced the credibility of the study. Additionally, a senior researcher, a recognized expert in qualitative research and widely published in scholarly journals, reviewed codes developed in the initial stages of the analysis process in order to ascertain the degree to which the raw data supported the codes.

Dependability is the public inspection of decisions made during the research process, and confirmability is the illumination of chains of evidence that link data collection, data analysis, and subsequent interpretations (Guba, 1981). I obtained an external audit (see Appendix D) from a researcher outside of the research study that is knowledgeable of the qualitative process (Creswell, 2009) as a means to satisfy the criteria of dependability and confirmability. The external auditor is an expert in the field of higher education retention for marginalized populations. As a mid-career researcher and administrator trained in qualitative research processes, the external auditor has published and presented empirical research on efforts geared towards increasing college retention for first-generation college students from a developmental perspective. The external audit consisted of examining all documentation – my observations, coded transcripts and prompts – to ensure the integrity of the decision-making process. That is, the external auditor ensured reporting and practices aligned and such alignment was evident in the chains of evidence (Guba, 1981). Transferability, the ability to make an informed judgment on similarities between the research context and other environments (Guba, 1981; Shenton, 2004), was satisfied by using thick description of the

research contexts, thick description in the research findings, and by investigating the phenomena of interest across multiple cases.

Research Ethics

According to Guba and Lincoln (2005), axiology is "the branch of philosophy of dealing with ethics, aesthetics, and religion" (p. 169). As mentioned earlier, my identity as a Black, African American male who has studied STEM informs my positioning within this study. Likewise, my upbringing and experiences inform the level of ethics and morality that I maintain. Growing up, living in a household with my mom, two sisters, older female cousin, uncle, grandmother, and grandfather has significantly influenced my perspective on life. With my grandfather being the pastor of my church and my grandmother being in education, both being influential in the civil rights movement and advocating for equity for Blacks, their lessons and ideologies have influenced my own. As a self-identified Christian, committed to advancing the Black community, I maintain the highest level of ethics in conducting this research and ensure that the voices of the students are shared.

Before collecting any data, the Institutional Research Board (IRB) - IRB 16-1559 - approved the study. I collected consent forms from the willing participants, making it known that participation in this study was completely voluntary and that they were free to drop out of the study at any time. During the data collection and analysis process, I reassured students that there was no correct answer and that whatever truth they revealed would be the basis of this study's findings. To protect the participants' identity, the students developed pseudonyms I use throughout the study and I masked any information that could be linked to them.

Table 2

Exemplar of Coded Data

Theme: STEM as Conduit, URE as Resource or Tool			
Category	***Codes***	Um, it's something that I participate in. It's, it's like, it's my career for now you know... It's like something I have to do right now	Buttercup Int.1 pg.16
Perception of STEM	STEM as Conduit	Um, yeah, because- well, I didn't know what to major in, but I was, like, looking up online what other anesthesiologists majored in, in school, and it really doesn't matter what you major in to go to medical school, but Chemistry is something that will help me, um, when I'm trying to get into school, like, perform better on the test, and everything.	Ginnette Int.1 pg.5
		I fear never getting accepted into an MD-PhD program and ultimately making a real impact on the lives of underserved women in my future career. I continue to pursue it because it truly is my dream and a wise woman once told me that "If your dreams don't scare the hell out of you, than you're not dreaming big enough"; so here I am, dreaming big and scared as hell. It scares me because this goal of mine gives my life purpose and if it falls through then my life would pretty much not have purpose	Charlotte Journal Prompt 1
	Network	I am participating in this program because it gives me the opportunity to link up with people who are in my major and have similar goals	May Journal Prompt 1
		I'm connected with a variety of students focused in different STEM fields and also faculty members who are involved with the program. A lot of faculty members support the program and we have opportunities throughout the years to meet these individuals. I appreciate having the opportunity to build these types of relationships.	Sunshine Journal Prompt 3
		I am in Hurston STEM Initiative mostly because I wanted a support group of connected scientists.	Jenny Journal Prompt 1

Perception of URE	Exposure	Not really. Being in the Shakur STEM Initiative program, it's made me realize how broad STEM can be because of seeing other students' ideas in their research. It reminded me of how broad STEM as a whole is. Which I like because I could always ... If I change my mind and don't want to do a certain thing, I can always change my path up a little bit and still be within the STEM community.	Buttercup Int. 2 pg.13
		I think the research was most beneficial. I learned how to use some equipment in the lab that I probably would never have even touched. I've learned some lab etiquette that you don't learn in the class like the teaching lab	May Int. 2 pg. 4
		(I) What are you thinking about doing after graduating? (R)Um, going to graduate school and becoming a chemist. (I)Any particular type of chemistry? (R)I'm not sure which area I want to do yet but I, I hope to, um, do some more research in undergrad, so I can, like, kinda learn what I like.	Nicole Int. 1 pg. 13
		I guess my ideas about my future and about what I want to do later on in life have diversified or changed in a way because I remember coming here. I was set on pre-med. Pre-med, become a doctor and that was it, but when I came here, I started getting an interest in research because of the Hurston STEM Initiative. We toured labs. We talked to professors. We talked to principal investigators and I think at that point my interest peeked for research	Sara Int. 2 pg. 2
		This summer, I participated in an REU that I feel impacted my journey a great deal. I had the opportunity to work in an environment filled with cutting edge scientists, but I learned more *outside* of the lab than I did behind my microscope. In various seminars, we discussed topics like the culture of science, diversity and the difference between fixed and	Teresa Journal Prompt 2

		growth mindsets. Those discussions and interactions helped mold me into a person less fearful about making mistakes, and more eager to learn and grow. I think it's impacted me this way because I learned the importance of learning through experiences instead of trying to "perform" well all the time.	
Perception of URE		A lot of opportunities. I got my internship last summer at [another institution] because umm... the program advisor for Shakur STEM Initiative sent me the email	Lexi Int. 1 pg.22
	Finances, Support, & Network	honestly because they were um supporting me financially. uh, coming to Shakur they didn't give me a lot of financial aid, that other schools did, and that's kind of a reason why my mom didn't want me to go here. But they were helping financially and they um they had opportunities for math people	Lexi Int. 1 pg.21
		I have built connections with Ms. G, Dr. J, and Dr. B. Ms. G is the program coordinator of the Shakur STEM Initiative program and she has helped me tremendously. I met her through my counselor who told me about the program. She will be covering my bill for the upcoming semester. Dr. J is a professor that is leading the Shakur STEM Initiative program. Dr. B was my teacher for the Shakur STEM Initiative course this summer. She is very helpful and supportive. She has also told me that there may be research opportunities available during the school year and to check with her or Dr. J	Nicole Journal Prompt 3
		Through the program, I have met amazing faculty. These faculties have got me my job I currently have and helped with various internship applications. All the time I meet new people, who bring me one step closer to my goals in life. I am fortunate to have met them.	Sara Journal Prompt 3
Perception of URE	Exposure, Network,	when I do see program staff, they are very friendly and if they have an opportunity that they think I will be interested in, they will let me know. Like I said, they're always there academically. One of the program staff is a professor in a subject that I had to take. I	May Int. 2 pg. 1

	& Support	sometimes go to him for help.	
		I do because when I first joined the program, they pumped it up. They pumped up STEM. They incited excitement in it for me. They made me want to dive in and just learn. They make it easier because they do everything they can to make sure that we're not as stressed as we could be. Not to mention that it is just very exciting to see black professionals in the science field who are as successful as they are.	May Int. 2 pg. 13
		I had my first job my second year of college, and it ended up being in the lab of one of the leadership members of the program. It was nice to have this opportunity and connection. He simply asked my group if anyone was interested in a tech position and as simple as that, I had a job. These types of connections and the networking the program provides have helped me a great deal throughout my years here on campus. I still work this tech job and I actually, even did research in this lab for a semester. Having this experience under my belt has opened a lot of doors for me with other positions so I'm pretty grateful.	Sunshine Journal Prompt 2
		I am a Hurston STEM Initiative Scholar, so I receive the opportunity to network with many science faculties in the university, which will help when I am in need of recommendations and exposure to fields I am interested in.	Sara Journal Prompt 1

Note. Categories provided are listed in the far-left column, followed by the codes ascribed. Examples of the codes are in the third column, with the source of the examples provided in the fourth (far right) column.

Chapter 4: Findings

In this chapter, I present the findings for research questions regarding the expression and influence of race, gender, and other identities on STEM identity and retention for Black females in undergraduate research experiences. These findings are the result of what started as a thematic analysis using a critical lens. Embracing a CRT informed positionality, I appropriate the use of counter-storytelling and narratives as a way to reveal the experiences and messages of Black women, who are often misrepresented or ignored in majoritarian narratives and traditional reports (Collins, 2000; Solórzano & Yosso, 2002).

Seeking alternative ways to best present this data, I elect to use a variety of alternative literary forms to ensure that the presentation style best captures the messages and experiences of these participants (Coffey & Atkinson, 1996). Additionally, these forms address the research questions in an appropriate manner through reflective reporting for case studies (Gall et al., 2003). Alternative reporting styles allow researchers, "to work out and spotlight particular ironies or paradoxes inherent in particular positions and cultural conventions" (Coffey & Atkinson, 1996, p. 123). As with all alternative presentations, ensuring the authenticity of the work is of grave importance. To prevent crafting an entirely fictional account, Coffey and Atkinson (1996) recommend that researchers use a large degree of

"artistic restraint" and refashion the actual data, using primarily the participants' words to develop the presentation.

To address research question one, Black female students' conceptualization of their identity within their STEM URE context, I use poetic transcription (Glesne, 1997) to represent the findings obtained. My decision to use poetry as a way to capture and reveal the voices and perceptions of these students was based on literature that speaks to the power of poetry for Black women (Lorde, 2007). To address research question two that emphasizes the positioning of those identities and how it informs STEM persistence, I provide a graphic representation that outlines the story of Black females' journey to achieve their goals. To address research question three, the influence of their said identities on their perception and experience in STEM and STEM URE, I use composite counter-storytelling (Cook & Dixson, 2013; Patton & Catching, 2009) fashioned as a vignette (Humphreys, 2005; Langer, 2016). The vignette captures the essence of how Black females' identities shape their perception of their STEM URE. The findings for research question four provide an understanding of these students' associations with STEM. These findings convey the extent to which they perceive STEM as a part of their identity. To address research question four, I present emerging themes derived from the data.

Each question sets the foundation for the following question, collectively shedding insight on Black females' perspectives and understanding of their identity as it relates to STEM identity and subsequently STEM retention. I present the findings in part one and discuss them in part two.

Part I: Presentation of Findings

Findings that I gathered from this study address the four research questions pursued. The findings I gathered are presented as (a) Identity Conceptualization, (b) Positioning of Identity as Strength or Asset, (c) Perception of STEM and STEM URE, and (d) Association with STEM. In presenting my findings in this manner, I address each research question separately, but also demonstrate how they collectively share the stories captured in this project.

Identity Conceptualization

Question one involves the participants' perception and understanding of the various identities that Black females express within STEM and STEM URE. The goal in answering this research question is to reveal which identities are most salient for these students in this context and why. To determine the students' understanding and perception of their identities, research question one was composed as, "How do Black female students participating in STEM undergraduate research programs conceptualize their race, gender, and other salient identities within their STEM experiences?" Analysis reveals various displays of the students' salient identities including presentations of their race, gender, and religious identity in either an isolated or intersectional manner. In conveying their understanding of their various identities, these students report perceptions of their identity as being either externally defined, internally defined, or understood through vicarious associations. The regulation of their understandings was contingent upon these students' belief in their ability to choose what their identity meant, and whether or not their identity expression was because of their choice or due to the influence of someone or something else.

The findings consist of a poem composed from the collective interviews and journal prompts gathered.

I Am… In her writing, "Poetry is not a Luxury," Black feminist scholar and poet, Audre Lorde (2007), discusses the power of poetic prose to capture and reveal the real concepts, ideas, and understandings behind the experiences and power of women. Lorde understands poetry to be a "revelatory distillation" (2007, p. 37) that shares both the ideas of Black women – ideas being a source of liberation – and Black women's deep, dark consciousness of living – their experience being their source of power and the creator of true knowledge and understanding. Embracing Lorde's perspective on poetry as it pertains to its ability to capture the essence and meaning of Black women, I utilize poetic transcription (Glesne, 1997) to present the findings pertinent to research question one. Poetic transcription is a nontraditional way in which researchers can present their findings (Glesne, 1997). It is a process bound by a set of rules that the researcher delineates; in the process, the researcher uses the participant's words to construct a poem that captures the meanings, or "essence" obtained (Glesne, 1997).

Similar to Glesne's (1997) approach, in constructing *I Am…*, I took the words of the participants from either their interviews or journal prompts to construct this poem. I rearranged the order of the statements, organizing them by related concepts or ideas (e.g., religious identity, sources of support, etc.) to generate the overall flow of the poem. Fashioning a poem from the participants' words emphasizes the rhythm and flow of the original speech, in addition to capturing the personal and emotional content of the data (Coffey & Atkinson, 1996). In developing the poem, rather than using individual poems for each participant, I fashioned a composite poem. The composite poem takes words from each participants' interviews and journal prompts to produce one overall representation of their collective experience.

Compositing allows for the development of a narrative that adequately captures the reports and experiences of the individual participants as a collective, one goal of the guiding research question, and reduces the instances in which any unique characteristics or identifiers inadvertently compromise an individual's anonymity (Hubain et al., 2016). To fashion a poetic prose and generate a rhythm that conveys the appropriate meaning, like Glesne (1997), I used enough of the participant's words to produce an overall structure and format that was appropriate. Words from individual interviews and individual journal prompts as well as phrases across participant data constitute each stanza. My interpretation and analysis of the data are embedded in how I craft, compile and shape the phrases of the participants to adequately convey the ascertained meaning ascribed to their responses. I explicitly unpack and discuss these interpretations after the poetic transcription.

I. I Am…

African American… Muslim… Nigerian… Christian… Black

But…
(Interview #1 and Journal Prompt 1, Buttercup, Lexi, Nicole, May, Ginnette, Teresa, Sunshine, Charlotte, Jenny,& Sara)

II. First, I'm a Woman
I'm a Female… a Cis-Woman
I'm African-American…African American slash Black
A Black American… a young Black Woman
Female, African-American. African American Female
I am an African American Woman, a Black Lady
(Interview #1 and Journal Prompt 1, Buttercup, Lexi, Nicole, May, Ginnette, Teresa, Sunshine, Charlotte, Jenny, & Sara)

III. You face discrimination as a Black person and as a Female
A Black Woman in society, there's so much pinned against you
Being African-American, that's a challenge in itself
People don't really care about us
As far as people of color go, African-Americans have the worst of it
Being Black and Female presents a disadvantage
(Interview #1, Nicole, May, Jenny, & Lexi; Interview #2, Sara)

IV.   Society doesn't see Black Females as Scientist.
       Black Females are sassy, loud, intimidating, not intelligent, or sleep around
       Black Females have bad attitudes; being entertainers, or baby mommas
       People aren't used to seeing Black doctors, chemists, mathematicians, or engineers
       There's not many minorities in STEM
       It goes back to exposure… The representation is lacking!
       (Interview #1, May, Lexi, Jenny, Ginnette)

V.   STEM is hard to get into, especially for people of color
       It's really hard to get Black people into STEM, you'll see very few Black people
       STEM is pushed more on White people and Asians, they're stereotyped as smart
       A Black Female to enter that field? It's very rare.
       There aren't many Black American Females in the STEM field. It's very uncommon
       actually
       You are the minority, a Black Woman in STEM…We're the minority in STEM fields
       (Interview #1, May, Lexi, Nicole, & Buttercup; Interview #2, Ginnette)

VI.   I was the only Black Girl, and the teacher would make Black jokes
       This boy that used to call me stupid, He said I was stupid cause I'm Black
       Privileged White students, very ignorant, they had questions, and I'm impatient
       Not seeing a lot of Black people, feeling like I don't belong
       Going to White schools, I wasn't treated fair by teachers, they would single me out
       Being in class with White people, there was racial tension among the students
       (Interview #1, May, Nicole, Buttercup, Teresa, & Jenny; Interview #2, Nicole)

VII.   My neighbor, she was Black, she told me that I made Black people look bad
       One woman from church, in her mind, MD/PhD, that's reserved for them over there
       When it happened, I was ashamed of myself
       Sometimes I would believe it, but sometimes I just didn't
       A lot of the self-doubt came through, I shut down… I became suicidal
       Maybe I really am the problem?
       (Interview #1, May & Nicole; Interview #2, Sara; Journal Prompt #2, Sara)

VIII. But I had to realize that I wasn't
       I shouldn't be afraid of not being accepted in this environment
       I realized we are just as good as them
       They instill in us that you can't do it, we take that
       We tell ourselves, "just because they said, we can't do it," But you can.
       They have no right to make us feel inferior!
       (Interview #1, May, Lexi, Sunshine, Jenny, & Sara)

IX.   Growing up, I've had social safety nets, my family, church family, and dance school
       I've been around Black people all my life, I didn't want to change that
       Black people…It's just the culture, it makes it more relatable
       My high school, it's a historically Black school, I didn't feel any negativity

The community, it's mostly Black people, the community supported me a lot
I wanted to attend an HBCU, Black people in America are more open to Islam
(Interview #1, Lexi, Buttercup, Sunshine, & Charlotte)

X. Black Females in STEM have a little bit more to prove than others do
In STEM, you have to prove yourself more
If I don't show them up or show them they're wrong, they won't accept me
People have an idea of you before they even know you…
Those disadvantages make me want to disprove the stereotype
If I show a sign of weakness, it brings out their stereotypes of me
(Interview #1, Sara, Jenny, & Ginnette; Interview #2, Sara, Lexi, & Ginnette)

XI. I sometimes stay quiet. It is still intimidating
I don't want to be looked at as stupid
I still have doubts, there's other things I could be doing
I've been struggling my whole life, but I was determined
"I'm going to learn this thing," nevermind ... I tried…I'm still learning though
I don't think God would bring me this far for me not to be doing it in the future
(Interview #1, Sunshine, Charlotte, Buttercup, Sara, & May)

XII. If I am feeling bad, I always pray
Whenever I don't know what to do, I just try and pray
Just praying helps
I turn to the Bible and I go to church
My faith is really important to me
I rely on my faith… I enjoy serving in my campus ministry/ church
(Interview #1, May, Lexi, & Buttercup; Interview #2, Sara; Journal Prompt #1, Teresa)

XIII. I'm self-sufficient. Getting stuff done on my own.
I'm responsible for the things I do and the outcome
I don't need someone pushing me, I can do that myself
I'm strong. I can keep going, wanting to pursue my dream to help underserved women
I want to be a part of helping people, I want to help Black youth
I'm really interested in racial disparity issues
(Interview #1, Lexi, Sunshine, Ginnette, & Charlotte; Interview #2, Teresa; Journal Prompt #2, Charlotte)

XIV. My Mother…She inspires me…when she's talking and spitting out facts
My Mom… seeing her become a nurse inspired me to make a difference too
My Mom is a Chemist. She's the reason I've pushed towards science, mathematics
My Mom, she's very supportive
My Mother has been really influential
My Mom would have supported me regardless
(Interview #1, May, Ginnette, Lexi, Sunshine, & Buttercup

XV.	Being a Black Female means being driven, strong, facing adversity
	Proud, confident, strong, determined
	Being a Black Female, it's a good thing!
	More powerful, intelligent, and strong
	To be a Black Woman, it's hard, but it's great!
	To be a Black Woman, it's difficult at times, but I'm proud!
	(Interview #2, May& Sara; Interview #1, Lexi, Ginnette, & Sara

XVI. Being a Black Female in STEM means success…It can be powerful
Just one of few. The cream of the crop.
There were two African American women in that lab, I appreciated that
My identity as a Black Woman drives me to do my best in STEM
For now, I'm the minority in STEM. They'll see me as a Black Woman
There is nothing that I can do to really change, I might as well work with what I have:
(Interview #2, May, Nicole, & Teresa; Interview# 1, Lexi & Buttercup)

XVII. Have a lot of strength and perseverance, resilience
Have to motivate myself
Have to navigate to get what you want
Have to be knowledgeable
Have to be confident in ourselves
Have to be determined
(Interview #1, Lexi, Nicole, & Charlotte; Interview #2, Sara)

XVIII. We can overcome these obstacles that life throws at us because we are Black Women
Slave mothers had a lot to deal with, but they still managed
We're so unique. We always stick out.
Taking the scraps and making a lifestyle
I can do this. I went through this and I did it! You can do it too
You got to take that first jump and get in there
(Interview #2, May, Sara, Sunshine, & Lexi)

XIX. I'm a sister, a daughter
I'm a human being so I have multiple parts
I am still the person that I am… I'll Still Be Distinguished
I have two identifiers: Black and Female
My Blackness is huge. My being a Woman is huge
African American Woman…It's just a different vibe
(Interview #1, May, Nicole, Ginnette, Charlotte, & Lexi)

Demographics Identified. *I Am…* captures the expression of these participants'

salient identities within their STEM URE context. As demonstrated mainly by the first stanza

and all throughout the poem, these participants' race and gender identities were the most

salient identities expressed. The participants used words such as "female" "woman" or "lady." When used in their stories, their word choices of "female," "woman," or "lady" indicate meanings beyond biological sex, a concept I discuss later. However, in her definition of what it means to be a Black female, Teresa shares, "I think it means to be biologically female," (Interview #2) focusing specifically on the biological sex. Words such as "Black" "Black American" "Nigerian" and "African American" highlight these females' racial identity, associating racially with people of African ancestry or descent (Larkey et al., 1993; Smith, 1992). For most of these females, the terms "Black" and "African American" were seen as interchangeable, acknowledging that both terms defined what they considered to be their racial identity. Though not specified in this poem, Buttercup definitively stated that she did not see the terms Black American and African American as being interchangeable when referring to her race:

> I identify myself as a Black American. Um, a lot of people would say like, correct me and say African American, however, if I were to go to Africa today, I wouldn't know where to go, I wouldn't know who to talk to. I wouldn't know how to communicate outside of English. So, I personally identity myself as a Black American. (Interview #1)

Buttercup acknowledges both race and ethnicity/nationality within her definition of Black and African American. Her reference to time, "go to Africa today," implies an understanding of the history and her connection with an African ancestry, suggesting that she sees race as a historical connection among a group of people with shared ancestry (Haney López, 1994). Outside of Buttercup's explicit acknowledgment of ethnicity/nationality, another participant, Sara, implicitly acknowledges her ethnic and racial identities.

Sara describes herself as being, "Nigerian, American born, woman" (Interview #1). She delineates ethnicity/ nationality as she describes her American grandmother as being,

"African American Black," (Interview #1). Sara also links her ethnic and racial identities throughout her story by describing herself as "Nigerian American slash Black woman" (Interview #1) or talking specifically about her experience as a Black woman, "also, I feel like as a Black woman we are always taught to be strong" (Interview #2). In these statements, she links what she has previously identified as her ethnicity/nationality, Nigerian, to race, being Black.

Beyond the direct statements that capture these participants' race and gender identity expression, throughout the poem, other evidence of their race and gender identity as a Black female or Black woman is present. Through their stories recanted of previous experiences and encounters, these participants show their race and gender identities as being Black and female by presenting events in which their race and gender identity sparked specific encounters with other individuals. The experiences represented in stanzas VI and VII capture a moment in time in the participants' lives in which a negative encounter triggered an awareness of their racial and/or gender identity. Negative encounters occurred either when they were the only Black student within their environments, or when other individuals – a teacher, peer, neighbor, or fellow church member – found fault or limitations within them due to their identity as Black females.

As in the case of stanzas VI and VII, stanza IX captures moments in which these participants were made aware of their race and/or gender identity; in contrast to stanzas VI and VII, positive encounters served as the stimuli. Positive encounters included being surrounded by all Black people and enjoying their presence, growing up in an all-Black neighborhood and feeling a sense of community and support, or wanting to attend a Historically Black College or University because of the belief that Black people were more

open-minded. With each statement, the participants equated a sense of comfort, support, and community from being surrounded by Black people.

Outside of their race and gender identity, the next most salient demographic identified among these individuals was their religious or spiritual identity. Similar to their race and gender identities, these participants directly stated that they were religious people and that their religions or beliefs were an important aspect of who they are and how they identify. These students shared that they were "Christian" or "Muslim," or acknowledged their religious identity through statements that disclosed religious practices such as praying, reading the Bible, and going to church.

I Am… captures the complex nature in which these participants developed an understanding of the various demographics disclosed – specifically focusing on race, gender, and religion – and it presents the extent to which those understandings influenced the salience of those same identities within their every day and STEM contexts. In their revelations of their identity – Black, female, religious – these students revealed that experiences (encounters) and individuals had the greatest influence on their understanding of their identity. However, the expression of their identities was contingent upon their decision to either accept, embrace, refuse, or deny the understanding they obtained from those experiences and individuals as indicated in stanzas VII, VIII, XII, XIII, and XIV. Those previous experiences that laid the foundation for their understandings involved an attack from another individual due to the participants' interest and engagement in STEM.

Academically, negative experiences took place in their school. As represented in stanzas VI and VII, participants recall being verbally attacked, called "stupid because [she's] Black," humiliated and belittled by "Black jokes," or subjected to a barrage of "ignorant"

questions from "privileged white students." These participants believed that each of these

negative experiences was because of their race, gender, and religious identity – Black female,

or Black female and Muslim – being seen as different, foreign, or not belonging within those

STEM spaces. Evidence of their religious identity influencing their negative experiences

comes from messages shared in stanza VI and IX that contrast the "privilege white students"

with the open-minded Black people as shared by Buttercup:

> I wanted to attend a HBCU because I find that going back to the whole religion thing, I find that Black people in America are more open to um, Islam I find. And I went for my freshman and sophomore of high school, I went to a predominantly white high school, and it was privileged white students. Um very ignorant. They didn't really understand, had a lot of questions, and I, I'm impatient so it was irritating. And then my junior and senior year of high school, I transferred to a predominantly Black school where I went from people not knowing much about Islam to people having a distant cousin that's a Muslim. Like, almost, a lot of Black people that I know have like, know someone who's a Muslim and it was just more open to me being Muslim and who I am. (Interview #1)

Socially, their negative experiences occurred outside of the school; these experiences related

to their pursuit of and engagement in STEM. Interestingly enough, a Black female

perpetrator played a key role in their negative social experiences: they "make Black people

look bad" due to the fact that, "I was the only Black person in the [Academically Gifted

Science] class" (May, Interview #1) or that they should consider alternative goals and plans

because their current dreams were too ambitious for Black females. Charlotte shared:

> She said, "Oh, what do you want to do with that?"
>
> "I'm thinking maybe MD/PhD, just MD, not really sure, but maybe MD/PhD would be pretty cool."
>
> She goes, "Hmm, maybe you should look into plan B. MD/PhD, that's kind of big. What would be a plan B?"...
>
> It's dreaming big, MD/PhD I know the double degree. It will take a very long time and I guess in her mind that's reserved for the really, really, really smart

people who most likely doesn't look like me, so what is your backup in case that doesn't work? (Interview #1)

The positive experiences described by these participants also occurred within their academic and social settings and involved their perception of a community or support related to their race, gender, and religious identities. Within *I Am…* these participants' sense of community and support is primarily due to their racial identity. "I've been around Black people all my life, I didn't want to change that," "My high school, it's a historically Black school, I didn't feel any negativity" and that "I wanted to attend an HBCU, Black people in America are more open to Islam" are statements that comprise stanza IX. These statements highlight the participants' awareness and acknowledgement of their racial identity as Black with the perceived positive experience it creates when surrounded by others who are also Black.

Beyond capturing the various identities that these participants revealed as salient, *I Am…* displays the manner in which these students disclosed their salient identities; their identity statements either being isolated or intersectional. Within their interviews and journal prompts, when asked, "How do you identify," some participants presented a list of qualities that captured their race, gender, and religious identity. This list is highlighted in the first stanza of *I Am…* where the participants gave responses such as, "African American," "Black American," "female," "woman," "cis-woman," "Muslim," or "Christian." Their responses were presented, for the most part, in sequential order: race, gender, religion, or gender, race, religion. Presenting their identities in an individual, sequential order, while using phrases such as "First I am a…" suggest that these participants saw their identifiers as distinctive enough to both individually and collectively influence their experience.

A few of the participants, however, responded to the same question of "how do you identify" with the answer "African American woman," "African American female," "Black woman," or "Black lady." These responses, unlike the others, presented a more intersectional approach towards their understanding and expression of their identity, where their experiences as a Black individual could not be separated from their experiences as a woman (Crenshaw, 1991). Despite the differences in their presentation of identities – isolated or intersectional – when it came to discussing their identity through their stories and experiences, all of the participants, at some point, would provide an intersectional approach to their understanding and expression of their identity. Through their stories, the participants also demonstrated instances in which one particular identifier was most salient. These particular moments occurred within a specific context or during a specific event, suggesting environmental influences on their understanding and expression of their identity.

Meanings Inferred. Outside of demonstrating their various identifiers, both in general and within STEM, *I Am…* uncovers the ways in which these participants conceptualize their identities, the meanings they associated with their identities, and the manner in which they ascertained those insights. When describing what it means to be a Black female, the participants' responses included characteristics such as "strong," "intelligent," "confident," and "hard but great" (stanza XV). Within these descriptions, the participants attribute their understanding of their identity as a response to or based on external forces, such as their environment and the people within it. Evidence of these participants' identity being externally regulated – based on the perception of what society says – show throughout the poem.

As Black females, these participants express that their identity is comprised of the effort they must exert, in response to the environment and society's expectations, to be recognized and appreciated by society as indicated in stanzas X and XV-XVIII. They speak of the stereotypes that they must overcome, the discrimination that they must face, and the psychological impact of the stereotypes and discrimination. There is also a heavy emphasis on the amount of work – physically, emotionally, psychologically – that they believe they must invest in order to deal with or cope with their circumstances.

I Am… also captures evidence of an internally regulated or self-determined (Harris-Perry, 2011; hooks, 1995) definition of what it means to be a Black female. Harris-Perry (2011) and hooks (1995) state that in the face of opposition and stereotypes, rather than be the "sum of their disadvantages" Black women become active agents in creating meaning out of their circumstances. A self-determined point of view is one in which Black women choose not to embrace a victim mentality in response to racism and stereotypes, but rather fight for liberation and the chance to define their own sense of self and destiny (Harris-Perry, 2011; hooks, 1995).

Stanza XIII and XIX both reveal how these participants define the essence of being a Black female that is separate from the perceived stereotypes generated by society (as shown in stanza IV). In stating that they are "self-sufficient" or driven by a purpose to help their community, these Black females convey characteristics that speak to their self-determined ability and motivation to define who they are as people. Acknowledging that purpose, (i.e. God would not bring me this far for me not to be doing [STEM] in the future), drives their lives and decisions, and implies that their decisions, despite the ease or difficulty of their external environments, are made because of who they understand themselves to be and what

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they believe they represent. Making claims that they are "human" and made of "multiple parts" highlighted in stanza XIX also denote that they are more than what people perceive them to be because of their presumed race and gender, suggesting that they define who they are as people.

These participants exhibited characteristics of being "self-sufficient," "doing things on their own," and "strong" (stanza VIII) through their independent behaviors and limited interactions that I observed in their STEM URE settings. Within the research lab, I observed that most participants often acted alone, independently addressing their specific task for the day. In observing Charlotte in her lab research experience, I documented in the field notes the following: Charlotte still appears to be independent and capable of handling her task alone. She moves as if she has done this before, and is able to keep things moving (switching out dishes and counting) to a steady flow or rhythm" (Observation #1). While working on their various projects, these participants also had limited interactions with others that were present. "While looking through the microscope, she manipulates the contents of the petri dish. She is working independently, and makes all of the decisions. Jenny doesn't speak to anyone, nor does she attempt to ask any questions" (Jenny, Observation #1). Like Jenny, many of the participants I observed worked independently on their task, and did so with limited communication with others on those tasks. In the instances in which they did speak to others within the setting, the conversations they carried were casual and about activities external to their current STEM URE setting.

> She also gets into a conversation with the white female about her weekend plans. The white female shares that she plans on shadowing a doctor at the emergency room. Sunshine lets her know that those plans are cool and ask if any other students get to shadow, to which she replies, yes. (Sunshine, Observation #1)

The conversation did not involve the participant's current task. The conversations also did not entail the participant asking specific questions or asking for assistance, despite the fact that the conversations took place while the participant was still engaged with her task.

Outside of illuminating their understanding of their identity as being self-determined, *I Am…* also shows these participants make a conscious choice to display characteristics of strength, persistence, and determination. Stanzas III, IV, and VIII expose these Black females' self-determination in defining their identity as it presents the contradictions between what they perceive society to say about Black females and the choice they make to refute those stereotypes. The participants' efforts to disconfirm the stereotypes of Black females also demonstrate their decision to influence how others perceive them. Although the onsets of these decisions are externally regulated, the participants' conscious efforts to disprove or overcome the stereotypes reveal the power of choice they believe they have in constructing the meaning of their identities. Other statements, such as "work with what I have" also highlight these participants' expression of agency, their belief in their ability to control their environment (Bandura, 1989).

An additional way in which these participants reveal the meaning they assign to their identities is through their descriptions of their mother or other Black women. For the majority of the participants, their mother is a member of or affiliated with the STEM community through their occupations. As nurses and chemist in stanza XIV, the mothers of these participants have played an active role, motivating and inspiring them to pursue careers and opportunities in STEM. The encouragement and support for the participants to pursue STEM provided by all of the mothers, both those in STEM and those who were not identified

as being a member of or affiliated with the STEM community, in addition to their sacrifice

and labor, serve as inspiration for these Black females to pursue STEM.

Introduced in stanza XIV, but further explained in their interviews, their mothers'

actions and engagements within their careers, as well as their messages of love and support

vicariously teach these participants what it means to be a Black woman, in general, and in

STEM. May shares:

> My mother serves as an inspiration for me because she is 39 years old, she has
> 3 children, she takes care of her mother and she is still going to school. She's
> been in school for as long as I can remember. There was one point in time where
> she wasn't in school but even then, she was still learning and now that she's
> working on her doctorate and I see how hard it is for her, because she has 3
> children to take care of. She was the only source of income in our household,
> but she's still pushing through it. She kind of inspires me when school gets hard,
> so I think about how much my parents have to deal with on top of them both
> getting their education and still being there for me and my sister, my brother.
> (Interview #1)

Like May, others provide similar accounts regarding their mother and how, "I would hear my

mom talking about working in the lab" (Buttercup, Interview #1). They also share that "I'm a

lot closer to my mom now because when I told her what was going on with me, she actually

understood and actually supported me" (Sara, Interview #2), or that:

> my mom would have supported me regardless of whatever… And she was like
> "oh my gosh, it's okay. It would have been all right if you just told me. I wouldn't
> have been mad or upset or anything". She's like "I just want you to be doing
> what you want to do and be happy and I know that whatever you choose or
> whatever you end up doing will be fine. I know you going to be okay because
> you've been able to figure out your way so far". I think that's what she said.
> She's like "yeah, I think you'll be all right so I wouldn't be too, too worried about
> you. Yeah, I want to know what's going on but I will support you in whatever".
> That was good. (Sunshine, Interview #1)

Strength, determination, and perseverance are all characteristics used to define their

mothers, specifically for those participants whose mom is in or affiliated with STEM. These

characteristics mirror the same characteristics they use to define Black females in general and

within STEM fields. Other examples of these participants vicariously developing an understanding of what it means to be a Black female are shown in their statements regarding general assumptions about Black females. Referencing slave mothers and speaking of them as being innovative and creative, in addition to stating beliefs about the experiences of Black women, despite not having experienced them personally, both connect to these participants' vicarious development of an understanding of what it means to be a Black female. Within their stories of their mothers, other successful Black women, and the slave mothers, these participants shared how they felt connected to or have learned from the experiences of other Black women. Aspiring to be like their mothers or other successful Black women, these participants disclosed that they felt empowered to succeed because they could see themselves in the same positions or exceeding those Black women predecessors.

When it came to defining the meaning of their identities within their STEM context, these participants' understanding was similar to their understanding of their identity in general, or in some instances, more intensified. The same descriptors used to define Black females, in general, applied to what they believed to define a Black female in STEM. Continuing in their description of the effort and energy Black females in STEM must invest, these participants attribute "Success," "Just one in a few," "rare," and, "The cream of the crop": to being Black females in STEM. Each description provided suggests that the mere presence of a Black female in STEM, despite their work or impact, is a major accomplishment. Their notions of Black females in the field being a symbol of achievement were due to their beliefs about and experiences with STEM fields being white male dominated that create obstacles and barriers to either oppress or exclude Black females. The

obstacles and barriers exist because of their identity as Black females, as shown in stanza's V, VIII, and X.

Stanzas V and X highlight the general sentiment expressed by these participants regarding the obstacles and barriers in STEM for Black females. "Show them up or show them wrong," facing pre-judgments, and battling stereotypes all speak to the challenges Black females in STEM face because of their race and gender identities. These remarks specifically speak to the general or societal perceptions of Black females' abilities, capabilities, and work ethic as it relates to them being able to handle the rigor of STEM. In one of the interviews (not included in *I Am…*) one participant recalls comments of her URE's Principal Investigator:

> "You're doing well in lab, but sometimes I see you struggle with explaining some of the genetics, and if you're struggling with stuff, that tells me you don't care about this," and I didn't know where he was getting this from. I'm like, "I really don't know where you're getting this from. I might have struggled a bit with explaining some genetics, but I would always go back and read and then the next time we meet I would know it better." He was like, "Yes, I know you were good with that, but still if you're struggling in the first place, that means you're not caring."… Then I was telling him what I wanted to do in the future, and then he was, "You know, you don't *have* to be a scientific researcher and get a PhD for that. You can still just be an MD or do public health or something if you want to get that done. You don't *have* to get a PhD." (Charlotte, Interview #1)

This text, in addition to the meanings gathered from stanzas V and X, indicate the participants' views of the challenges and obstacles Black females in STEM face as a result of how others (society) perceive their abilities, capabilities and efforts, with those perceptions being vastly negative. For these participants, seeing other Black females in STEM as success means that those individuals were able to "deal with and live above" the misconceptions and mistreatment.

Despite the presumed challenges they believed they would face in STEM because of their identity, these participants understood their identity in STEM to be based upon their decision, again evoking their power to choose whether or not to give into or fight against the presumptions they faced. In their reports – as shown in stanzas XI-XIII, XVI, and XVII – although having low moments and periods of self-doubt, these participants decided to embrace an identity of strength, persistence, and perseverance. They believed that they "are responsible for [their] outcomes."

Question One Summary

Overall, as shown in *I Am…*, this group of Black females reveals that within their STEM URE context, their race, gender, and religious identities are most salient. Their development of those said identities and the meanings ascribed to them occurred outside of their undergraduate research experience, primarily before their college enrollment (stanzas IV-X) and are based on previous academic and social engagements. Despite the differences in their engagements, each experienced encounter involved their interest in and pursuit of STEM and their race, gender, or religious identity expressed. Negative incidents involved perpetrators, both Black and White alike, who found fault or limitations with respect to participants' abilities and capabilities due to their presumed identity. Positive encounters involved individuals who either supported or encouraged these participants regardless of their STEM interest.

The understandings and meanings associated with these participants' identity as Black females were due to a combination of social regulation, self-determination, and vicarious learning. Successful Black women in STEM-related fields and successful Black women, in general, served as sources of motivation and inspiration for these Black females;

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they also served as role models for what it meant to be a Black female. Despite their acknowledgment of what they believed to be society's definition of a Black female, mainly one that is negatively skewed and based on discrimination and stereotypes, these Black females felt that their ability to fight and overcome the stereotypes spoke more to who they are and what it means to be a Black female. The effort and decision to negate negative perceptions encompassed their understanding of their identity, both in general and in STEM. For them, their STEM environments represented an intensified microcosm of their everyday world.

Positioning of Identity as Strength or Asset

Question one addresses how these participants conceptualize their identities in STEM URE. Findings suggest social regulation, self-determination, and vicarious learning influence their most salient identities, which are related to race, gender, and religion. Within their URE space, putting forth effort and making decisions to negate negative perceptions and stereotypes regarding their capabilities and abilities within STEM are expressions of their identities.

Building on question one, research question two is phrased as, "How do Black females in STEM undergraduate research experiences position their race, gender, and other salient identities? Does their identity positioning inform their persistence in STEM? If so, how?" Analysis reveals that these Black females position their identity as either resilient or revolutionary through demonstrating determination and persistence. Embracing either resilience or revolution, their identity serves as a source of strength and an asset for their persistence in STEM.

The study participants' decision to continue in the face of adversity marks a resilient identity (O'Connor, 2002). A revolutionary identity builds on resilience to include their conscious efforts to address, change, or invalidate stereotypes and stigmas associated with Black females (Lorde, 2007). These Black females derived lessons of determination and persistence from previous engagements not related to their URE. These engagements were both STEM and non-STEM related and occurred both before and during college. Through defined purposes and goals in combination with the adversity the study participants faced during their previous engagements, determination and persistence contribute to a revolutionary or resilient identity.

As Black females, they endured incidents influenced by racism, discrimination, bias and prejudice. Rather than succumb to the hardship inflicted upon them and embrace a victim identity, they found strength from within to continue in their stride and tackle adversity by invalidating stereotypes. These Black females indicated the use of this same strategy to the various difficulties and challenges they experienced in their STEM URE. In their STEM URE, their identity serves as a source of strength because of their reflection on and acknowledgment of their presence in STEM, their completion of various milestones in their STEM URE, and their understanding of their identity's meaning within a larger societal context.

Their identity as Black females also serves as an asset for them in navigating the STEM terrain. Being aware of the fact that as Black females they are underrepresented in STEM, they see their identity as being an asset they can use to gain access and entry into various STEM-based opportunities, including their current URE. Leveraging their identity, these participants shared that they have either capitalized or can capitalize on diversity

initiatives geared towards increasing access to and engagement in STEM. *TENACI-SHE*, a

visual depiction I created based on my analysis of the participant data (see Figure 2), captures

this groups' identity positioning.

TENACI-SHE.

Figure 2. Graphic representation of the participant data collected regarding the positioning of their identity as a strength and asset. The visualization is comprised of four panels that outline the process these individuals undertake that contributes to their identity positioning. The collective of the panels tells the story of their journey to fulfill their goal or purpose, and how the obstacles that they faced external to their URE, because of their identity, provided the necessary skills and characteristics to overcome any challenges they faced within their URE. T. Dozier created, under my direction and instruction, *TENACI-SHE*.

Identity as strength. *TENACI-SHE* illustrates the way in which this group positions their identity as Black females as a source of strength, enacted through resilience and revolution, within their STEM URE. Each panel within *TENACI-SHE* represents a specific component of their overall story and interpretation of how and why these participants perceive their identity as a source of strength within their STEM URE space. Collectively, the visual conveys how the various components function together to aid in these Black females' navigation of and continued engagement in their STEM URE. Each panel highlights the key features related to their identity that I used to compile their narrative. Those highlighted features include the previous oppositions these Black females faced and their decisions in response to that opposition; the source of their motivation and perception of their URE; and the inner tools used to navigate their URE.

Oppositions and the motivation to overcome them. Figure three displays a Black female facing a wall that is hindering her from progressing along a pathway. The wall represents a source of opposition or challenge that these Black females faced prior to their URE engagement. The challenges and oppositions experienced prior to URE are both STEM and non-STEM related. Most of these challenges and oppositions involved discriminatory responses and attitudes towards their identity as Black females, such as, "white people thinking I'm stupid because I'm Black…there's this boy that use to call me stupid all the time, he said I'm stupid cause I'm Black" (Nicole, Interview #1). Another example would be, "the teacher would sit in the class and make Black jokes with the students" (May, Interview #1).
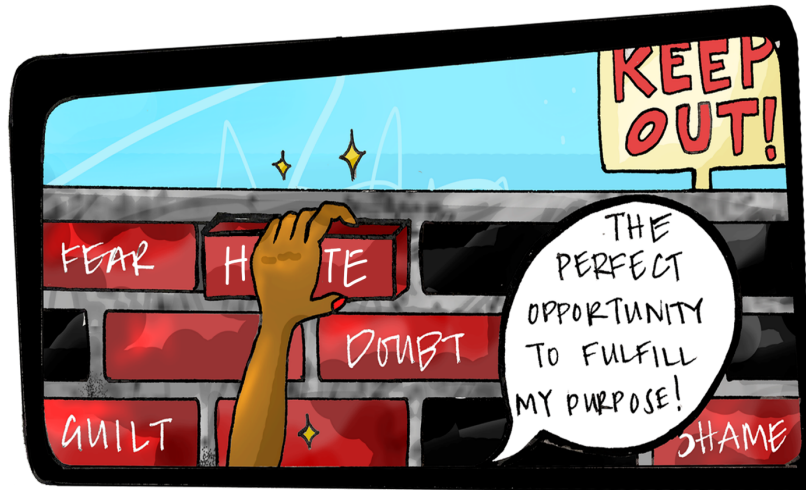
Figure 3. Panel that highlights opposition faced by participants and the characteristics developed from the oppositional experiences.

Likewise, they shared that being a Black female meant being discriminated against, mistreated, and having to face opposition because of society's negative narrative regarding their abilities and capabilities as seen in Jenny and Ginnette's responses. Jenny expresses her desire to pursue a variety of STEM occupations, "I went through the vet phase…then…an orthopedic surgeon…a forensic anthropologist…a veterinary forensic anthropologist…an orthopedic surgeon again, mostly to prove to people that women COULD do the job and they could do it well, especially a Black woman" (Jenny, Journal Prompt #1). Jenny acknowledged the challenges by her intent to disprove the stereotype that Black women are incapable of performing well in STEM. Ginnette, on the other hand, blatantly describes the opposition Black females face. She shares, "But it's like naturally an obstacle that you have to deal with because people do not take you seriously, being a Black woman. Especially like in STEM. You have to prove yourself more" (Ginnette, Interview #2).

As shown in figure three, each participant spoke of having to deal with, navigate through, or overcome various barriers. Nicole equates being a Black female to being "treated

unfairly, but [having] to know how to navigate to get what you want" (Interview #2). She

believes this sentiment because of her belief, "in America you face discrimination as a black

person and as a female. So, that is why I said that" (Interview #2) and her personal

experience, "Growing up, going to mostly white schools, I wasn't always treated fairly by

teachers. Sometimes they would single me out or sometimes when I was the only Black girl

in the class, people wouldn't want to work with me" (Nicole, Interview #2).

Jenny also believes that as a Black female she has to face and "deal with certain stuff,

whether that's [due to] my Blackness or from being a female" (Interview #2). When thinking

intersectionally, Jenny acknowledges that, "being a Black female and just that combination is

a lot" (Interview #2), regarding her experience and society's influence on it. Rather than

allowing the opposition to determine their outcome, these participants pushed forward,

seeking to achieve their goal or fulfill their purpose.

Lexi shares that, "I feel like I was put here to help others" (Interview #1), and that

this purpose informs her choices, decisions, and engagements. Through its relation with her

interest, her purpose influences her behavior because, "If I'm really interested in what I'm

doing, I'm going to want to do it regardless… I'm a natural leader. I just feel like if I have a

talent, I need to use it." (Lexi, Interview #1). Purpose also guides Charlotte's actions. She

shares:

> [W]hen I find myself kind of lost and have a lot of things to deal with, I always
> try to make sure I find my center again, which is like, "What is my purpose?
> Why am I here?" So, I keep asking myself that purpose and part of that purpose
> is lots of other different people in my life and so are the reasons why I do what
> I do… Definitely. Just being African American, being a woman, both of which
> are huge reasons why I have found my purpose, just being within the
> community. (Interview #2)

Like Lexi and Charlotte, Sara's goal orients her decisions, even in the face of opposition. Sara shares that, "my future goal was to do research" (Interview #2) and this goal is what "pushed me to keep on doing because even if I'm not understanding it right now, eventually I will understand it" (Sara, Interview #2).

Informed by their purpose or goal, their identity as Black females manifested as resilience through their determination to persist or revolution through their conscious statements of actively seeking change regarding the perception of Black women within their STEM spaces. This change ranged from challenging negative stereotypes to representing Black women in STEM. Their display of a resilient or revolutionary identity is depicted as the character taking specific bricks out of the wall in order to pass through it (see Figure 3). In figure three, the brick being removed is labeled "hate," demonstrating the strength these Black females' employ to dismantle obstacles that hinder their progress.

A resilient identity is marked by their decision to continue in the face of adversity, where "none of the teachers really seemed supportive of me" (Nicole, Interview #1), while feeling like, "I don't need someone pushing me, or motivating me, I can do that myself. So, I continued to do that, and continued to strive to be the best." (Ginnette, Interview #1). A revolutionary identity builds on resilience to include their conscious efforts to address, change, or invalidate stereotypes and stigmas associated with Black females. May exhibits a revolutionary identity as she shares, "I know that being Black and female in some ways presents a disadvantage because of what society thinks. So those disadvantages make me want to disprove what the stereotype is" (Interview #1). Her statement demonstrates acknowledgement of an issue related to Black females, and her conscious decision to address it through her engagements.

Sunshine also demonstrates a revolutionary identity as she directly links her identity to her goals. She states:

> One important thing for me, as a Black woman is ... I wanna make things better. I wanna improve I guess access for other Black people. Last time when we were talking about that article [on Black male enrollment] the other day I was like, "Man, this is the problem. This is something that we should try to address." I feel like it's kind of our responsibility in a way. (Interview #2)

A resilient or revolutionary identity carried over into their STEM URE spaces, informing and influencing their decisions when faced with new challenges specific to STEM-based research. Figures four, five, and six display the enactment of their resilient and revolutionary identity within STEM URE.

Seeking new opportunities. In figure four, the character is presented with the chance to pursue an opportunity designed to increase diversity. This special opportunity emerges after initial oppositional experiences that she was able to overcome by way of characteristics that contributed to resilience or revolution – depicted as taking bricks out of the wall in order to pass through it in figure three.

Figure 4. Visual representation of their pursuit of STEM undergraduate research experiences.

Figure four represents the study participants' chance to participate in an undergraduate research experience that targets underrepresented populations. Both STEM URE programs in this study were designed to increase STEM engagement and retention for underrepresented students. The underrepresented population for the Shakur University program includes students who identify as Black or Latinx. The STEM URE program at Hurston is made up of students who identify as Black, Native American, Latinx, or are from low socioeconomic backgrounds. In order to participate in either program, students must be a member of an underrepresented or "minority" group. Figure four also highlights the participants' overall intended or developed reason for why they decided to participate in the URE, captured in the thought bubble. In their interviews, these participants shared that they decided to participate in their URE programs due to it being "something I want[ed] to look into because of the whole cancer thing and my sister" (Teresa, Interview #1) or "I thought by also participating in this program I would gain experience" (Nicole, Interview #1). In both examples, the participants describe participating in their STEM URE because of the opportunities it afforded them in achieving a purpose or goal.

Their participation in a URE designed for underrepresented students also supports the inference of their identity being positioned as an asset, an idea that I explain further in a later section.

Incurring new challenges. In figure five, the main character comes across a river that she must cross to continue on her journey (see Figure 5A). The river signifies a new challenge or opposition that she faces within her new opportunity. Representative of their shared experiences, the main character transforms the bricks from her previous challenges and uses them to build a bridge over the river (see Figure 5B). This visualization captures the

way in which these participants applied their resilient or revolutionary identities in their URE to address any challenges that they faced. The challenges that they experienced within the URE varied.

May recounts having difficulty with her equipment: "[o]ne big challenge was the main piece of machinery that I was using broke down" (Interview #2). She also had to figure out other ways to obtain her results, "[t]he biggest challenge was trying to figure out an alternate way of getting the same results without that piece of machinery" (May, Interview #2). Rather than abandon her experiment for something else, May shares that, "I really wanted to do what I was doing so I just figured out my own, then I presented it to [my PI] and she was okay with it" (Interview #2). Her interest and connection to her project pushed her to find alternative ways to supplement for the machine. May attributes her persistent to a self-defined characteristic of "[liking] to finish what I start" (May, Interview #2).
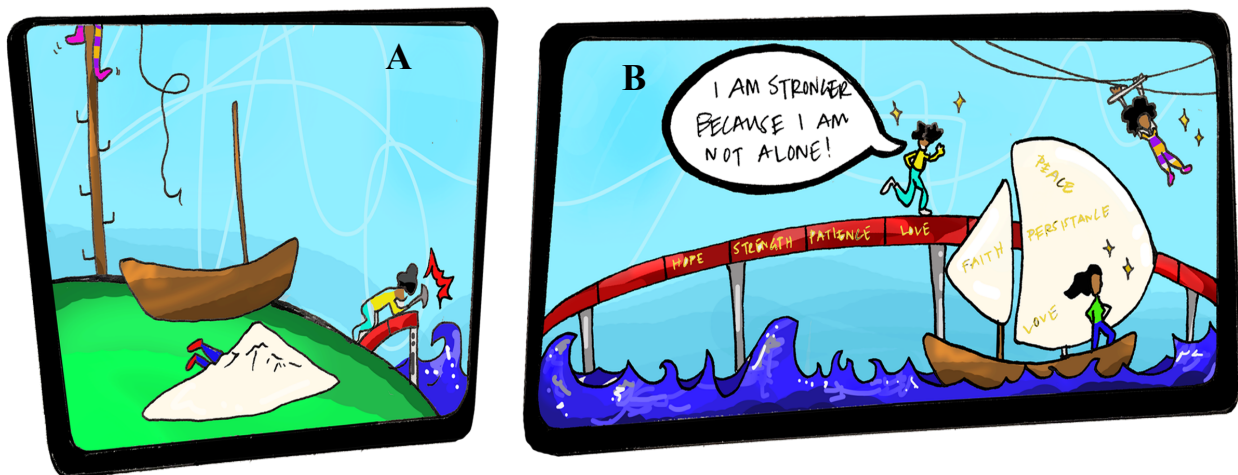
Figure 5A&B. Visual presentation of participants facing and overcoming a new challenge once entering the new opportunity. The panels highlight the main character using the bricks taken from the wall (Figure 4) to address the new challenge faced and acknowledging the presence of other Black females. Other Black females are present within the same context using other means to overcome the same opposition.

Additionally, May attributes her creativity and innovation in addressing problems to her having to "become more resourceful," a lesson she learned when she first got to college, and to her "[d]etermination… because science is never easy" (Interview #2). May believes that in science, "[t]here's always going to be challenges," and in knowing that she "likes to finish what [she] start[s]," May stated that regarding challenges in the URE, "I was determined that I was going to get those results," enacting whatever creative solution she could to solve the problem (Interview #2). Some of the creative solutions included her using her hands and hot water bath to heat the particular solution in specific increments (May, Interview #2).

Other challenges these participants faced within their STEM URE included challenges that were due to their limited knowledge of their research area and it hindering their progress. "[I]t was really frustrating, because I couldn't get it to work at first. I didn't really know what I was doing…It was confusing…I wasn't sure what to do" (Nicole, Interview #2). Like May, Nicole applied a lesson she obtained from prior experiences, "I feel like [internal drive is] something that I've had before…Probably the earliest that I can remember is when I was learning how to ride a bike" (Interview #2), to get to a position where her research project was successful. Nicole shares that, "I just really wanted to get it to work, because I felt like I put so much into it and so much effort. I just felt like I should just keep going" (Interview #2).

Charlotte experienced a different challenge in her STEM URE that directly related to her identity as a Black female. One challenge she recalls is having to be a voice for Black people, explaining potential reasons why they do not participate in research studies. In her statement, she describes:

I remember once we had a conversation about just African Americans and their willingness to go to doctor's offices. This was in the middle of me talking about what I want to do in the future. So, my PI really didn't understand that that would be the case, which is ironic considering he uses HeLa cells, but he was just like, "Oh, really? They would be more resistant to going to a doctor or being a part of a study?" I said, "Well, absolutely." So, you know, having conversations about that in terms of biomedical research and just, you know, medicine with the other scientists in the lab. That kind of gives a bigger social picture. (Interview #2)

In this text, Charlotte talks of having to educate her PI on the larger social issue related to Black people and scientific research. She even references the fact that they use a particular strain of cells, HeLa cells, that were unknowingly and unwillingly extracted from a Black woman named Henrietta Lacks in 1951 (Skloot, 2010), and that her PI did not make the connection between Henrietta's experience and that of other Black people regarding scientific research and racism.

Additionally, Charlotte felt the need to be a representative of Black female scientists in her lab. Being the only Black female in her lab environment, Charlotte believed that she needed to portray certain characteristics and maintain a certain work ethic as a way to be a positive representation of Black females. She felt that in being a Black female and maintaining a certain demeanor she would create the opportunity for more undergraduate Black females to participate in her research lab. In her story, Charlotte shares:

I never want to look like I'm not putting in my all into my experiment…It can just be a little bit intimidating in those respects…because there's no other African American women in that lab, I pretty much am their representation of African American female scientists, so I can't make us look bad if you will. I've got to make sure that I represent us in a way where it can potentially open a door for more African American women to enter into the lab. Yeah, just so I can make sure and represent because it's never just me as an individual. I can never just represent myself. I'm always representing someone else and that's just in anything that I do and that is something that my parents have always taught me. I'm always representing I guess my community, my family, and things like that. (Interview #2)

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Charlotte not only talks about having to be a representative for Black females in her lab so that there can be other opportunities, but she also connects her knowledge and understanding of what it means to be a representation of others to lessons previously instilled in her by her parents. In this text, she draws from a lesson previously taught to her and applies the knowledge gained in her current setting to navigate her STEM URE.

Teresa also relates her identity to challenges she finds within her STEM URE. Her challenges, however, differ in that she implicitly addresses the challenge of the lack of diversity in STEM research as a whole. Teresa sees homogeneity of any sort as a challenge because, "when you have the same sort of people in these positions of influence and with the opportunity to develop research projects they might overlook certain things that people from different backgrounds might experience and might want to research" (Interview #2). Teresa finds her identity to address this challenge given that, "[my identity] can be powerful… it's powerful, because [she] brings different experiences and stuff to STEM. [I] bring different issues into focus" (Interview #2).

Each voice captured shows elements of either resilience or revolution in their STEM spaces. These Black females decided to continue working towards achieving results in their STEM URE despite any challenges they faced. They apply their identity, and tools ascribed to it from previous engagements, in their STEM URE to incite change and make an impact. In addition to pushing through their various hardships, these Black females illuminate the amount of effort they put forth in their STEM URE and the reasons why they put forth such effort. Recognizing the presumptions surrounding their identity as Black females, these participants share that they feel the need to give their all in their URE as a way to negate negative perceptions of Black women. In feeling the need to represent their race and gender

and actively fight against stereotypes and prejudices, these participants also report the impact associated with their presence in STEM URE.

Being physically present and able to persist in URE serves as a source of strength and motivation for these participants. Again, recognizing the limitations attributed to Black women both in general and in STEM, these participants saw their continued presence in STEM URE as representations of success and proof that the presumptions and stereotypes were false. Ginnette states that she feels "distinguished… Just knowing that there's not many people like me pursuing what I'm pursuing. That makes it feel like a bigger accomplishment I guess, or achievement" given her pursuit of a STEM career and her knowledge that "being a Black woman in STEM, that's not a regular occurrence. It's a predominantly males, I think predominantly white males, so Black women are a minority" (Interview #1). Her presence in STEM, "gives [her] more motivation because [she] likes the idea of accomplishing something that not many people like [herself] have accomplished" (Ginnette, Interview #1).

Similarly, May and Sunshine divulge that they see their presence in STEM as a hallmark of success, finding motivation and encouragement to continue and inspire others. May shares, "[f]irst of all it means success. STEM is generally a hard field to get into, but especially for people of color and for females" (Interview #2). She further connects her presence to motivation and encouragement as she states, "being a Black female in STEM is a good example to younger Black females that you can be something different than what everybody thinks you can be" (May, Interview #2).

Overall, these participants view their identity as Black females as being a source of strength in their URE. Their purpose and goals, informing their display of resilience or revolution through determination and persistence, provide them with the motivation and

encouragement needed to succeed. Their presence in URE serves as proof of their ability, capability, and deservingness to be in STEM.

Identity as an Asset. Outside of being a source of strength, the panels in *TENACI-SHE* capture the way in which these participants perceive their identity as Black females as being an asset for their continued engagement in URE. Figure four acknowledges a diversity-based opportunity presented to the main character of the story. Despite having very little representation within this initiative, as seen on the sign with the asterisks, the character chooses to pursue the opportunity primarily due to her goal of wanting to help others in addition to opportunity's focus on diversity (see Figure 4). In their interviews and journal prompts, the participants shared they believed their identity as Black females serves as an asset for them because they can use it to gain access to STEM diversity-focused opportunities, such as their current undergraduate research program. They acknowledged the fact that there "aren't many Black American females in the STEM field. It's very uncommon actually" (Buttercup, Interview #1). Because of the limited presence of Black females, they had a greater chance at obtaining additional support and resources, due to "[p]eople want[ing] to see [them] more in the field, so they give [them] more opportunity" (Buttercup, Interview #1).

Ginnette states her identity is an asset for attaining STEM opportunities given the objective of a diversity-based URE and its desire to "want to work with and help minorities in STEM like Black women" (Ginnette, Interview #2). Nicole sees her identity as an asset when looking at potential STEM careers, where being a Black female "could be an opportunity, if some companies are looking for minorities" (Nicole, Interview #2). Capitalizing on the limited number of Black females in STEM, these participants pursued or

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accepted opportunities such as their URE program to gain the support they felt was necessary to achieve their goals.

These participants also allude to their identity as Black females being an asset for continued engagement in and navigation of their URE when other Black females are present within the context. Figure five introduces other Black female characters into the story, where, within the same space as the main character, they too are addressing the challenge of crossing the river. Figure five also depicts the meaning and feelings ascribed to the main character from seeing others similar to herself addressing the same challenges as herself. In figure five the main character says, "I am stronger because I am not alone" (see Figure 5B). Her words represent a sense of empowerment these Black females gain from their shared experience. Being in a URE or STEM engagement with Black female peers who too are experiencing similar challenges provides solace and motivation for Black females to continue in their STEM engagement. It is in this context, being a Black female in a STEM URE with other Black females, where their identity as Black females is an asset used for continued engagement.

Figure five-B is based on the accounts that describe the feelings these participants gained from being in a cohort with other Black females. Nicole describes seeing other people "struggle" as meaningful because it meant, "you're not the only one struggling to get your product to work" (Nicole, Interview #2). In struggling together, Nicole found a greater sense of connection among her cohort and accomplishment in their success, specifically during their group presentations. For her, "It felt good, seeing what I accomplished and what everybody else accomplished. Knowing that I was a part of the program" (Nicole, Interview #2).

Charlotte finds it, "empowering, knowing that because there's like academic females. We can talk to each other. We can kind of stick together and support each other even within the context" (Interview #2). Sunshine believes that, "it's inspired me. [J]ust looking at what they've done, the African American women especially... I just feel like there's nothing that we can't do" (Interview #2). Jenny also finds that it is, "better being on the struggle bus with other people than to be by yourself" and that "[i]t's definitely helpful in the sense that I have other really strong Black women around me" (Interview #1). For Jenny, being with other Black females in a STEM URE was "confirmation that yeah, I mean Black females can do anything, it doesn't have to be what society tells you that you have to be" (Interview #2).

As a Black Muslim female, Buttercup finds motivation in seeing other Black females in STEM and inspiration in seeing another Black Muslim female. She maintains an optimistic point of view regarding Black Muslim females by sharing, "[w]e're growing because...You got to start somewhere. Seeing that there's not just me, that's a good thing for me, that's encouraging" (Buttercup, Interview #2). In her acknowledgement of perceived growth in numbers and the physical presence of another person who shares her salient identities, Buttercup discloses the encouragement she receives to continue in her own endeavors.

These participants disclose that seeing other Black females, who like them are pursuing and achieving in STEM, motivates and encourages them to continue. There is a shared sense of empowerment between everyone who identifies as a Black female, and their identity as Black females is an asset as it provides them with access to this shared empowerment. Additionally, their identity as Black females becomes an asset for their continued engagement in STEM URE when other, older Black females who have achieved in STEM are present within their STEM context.

Older Black females in STEM – their mothers, postdocs, graduate students – embody characteristics that these participants strive to mimic or embrace. For May, seeing her mother interact and engage with her colleagues, being able to speak scientifically and command respect, is inspirational and educational regarding what it means to be a Black woman in STEM (May, Interview #1). Striving to be like her mother, expressed as the excitement of being able to hold conversations with her mom, May, "want[s] to learn more because [she] want[s] to engage in educational conversations with [her] mom…[she] want[s] to feel that [she] can be on her level" (Interview #2). Similarly, Sara finds that her postdoc, a Black female, represents everything that she wishes to achieve.

Sara describes her postdoc as being, "amazing. She's great. She is Black… She's extremely smart. Extremely bright. She's very patient with me… she can actually tell the experience of, 'Oh, I was a minority in a place where usually minorities don't go'" (Sara, Interview #2). Sara choose her postdoc's name to represent her in this study as a way to acknowledge the desired characteristics that her postdoc embodies. Sara – the participant – says that her postdoc, "is my mentor. She has gone through the things I have gone through… She has her Ph.D.….she keeps on going. She keeps pushing no matter what she faces" (Sara, Follow Up). Her postdoc's strength, persistence, and determination to continue in the face of adversity are qualities that Sara strives to exude, seeing them as the necessary skills utilized to overcome negative experiences in STEM URE. Sara specifically highlights that both she and her postdoc, as Black women in STEM, experienced imposter syndrome (Sara, Follow Up). Her postdoc being able to "push through" to obtain her Ph.D. and continue to do scientific research is proof to Sara that she can also overcome her feelings and achieve in her STEM URE.

Sunshine describes the feelings she received when she saw a flier about another Black female scheduled to defend her dissertation. She shares that, "there was this beautiful Black woman and I was like, 'Oh my goodness. I'm so proud of her.' I didn't even know her but I was so proud" (Sunshine, Interview #2). Being proud of the other Black female's accomplishment highlights the importance of being present in STEM to Sunshine as she states, "I just know how important it is to have Black women… because there aren't a lot of Black women who wanna study STEM. It's important that we are there" (Sunshine, Interview #2). Her recognition of another Black female successfully completing her Ph.D. in a STEM field lead Sunshine to develop a sense of pride that was only afforded to her because of her shared identity with the Ph.D. candidate as a Black female.

Being a Black female in the context where there are other Black females who have achieved in STEM, creates a situation where their identity as Black females serve as an asset for their engagement. These proposed role models inspire and motivate the participants to continue in their engagements by embodying the characteristics they wish to exude. These role models provide a sense of hope regarding their own capabilities of succeeding, as the participants push to emulate the role models afforded to them because of their shared identity as Black females within STEM space.

Question Two Summary. Overall, these participants found their identity as Black females to be sources of strength and an asset for their continued engagement in and navigation of STEM UREs. Their identity served as a source of strength as their purpose or goal shaped their identity expression to be either resilient or revolutionary, characterized by their persistence and determination to continue. Their identity as Black females also served as a source of strength because of their physical presence in STEM UREs, signifying that

they have beaten the odds regarding Black females' engagement in STEM URE. In beating the odds and being in a place that is dominated by majority White males, these Black females felt the need to represent their race and gender by putting in more effort to fight negative perceptions and stereotypes.

These participants saw their identity as Black females to be assets leveraged given the underrepresentation of Black females in STEM and the push for diversity in STEM. Capitalizing on diversity efforts, these participants sought opportunities they felt would aid in achieving their overall goals and purpose. Additionally, their identity as a Black female served as an asset within these diversity-focused initiatives when there were other Black females present that were having similar experiences. As Black females in a shared struggle, these participants found solace and encouragement from celebrating and commiserating with each other. Their identity granted them access to this source of empowerment and motivation. Their identity also served as an asset in the case where there were Black female role models who were identified as being successful in STEM. Being a Black female facilitated associations with successful Black females, providing the participants with living embodiments of the various characteristics and roles they believed were necessary to achieve in their STEM URE.

Perception of STEM and STEM URE

Building on question one and two, question three examines these Black females' perception of both STEM and their STEM URE. Question three also explores the extent to which these participants' conceptualization of their identity influenced their perception of STEM and their URE. To address students' perception of and experience in URE, research question two was composed as, "How do Black females in STEM undergraduate research

programs perceive STEM and their STEM undergraduate research experience? To what

extent does their identity inform these perceptions?"

Analysis of the participant data reveals that these students see STEM as a conduit or

pathway. This perception is based on their defined goals or purpose, informed by their

conceptualization and positioning of their identity STEM UREs are perceived as resources,

opportunities, or tools that these participants utilize to obtain their goals or fulfill their

purpose. The participants' experiences as Black females and their understandings of their

identities, discussed in questions one and two, inform the students' goals and purposes. As a

resource, opportunity, or tool, URE provides the necessary network, exposure, experiences,

and support needed to achieve their goals.

I present these findings using a vignette[7], *Sisters of the Struggle*, informed by the

study data that pertain to their engagement in URE. There are three different characters

within the vignette. Each constructed character represents a different sub-group of the study

participants (See Table 3). The participants expressed interest in and reasons for pursuing

STEM served as a basis for the groupings, which are explicitly unpacked in the "Perception

of STEM" subsection. Their reasons for pursuing STEM provide insight on how they

perceived STEM. The subsection "Perception of URE" unveils these participants' view of

their undergraduate research experience; these views were evident in their reasons for

participating in the URE. The data indicated the participants' reported goals and purposes,

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[7] Vignettes are accounts created to provide a vivid portrayal of a particular event that allows the readers to develop a deeper understanding and meaning of the story shared (Humphreys, 2005). It is an attempt to bring to life the collected data (Humphreys, 2005). My analysis and interpretation of the data serve as the basis of the vignette (Langer, 2016).

conceptually related to how they viewed and positioned their identities, informed their

perceptions of STEM and STEM URE.

Table 3

Study participants and their associated composite character.

	Composite Character		
	KADENCE	*NYLA*	*NASYA*
Participants	Sara	Charlotte	Sunshine
	Jenny	Lexi	Nicole
	May		Ginnette
	Teresa		Buttercup

Sisters of the Struggle. Setting: It is a normal day on campus where everyone is

outside on the lawn enjoying their lunch. Walking down the strip are three Black females, all

friends who met through their common research program. These girls are casually walking

down the path, with not a care in the world.

Scene:
Kadence: Girl! You will not believe what happened.

Nasya & Nyla: What? What happened?

Kadence: So, yesterday, this guy hit me up about doing some research study. He was like, he was interested in knowing about me and stuff and wanted to talk with me about my interest in Chemistry and what I want to do with my life afterwards and what not. It caught me off guard, but as he was explaining it, I thought it was pretty cool.

Nyla: For real? What's his name? I had someone hit me up about that too. Telling me that he wanted to learn about how Black females survive in their STEM experiences and courses.

Nasya: Yeah, I got the same email. I think it's pretty cool that somebody is

interested in my story and wants to know more about me as a person. I mean, all of the other information and questions that the other people in our program ask and what not is cool, but this one seemed a little different.

Kadence: Yeah, I got that feeling too. I just wonder how much I'm going to say or what I'm going to say. I mean, it's not like I have anything to hide or anything, but I don't know, talking about yourself is real personal.

Nasya: Yeah, that is true. But I know what I am going to say. I am going to keep it real. STEM is hard. The classes are difficult. But even though I struggle, I am sticking with it.

Nyla: You can say that again about those classes. I don't know how you do it, Nasya, cause uh, Physics, it is kicking my butt something serious. By the way, why are you even majoring in Physics to begin with? And how is your research coming along?

Nasya: I feel like I told you this before. But I have ALWAYS been interested in something Physics related. I mean, I can think back to when I was in like elementary school. I use to play this game called Rollercoaster Tycoon all the time, it was my favorite. I had the chance to build my own rollercoasters, and it was so cool. Not only that, but I use to go to these summer camps and participate in different programs and stuff. We would always be doing something physics related. One time we did the whole egg drop experiment where you only had straw, tape, paper, and a couple of paperclips, and you had to make something that would protect an egg from breaking. And I was good at it. My egg didn't break, even after they dropped it from the roof of the building. Learning about concepts such as gravity, force, speed, and stuff like that was really cool. I feel like it can help me in the future when I become a world class car engineer that designs a car that is not only eco-friendly, but one that lets you text and be on snapchat without worrying about getting into a wreck or anything.

[Group laughs]

Nasya: But since you're grilling me, what about you? Why are you riding the Biology struggle bus? I mean, it can't be all that good.

Nyla: Yeah, Biology is definitely a struggle, but you can do so much with it. It is one of those majors that gives you the chance to really make a change and impact on the world. I mean think about it. With a Biology degree, you learn a lot about the human body and how it works. You learn about the Earth and how it started. You learn about the ecosystem and what is in it. It is so versatile. And for me, you already know that I

am trying to save the world. With there being so many poor, uneducated, unhealthy Black families out there, I feel like with this degree I can help change that. I can make a difference in their lives anyway that I go. I can be a doctor and help heal them. I can be an educator and teach them about science and health. I can work with the environment and make the world a cleaner place for them to live. I can pretty much do anything. Personally, I want to go to medical school. I also want to do research so that I can possibly find a cure or create some new treatment or something. Anything I can do to help my community and help my people makes me feel fulfilled. It's like I am completing my purpose. Or I'm doing what I am supposed to be doing in life, helping my Black community. We got it hard. Nobody is going to help us but us. If we want to be those successful lawyers, and doctors, and professionals and what not, then we got to give back to the next generation and make sure that they are good and have a fair chance. You can't have a fair chance if you don't have clean water like in Flint, or if you are living in a food desert and don't know much about healthy eating, or if we are dying from diseases like sickle cell. I also have to give a special shout out to my middle school Biology teacher though, Mrs. Jamieson! Had it not been for her exposing me to all of the wonders of Biology and making it super cool and fun, I probably would be doing something else.

Nasya: That is 100% real! It's like we have so much against us that we have to overcome. What about you, Kadence. You've been kind of quiet. Why are you in Chemistry? You must be extra smart because God knows Chemistry is not for me.

Kadence: [chuckles] well if Nyla is on the Biology struggle bus, then I am on the Chemistry struggle bus because this thing is no joke. I feel like I have already told you all this story before though. The one about my Aunt.

Nyla: You might have mentioned it before, but you can definitely tell us again.

Kadence: I remember it like it was yesterday. As you both know, my aunt is like a second mom to me. She has helped raise me, took care of me, bought me things, taught me lessons about being a woman, everything. She just had a baby girl, no more than like a year prior to this event. It was early one morning when I was staying at her house and I heard a loud scream. I jumped out of the bed and ran downstairs to her room because it was where I heard the noise. I wasn't sure what was going on or what to expect, but whatever reason, I had a very uneasy feeling brewing in my stomach. It was a real bad feeling. The air was thick and heavy, and it was hard to breathe. It felt like someone was purposefully sitting on my chest and that I had to use all of my strength to lift up long enough to grasp a quick gulp of air. The room smelled of panic and

desperation. Everything had seemed out of order and in disarray. I looked and saw my aunt holding her baby crying. She was saying. "my baby my baby, what's wrong with my baby girl?" It was so weird to me because I had never seen her act like that. When she saw me, she yelled, "Call 911!"

My aunt's eyes were bloodshot red and she looked so frightened. Ya'll, I had to have stood there forever. I couldn't move. After realizing what was going on, I finally woke up and grabbed the phone. I called 911 and told them everything I knew. Stuck in a moment that felt like eternity, we waited for the ambulance to arrive. Later, I found out that my baby cousin had a seizure due to Rett syndrome. It's a genetic disorder that only affects girls and it stops brain development.

At the time, I had no idea what that meant. I only had questions, lots of questions. What is Rett Syndrome? Why does my cousin have it? Is it something she caught? How can she get rid of it? Why her? Did she do something wrong? I asked my mom all of these questions and a million more. Being the brilliant woman and doctor that she is, she answered as many of my questions as possible, though many of the answers were questions themselves. That day forever changed my life; It sparked something in me. I felt like I now had a sense of purpose and an avenue to direct my natural curiosity. I could major in Chemistry and then get a doctorate degree and do research. I could find the cure for Rett Syndrome or discover a way to prevent it from happening so that others would not have to go through that same experience.

I was always interested in science, or was good at doing science, like you Nasya. But it wasn't until we learned that my baby cousin had Rett Syndrome when I made the decision to really pursue STEM. Like you, Nyla, I am interested in and passionate about helping people and making the world better. That is who I am. Adding my aunt's experience to the equation only strengthened my interest and gave me a sense of direction.

Nasya: Wow. That is deep. I definitely don't remember you telling us all of that. I feel like I would have remembered such a story had you told us. How is your aunt now? Is she ok? How is your cousin?

Kadence: My aunt, she is ok. She has her good days and bad days, but she is still making it. My aunt is a soldier. My soldier. My baby cousin, she is amazing. I mean her condition isn't getting better. And I've since learned that there is no cure. Her muscles weaken, she has very little movement, she hasn't grown much, and she has frequent seizures. Sometimes I feel like she tries to smile, and that she would be a happy kid, but I don't know. She is still with us so she is a fighter as well. But it is super hard on the family caring for her.

Nyla: That's real. She is definitely a trooper and a fighter.

Kadence: Yeah… We are just blessed that she is still here. God is definitely with the family. Only He can pull us through. But I pray every day that He rewards me with the knowledge and understanding to figure this thing out. Nobody should have to go through this experience if I can help it.

Nyla: Amen. I can understand that. Every day is a blessing. Shoot…Changing subjects, [chuckles] my blessings come on Mondays, Wednesdays and Fridays. Those are the days that I get to go to lab. It is one of my favorite activities. I enjoy it. Way better than my classes.

Nasya: Yeah, lab is cool… I mean, well, no I'm not gonna lie, I like it. But our program though, that's definitely the ultimate come up! Lord knows I wouldn't be here if it wasn't for that scholarship money paying my way.

Kadence: Me too. This school is not cheap, and a good education, is not free.

Nyla: mmm hmmm (affirmative)

Kadence: Nasya, what are you doing in your research lab, or whose lab are you in right now?

Nasya: Well, right now, I am in Dr. Walker's lab. I am working on their research at the moment, but it really aligns with my own interest and ideas. It is really cool, we are engineering a self-automated car. Not the whole car, but a key feature in helping with the self-automation process. It is really circuit heavy and involves engineering as well, but it is so cool to me. It's like, I have the chance to work towards something that will be used by everyone someday, and get the chance to do physics and engineering. Don't get me wrong, it is definitely challenging and a lot to do. But, it is cool, and I enjoy the challenge. More now that I have a better understanding of what is going on and I have had some other experience under my belt. It's also good that Dr. Walker is a great mentor and is willing to help.

Kadence: That sounds like it would be fun. And that is dope that you are working towards something that is going to be in cars. Scary too because I know how you drive. I hope that you aren't test driving the cars or anything, because if so, the whole lab would be in trouble.

[Group Laughs]

Nasya: Ha. Ha. You can laugh all you want. You're going to be begging me to

hook your car up when you're looking for one. We will see who will be laughing then. But, like I said, we don't really build cars, we are designing or engineering a key part that helps with the self-automation process.

Nyla: Your project sounds super cool. I am really enjoying mine as well. Maybe not so much because of the fact that I am not doing something as exciting as building or engineering car parts, but because I know that in the long run it will definitely benefit me. Like right now, I am working with my PI to develop a co-polymer that can help with medicine release when ingested. It is a really intricate process where the drug that we want to deliver needs to be solid at one temperature and liquid at another. So, we have to figure out what are the necessary features of the capsule that the drug will be delivered in so that it can maintain its state long enough for it to be delivered to the appropriate part of the body before it releases. And the drug is for a disease that affects women, so it has the chance to change a lot of lives and potential to affect people that I may know or come in contact with.

Kadence: That sounds real huge! So, what do you mean you aren't doing anything interesting? The whole impact of your work sounds really interesting to me. All of the lives you could change for the better. I know that's really important to you. Especially with you being involved with a lot different efforts like mentoring, and service, and student government. You are like the poster child for being a world changer.

Nyla: Thanks! I appreciate that. I mean it is cool and it is fun, but a lot of what I do is mix chemicals and run small test or task. And when your experiment doesn't work or the results don't come out like you want them to, then it's like dang, all that work for nothing. And, while I know that it has the chance to make a change and have an impact, it's not like I am giving the drug to females and watching it change their lives in front of me. I am all the way at step one of a million step process before it goes to humans for testing. I know it's important, and I understand that this is the same process for most scientific research, but it's still one of those things where I wish I could see more of an impact right now.

Nasya: That makes sense. I totally get where you're coming from. And yes, I agree. I do think that all STEM research is like that. My project has its ups and downs as well. When it is up, it is definitely a high. But when it is down… It can be all the way down at times.

Kadence: You're speaking nothing but the truth right now. If it wasn't for my family and all, I don't know what I would be doing right now. I mean I am doing some pretty cool stuff when it comes to research and all, like technique-wise, and I do have the chance to really make decisions with

regards to the direction of my project, but sometimes I still feel like I'm not one hundred percent there. Especially when I mess up or have to get extra help. It can be embarrassing and a blow to my confidence. But, my purpose is to help other people, and I can do that through STEM. So, I keep going. I tell myself that no one has to experience what my family and I go through on a daily basis. There has got to be a way to beat it, and I am determined to figure it out. I push myself and motivate myself to keep going.

It is not all bad though. My project is cool, and it does relate. I just wish that it more directly connected with my interest. I am going to talk with my PI about it. They are really open and supportive, which is good for me. Especially when things aren't going right. It helps having someone assist you and not really be too judgmental or condescending. Shoot, I am appreciative of the fact that I met you all. I love ya'll so much. Had it not been for this program, I would not have gained my sisters of the struggle. Nor would I have had the opportunity to gain this experience and learn more information about research and look at things like neurological disorders on the biochemical level.

Nasya: Stop Kadence, you're going to make me cry. I love ya'll too. Coming to my school was the best choice for me, and being in this STEM program is definitely a blessing. Not having to pay for school, being able to explore my interest, and receive the necessary assistance to achieve my goals. But most important, I met my sisters here.

Nyla: To the sisters of the struggle!

[Everyone hugs and laughs]

Perception of STEM. The vignette features several elements that provide insight regarding these participants' view of STEM. Collectively, these participants view STEM as a conduit or pathway. This presumption is based on their expressed reasons for studying STEM.

Informed by their goals or purposes, each participant chose to pursue STEM to either address a personal medical crisis (characterized by Kadence), fulfill a predefined purpose (characterized by Nyla), or link a possible career with their interest (characterized by Nasya). Their intended goals oriented their decision to pursue STEM and were informed by their

conceptualization and positioning of salient identities. Despite commonalities among the group regarding their expressed goals, participant groupings by character were based on the participants' initial impetus for pursuing STEM and not how their reasons proliferated or progressed over time.

Unpacking their stories, Kadence represents those participants who decided to pursue STEM because of a traumatic family incident and their desire to learn more about the issue. I share excerpts from the data set of participants in this category to give voice to all of those who participated. In their stories represented by Kadence, these participants shared:

> When I was 17 my mom got pregnant with my sister. I remember being with her through that process, and going to doctor's appointments. Since she was a little bit older; she had some high-risk procedures to go through. She was high risk of the baby having problems. I hopefully want to, in the future, help women through that and also maybe possibly research the conditions that are associated with pregnancy at an older age… The main thing that drives me to do research is because my mother suffered from preeclampsia when she got pregnant with my little sister when I was 17. So, my sister is three now and so she's grown. She's healthy, but she was in the hospital for almost two weeks because of how the doctors were afraid of losing her and the baby. Yeah. I just feel like I want to figure out a way for women to prevent preeclampsia or what is associated with the condition to where we can actually stop it or treat it in a fast way to where it doesn't harm the baby or the mother. (Sara, Interview #1, #2).

> Cancer research because of my dad. One day I had a dream. A dream epiphany type thing where I had found some cure to a cancer and it was super detailed in my dream. I wrote it down as soon as I woke up. Especially because during the time I was really into journaling. Then I went and I told my parents about it, and it was before my dad had been diagnosed with cancer. I didn't really think much of it, but it did start something I guess, ignite something. When my dad was diagnosed, then it's like it became personal. (Jenny, Interview #1)

> It effects so many people that I can relate to and it has affected people in my family um some of the older people in my family have died from cancer. Um actually, when I was in middle school, I had something on the back of my ear. And when I went to the dermatologists to get it removed, they explained that it could have been cancerous. So, for me to know that it was that close for me, like I lived with it for so long and didn't realize it, it just lets me know that it's serious and it's something that needs to be fixed. I feel like I can add a lot to that research. (May, Interview #1)

I had an older sister and she passed away from cancer, so I've always been interested in cancer research. But, I think it was, like I'd like to do it to honor her, but it was never like a serious, like was able to go to a lab. I didn't know anything about lab until I got to college. I just knew of cancer and that disease. That knowledge of disease and stuff sparked my interest. (Teresa, Interview #1)

Each of the participants describe traumatic events they experienced within their personal lives and the role of these events in their decisions to pursue a STEM discipline and research career. Their decision to seek change so that it could have a greater impact on others beyond their immediate lives exhibits altruistic behaviors. The adoption of altruistic behaviors, therefore, connects their understanding of their identity to their decisions and subsequently their perceptions of STEM as being the conduit or pathway to resolve a personal struggle and provide a service to others.

The character Nyla represents the sub-group of participants who decided to pursue STEM because of the impact through their field that they could make on a particular population of interest. Regarding the populations of interest identified by this group, the study participants emphasized race, gender, or a combination of the two. In their stories, these students shared:

> Coming into [college] I did know I wanted to be a science major. I did not know if it would be biology or chemistry or physics or anything, but I do know it was definitely going to be science, because by the time I was a senior in high school I had already been exposed to different situations where I realized "hmmm I could actually do science in my future" …Also, that I want to use my STEM platform to make better the situations with minorities, for example, minority women. I do intend on doing research that intends to look at diseases that affect underserved women… when I first learned about epigenetics, it was in eleventh grade high school and it was the first time where I learned the idea that nurture actually influences nature. Basically, there can be environmental stimuli that releases chemicals that can alter genes being turned on and off. If your genes are turned on and off in a certain way, that can alter your behavior, alter if your body can function well, things like that. I was, hmm, what if this could be a potential lens for figuring out diseases that particularly affect people of color or

under-served people in low economic communities? What if this is a factor in terms of diseases? (Charlotte, Interview #1)

I knew that I wanted to become a high school math teacher …I know I wanted to get my PhD in community psych and do research on how to help black youth. Whether it was educational, public health, or anything like that… [N]ow I know that I want to do the school… I know I want to help people. That's why I want to be a teacher. And I want to help Black youth cause they're getting hard right now. (Lexi, Interview #1). My ultimate goal is to open a school that meets the specific educational needs of Black youth, specifically Black males. I believe that the battle begins in the classroom. We need to begin educating the youth of today effectively if we want to see a better tomorrow. (Lexi, Journal Prompt #1)

The desire to incite change among a specific population – e.g., underrepresented women or Black youth – informed their initial reasoning for pursuing STEM. This group of participants, represented by Nyla, shares altruistic behaviors with the group of participants represented by Kadence; however, the impetus of this group's altruism is a sense of purpose rather than a specific, traumatic incident. Some of the study participants in this group express a strong desire to help Black people: "I want my Black people to succeed and I just feel like they're kind of doing us a disservice… we're the underdog. There's so many other factors against us. If I could just do something for us it would mean a lot for me personally" (Lexi, Interview #2). This strong desire is purpose-driven: "Cause I feel like I was put here to help others" (Lexi, Interview #1). Their purpose influences their decisions, including seeking opportunities where "being an African American woman or just being Black was the predominant identifier of the group of people… [that] were doing [service for] the community" (Charlotte, Interview #1).

Additionally, these participants explore multiple disciplines – double majoring within and outside of STEM. Their majors include a STEM discipline, biology or math, and a humanities or social science, women and gender studies and psychology (See Table 1). The

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combination of different disciplines demonstrates their commitment to their communities –

underrepresented women and Black youth. Connecting their purpose to STEM through

consistent reiteration of why they are pursuing their goals, "that's why I want to be a [math]

teacher" (Lexi, Journal Prompt #1) and "[epigenetics] could be a potential lens for figuring

out diseases that particularly affect people of color or under-served people" (Charlotte,

Interview #1), the participants represented by Nyla display their purpose informing their

pursuit of and engagements in STEM. Their actions are intentional as they try "to make

everything a stepping stone, pushing closer to [the] goals" (Lexi, Journal Prompt #1),

including their choice in majors and concentrations, supporting the inference of their purpose

driving their decisions with STEM serving as the pathway taken to fulfill their purpose.

Nasya, the third character in *Sisters of the Struggle*, represents that last sub-group

found within these participants. This group based its decision to pursue a STEM discipline on

finding a field or career that matched both their interest and their self-defined capabilities.

Unlike the previous groups, self in lieu of helping others was more central to this group's

initial decision to pursue STEM. In their stories, these students disclosed:

> I used to want to go to pharmacy school and I used to want to study pharmacology. I was like, "I need to be a chemist"… I'm interested in public health right now and I don't know exactly what I want to do… right now, I'm looking at epidemiology. But, I'm really interested in some racial disparity issues. Maybe within like health and healthcare… I enjoyed most of my math and science classes in high school. They were hard but I enjoyed them and they helped me realize that's what I want do. I want to do something within STEM. (Sunshine, Interview #1)

> I've always liked math and science. And, in high school, I thought chemistry was really interesting. And, um, there's a lot of options with a chemistry degree. And so, I thought it would be a good choice for me… I really like doing math and I thought it was cool, like, combining it with science (Nicole, Interview #1). I would like to become a research chemist because I am interested in studying existing chemical compounds to create new chemical compounds. I am not sure yet what field that I would like to work in. (Nicole, Journal Prompt #1)

Well, in school I was always interested in math and science, over like, history and English, and so I started looking into careers dealing with science and math, and that's when I knew that STEM was for me…(Ginnette, Interview #1). Later in life, I would like to be an Anesthesiologist. Anesthesiology is something that a found when doing research on future careers. It seemed like something that I could see myself doing and being a critical part of a surgical procedure without being the surgeon sounds is cool to me. Now, becoming an Anesthesiologist is my ultimate goal. (Ginnette, Journal Prompt #1)

I expressed to my guidance counselor that I wanted to be an engineer and she made sure to look out for me whenever there were opportunities regarding STEM in engineering… I like math and I like technology and I like you know, learning about new technologies, and engineering is the forefront of that. So that's why I chose that…(Buttercup, Interview #1). I want to be an electrical engineer because, I believe that electrical engineers will always be needed in the work force, especially with the increased amount of technology being developed. I also want to be an electrical engineer because they are well paid. (Buttercup, Journal Prompt #1)

As demonstrated in these excerpts, these participants reveal that their initial decision to pursue a STEM major or career was because of their interest in STEM and the enjoyment they derived from engaging with it. Their interest was something that they have "always" expressed, implying that their interest began before their college tenure. Their decision to find a STEM career bore out of their interest and enjoyment in STEM, that was further developed when these participants were able to connect their interest in STEM to a larger social issue – e.g. racial disparity, medicine, and technological advancement. Though initially unsure of what they wished to achieve career-wise prior to engaging in STEM, these participants used STEM as a channel to explore their interest.

STEM-based activities, like math and science courses, assisted these participants in realizing they, "want to do something in STEM" (Sunshine, Interview #1). Their engagement in these activities lead to desired careers in fields such as anesthesiology or engineering because of the possibilities the career would afford them. Some of the participants equated

their career outcomes to altruistic endeavors, "I'm really interested in some racial disparity issues. Maybe within like health and healthcare… This is important, and I can see why this is important right now, and I can help a lot of people by looking at this" (Sunshine, Interview #1). Those who choose a career for altruistic purposes did so because they believed that, "science, it helps people, medically, and just make their life easier. STEM, I think all of STEM makes people's lives easier" (Ginnette, Interview #1). Their desired careers facilitated a connection between their STEM interest and the impact they could make: "with what I want to do, which is become a doctor, I'll definitely help people on a day to day basis" (Ginnette, Interview #1).

Other participants chose a career because of the personal satisfaction or accomplishment they could obtain from working in that field. "I want to be an electrical engineer because, I believe that electrical engineers will always be needed… I also want to be an electrical engineer because they are well paid" (Buttercup, Journal Prompt #1). Their career choice was based on practical decisions: "there's a lot of options with a chemistry degree. And so, I thought it would be a good choice for me" (Nicole, Interview #1). For these participants, combining their interest in STEM with a viable career choice was important because of the affordances they could personally gain.

Perception of URE. *Sisters of the Struggle* presents these students' perceptions of their URE as being an appropriate resource or tool utilized to fulfill their purpose or achieve their goals. All three of the composite characters shared the perspective of URE being a resource used given that all of the participants expressed sentiments that supported this inference. In leveraging this resource, this group saw UREs as opportunities that assist them in reaching their final destination or outcome. As a resource, participating in UREs provide

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them with the opportunity to engage with other students interested in STEM, connect with faculty and researchers, gain first-hand experience in their field, and have financial support to pay for college. Evidence of their perception of URE as a resource or tool comes from their expressed reasons for participating in an undergraduate research program.

Resources through networks. Establishing a network was one of the most prominent resources these students sought to obtain through their URE engagement. For some of the students, the decision to participate in a URE was based on the amount of support they would receive from both the program and the university, specifically connecting the support to the network of similar peers. "I am in [the URE] mostly because I wanted a support group of connected scientists" (Jenny, Journal Prompt #1). These students found their UREs to provide "the opportunity to link up with people who are in my major and have similar goals" (May, Journal Prompt #1), consisting of peers and other STEM professionals.

Peers within their network turned into "some of [their] best friends" (Sara, Journal Prompt #2), who provided motivation and encouragement for continuation in their studies: "That's exactly what I needed to motivate myself. For me to be around other people who are in STEM, other students who may be the first person in their family to be a STEM major" (May, Interview #1). These participants appreciated the peers in their network because their peers made up "study groups and shared seats on the Struggle Bus" (Jenny, Journal Prompt #3). Having peers in their network also gave some of these participants the opportunity to serve and give back through mentoring, allowing them to be a "resource to the younger [URE] scholars" (Charlotte, Journal Prompt #1). Having peers created a positive feeling for these students: "I was excited about having friends and people to support me who were also interested in science" (Sunshine, Interview #1).

Outside of peers, these participants also appreciated having STEM professionals in their network. Participating in a URE meant the opportunity to "network with influential faculty" (Sara, Journal Prompt #3) or have "access to very important science faculty on campus" (Charlotte, Interview #1). STEM faculty provided them with "recommendations and exposure to field" (Sara, Journal Prompt #1). These participants found their "professional relationships [to be] very valuable," being the necessary connections that could provide "summer research experience" (Charlotte, Interview #1).

Overall, these participants perceived their URE to be a resource because of the networks it provided. These students expressed excitement in learning and struggling among peers and gaining access to additional resources and acknowledge through STEM professionals. They found their networks to help them develop "a better idea of what I want to do with [their] future" (Sara, Journal Prompt #3), by providing them with the support [they] needed [by] being around really awesome like-minded minorities like me and having professional networks" (Charlotte, Interview #1).

Resources through experience. The experience these participants could ascertain through participation in a URE was a desirable resource. Participating in a URE provided these students with the chance to obtain "knowledge and guidance from STEM doctors" (Nicole, Journal Prompt #1). The knowledge and guidance would apply directly to their fields of interest, as students believed they would learn "more about [my STEM field] and how to implement it theoretically" (Buttercup, Journal Prompt #1). UREs also provided "valuable research experience that would help me to work towards my goal of being an Anesthesiologist" (Ginnette, Journal Prompt #1) or "hands-on experience that [would] benefit me when beginning my career" (Nicole, Journal Prompt #1).

Being in the lab and working alongside more senior scientist provided a valuable experience for these participants as well. They gathered experience navigating STEM as they listened to STEM professionals "talk about decisions they make and see[ing] a couple of them go through their defense and transition into being PhDs" (Jenny, Journal Prompt #3). Having the opportunity to observe and learn from more established scientist provided them with lessons on "how to use equipment and troubleshoot experiments" (Jenny, Journal Prompt #3). These participants also perceived UREs to be "research, experiment-based", believing them to be "a good program to be in, [where they] would learn a lot" (Ginnette, Interview #1).

Essentially, these participants perceived UREs to be a resource because they "wanted to gain research experience in [their] content area" (Lexi, Journal Prompt #1). These participants believed the experience would help them in their future endeavors by providing specific knowledge related to their field of interest. The knowledge obtained included theoretical and practical skills.

Resource through financial assistance and other support. Financial assistance and gaining other types of support was the last major resource these participants sought through participating in their URE. For some students, obtaining a financial scholarship was the deciding factor in attending their school of choice: "if I do get this scholarship, there was a certain chance I'm going to end up going to [Hurston]" (Sara, Interview #1). Receiving financial assistance was also the primary reason why other students chose to participate in their URE. Lexi shares that her primary reason for participating in her URE was because, "they were supporting [her] financially" (Interview #1). Like her, others also found the financial assistance to be an important resource and source of support. For some, the

financial assistance associated with the URE connected their interest and identity. Teresa shares that, "I was interested in scientific research coming into college, wanted support as a first-generation student, and found the scholarship a great help" (Journal Prompt #1).

In addition to financial assistance, these participants found their UREs to be a resource because of other sources of support it provided. Students chose to participate in their URE since it, "seemed the most interesting because it talked about scientific research and I thought that might be something that I want[ed] to look into because of that whole cancer thing and my sister" (Teresa, Interview #1). Participating in the URE provided the support they felt they needed given they already knew they wanted to study STEM for a variety of different reasons. Students shared, "I knew that I had an interest in science. I knew of course coming, I wanted to study chemistry… they could help to get that PhD if I really wanted it" (Sunshine, Interview #1).

UREs also provided support through "special tutoring for some of the hard math courses" (Lexi, Interview #2), or by giving these students the opportunity to address other needs such as attending summer school. "It sounded like a good idea because I needed to do summer school also. And they allow you to do summer school and they pay for it" (Nicole, Interview #1). Being a member of the URE also created a sense of pride in the students, particularly when they learned of its financial backing: "I'm not gone lie, when they told me that the program was federally backed up...I knew that I was going to be a part of something bigger" (May, Interview #1).

The overall support that UREs provided, specifically financial assistance, was a resource given to these participants. Having financial support as well as other types of support influenced their decision to participate in their URE.

Summary. The participants' responses show their perception of their URE environment as being a resource, opportunity, or tool leveraged while in pursuit of their interest, goals, or purpose. UREs provided the opportunity to connect with a scientific network or community, the opportunity to do research that potentially related to their interest and goals, and financial support.

For the majority of them, having a scientific community made of peers and other scientists (e.g., professors, PIs, mentors) was the most frequently acknowledged contribution that the URE could provide. They found comfort and solace in being able to learn with, celebrate, and even commensurate with others who would understand and even appreciate them within their STEM space. These students anticipated gaining valuable experience in their URE that would help them in their pursuit of their STEM career or interest. Experience came in the form of STEM-based knowledge, understanding, and skills applicable in both theoretical and practical ways. Likewise, the financial assistance and other types of support afforded to them informed their perceptions of their URE as a resource.

For some students, participating in the URE was the deciding factor for them attending college. This decision was based on either the support the program would provide in its totality or the financial support it would provide to alleviate the financial burden of going to college. For others, the support linked their interest and identity, or addressed a specific need related to their STEM coursework.

Seeing STEM as a conduit due to their pre-determined interests, goals, and purposes, in addition to pursuing a URE because of the means it provides suggest that these participants perceive UREs to be a resource, opportunity, or tool.

Influence of identity on perception. In connecting the participants' definitions of what it meant to be a Black female with their perceptions of STEM and URE, the extent to which their identity influenced their perceptions is revealed. The majority of these participants defined their identity as Black females to mean, "facing adversity and changing every negative into a positive" (May, Follow Up), "powerful because you bring different experiences" (Teresa, Interview #2), "deal[ing] with stuff differently" (Jenny, Interview #2), and "strong" (Sara, Interview #1). They also shared that being a Black female meant, "having less power…[but] hav[ing] your elbows out when you're having a seat at the table" (Charlotte, Interview #2) and "proud…confident in ourselves… determined so that we can overcome these obstacles that life throws at us" (Lexi, Interview #2). Through their responses, these participants demonstrate an understanding of their identity to be socially-regulated and self-determined, acknowledging both conflict and effort as core elements of their understanding.

Conflict refers to the challenges or other occurrences they face and experience because their identity is being socially-regulated, with society having negative perceptions of Black females. Effort refers to the choice they make and energy they exert to negate those negative perceptions and stereotypes of Black females, identity being self-determined (hooks, 1995). For the students represented by Kadence, applying those same core elements to their personal traumatic experiences (a source of conflict) these individuals disclose their effort to "change" or "deal with" their situation by expressing their desire to pursue STEM so that they could find ways to prevent other individuals from having a similarly traumatic experience.

Likewise, the participants represented by the character Nyla acknowledge the conflict that their communities of interest face, and the effort that they personally put forth to change their communities' outcomes. In both cases, their conceptualization of their identity as Black females influences their perception of STEM and subsequently their perception of URE via their initial impetus for pursuing a STEM major and their development or display of altruistic behaviors. STEM is perceived as a conduit and URE is perceived as a resource or tool, because their overall reasoning for participating in either mechanism was to assist others; these others often reflected aspects of their self-defined identities.

The participants who informed the development of the character Nasya also provided evidence of the understanding of their identity influencing their perceptions of STEM and URE. Unlike the participants who represented either Kadence or Nyla, these participants differed regarding the way in which their identity influenced their perception. One participant directly connected her identity to her perceptions: "I think since I am African American I see a lot more. It's easier for me to see what's going on in our population" (Sunshine, Interview #1).

In her statement, she discloses that her racial identity as African American makes her sensitive to or more aware of the experiences of African American people. She even states, I was going to say without bias but maybe that is the bias. I just think…Maybe I'm more empathetic" (Sunshine, Interview #1) sharing that her identity causes a bias when it comes to her perceptions. She explicitly links her identity as a Black female to an altruistic purpose by sharing, "One important thing for me, as a Black woman is…I wanna make things better. I wanna improve I guess access for other Black people…I feel like it's kind of our responsibility in a way" (Sunshine, Interview #2). Embracing this sense of responsibility

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combined with her exploration of STEM suggest that for this participant, her identity as a Black female informs her perception of STEM and subsequently her perceptions of URE because of her perceptions of STEM.

Another participant represented by Nasya demonstrates the influence of her identity on her perceptions via expressing altruistic goals and through vicarious associations. For this particular participant, her mom, being a Black woman in a STEM-related field, serves as a source of inspiration and exemplifies what it means to be a Black woman in STEM. Communicated through messages of love and support, in addition to her own work, this participant's mom demonstrates characteristics that the participants associate with being a Black female in STEM.

In describing her mom, she discloses that, "she's always on me to do my best, and just give everything my all when I try and do something, and also seeing her become a nurse inspired me to want to do something that will really make a difference" (Ginnette, Interview #1) – communicating messages of strength and power. The participant also reveals that, "she knows I'm smart, so she knows that I can do it... She tells me, and I also feel that I don't want to just give up on something just because it's hard" (Ginnette, Interview #2) – communicating messages of dedication and persistence. These highlighted characteristics mirror her description of a Black female in STEM, being "it's a good thing! More powerful, intelligent, and strong" (Ginnette, Follow Up). The participant's vicariously defined understanding of her identity comes from her mom, who also motivated and inspired her to pursue STEM as a way to give back and help others. Collectively, this information suggests that this participant's identity influenced her perception of STEM as being a pathway channel to

explore her interest as well as achieve her goal due to the vicariously adopted understanding of the meaning of being a Black female and the development of altruistic behaviors.

As a whole, all of the participants exhibited signs of their identity influencing their perceptions of STEM and their URE, despite there being differences in how their identity influenced their perception.

Question Three Summary. Overall, because of their conceptualization of their race, gender, religious, and other identities (i.e., socioeconomic status and first-generation), this group of Black females perceived STEM to be a channel to their pre-determined goal – characterized by their interests, desires, or purposes. In seeing STEM as a conduit, these participants perceived their URE to function as a resource, opportunity, or tool used to achieve their goals. UREs served this purpose by providing them with the network, experience, and financial support. Black females in this study utilized these functions of UREs to further their career of interest or to support their progress towards their self-determined goal. Most important, however, is the fact that these resources and tools were used in a way to strengthen or enhance conceptions of their identity – ideologies, beliefs, and understandings – that they brought into their context. In contrast to what is implied in the existing literature as discussed in chapter two, UREs as a resource or tool did not develop these participants from scratch, nor did it function to change or alter – from a place of deficiency to success – their understanding of who they were or their overall desired outcomes.

Associations with STEM

To further address the majoritarian narrative posited in chapter two that suggest UREs serve as a transformative site for Black students who must either assimilate or accommodate

their identities to be successful in STEM, research question four sought to uncover the perceived connection between these students' identity and STEM. Question four explores potential associations or connections between the participants' perceptions and their identity. Previous research involving Black student engagement in URE focuses on the resources afforded to the students and implicates UREs as sites for identity transformation, fostering a STEM identity for Black students (Hurtado et al., 2009). Given the students' revelation of their salient identities and proposed meanings, the goal in answering this research question is to determine how Black females perceive their URE and the extent to which UREs serve as sites for identity transformation in order to incorporate components of STEM, as suggested by the research literature. Research question four reads, "To what extent does Black females' conceptualization of their race, gender, and other salient identities inform their expressed association with STEM?" Three different categories emerged regarding their association with STEM. These participants either (a) perceived STEM to be part of their identity, (b) perceived STEM to be an activity in which they participate and not associated with their identity, or (c) perceived their identity's association to STEM as a combination of the two.

STEM as a Part of Their Identity. In their stories, both Sara and Ginnette shared that STEM was a part of them. They equated STEM as a part of their identity because of their overall interest and engagements. Sara shares, "I feel like it's part of my identity. It's one of the only subjects that I've always been really interested in… I enjoy doing it and I enjoy waking up to do it" (Sara, Interview #1). Similarly, Ginnette states that STEM is a part of her identity, "[b]ecause [she's] studying it so much that, it's, like, an important part of [her] life" (Ginnette, Interview #1). Both Sara and Ginnette emphasize a relationship between studying

STEM and STEM being of prominence in their life as reasons for why they see STEM as a part of their identity.

STEM as an Activity and Not a Part of Their Identity. Those who felt their identity as being distinct from STEM did so because of the lack of passion they had for STEM. Lexi shares that, "I love math but it's just something that I do. I feel like the educator part of the math is who I am. 'Cause I feel like I was put here to help others" (Interview #1). Likewise, Teresa bares, "I love learning about it and communicating its ideas and stuff, but I don't connect that to scientist because in my mind scientist is like lab work and stuff" (Interview #1). Nicole directly states that she "[does not] really have, like, a deep passion for it but I like doing it" (Interview #1). Buttercup also believes that "it's my career for now you know... It's like something I have to do right now…'Cause, in order for me to get where I want to be in life…STEM is the only thing that'll do that" (Interview #1). Overall, the lack of a personal connection to STEM made STEM just an activity for these individuals.

STEM as Both. The participants who found STEM to be both a part of their identity and an activity they engaged, reveal STEM as "being a part of me, just with my passion" (Jenny, Interview #1) or "I realize in small pieces like how [STEM's] related [to the things I wish to do]" (Sunshine, Interview #1). Like Sara and Ginnette for whom STEM was a part of their identities, Jenny's passion and Sunshine's desires demonstrate the prominence of STEM in their lives because of the relationship between STEM and their passion or desire. Like Lexi, Teresa, and Nicole, those who saw STEM as just an activity, Jenny describes, "[b]eing a part of it, I guess once you become involved in the community and research" (Interview #1). Sunshine states that, "[m]aybe the stuff that I want to do I don't realize how it is connected to STEM… That's how come I feel like I'm just a part of it and I'm just doing it"

(Interview #1). In the instance where STEM does not connect to her interest, STEM becomes just an activity for Sunshine rather than something that she sees as a part of her identity.

Question Four Summary. This group of Black females varied with regards to their perceived associations between their identity and STEM. In their responses, they perceived STEM to be either (a) part of their identity, (b) just an activity and not a part of their identity, or (c) a combination of both, being a part of who they are and just an activity in which they engage. For those who stated STEM as being a part of their identity, the association between STEM and their identity was due to a personal interest or experience they deemed to be significant. This idea of a significant personal interest or experience being what constituted the link between STEM and their identity held true for both individuals who only saw STEM as a part of their identity and those individuals who saw STEM both ways.

For those participants who perceived STEM as an activity in which they participate, their lack of connection was due to their lack of passion for STEM. In these instances where STEM was just an activity, STEM was acknowledged as a channel or conduit used to achieve a specific goal, exhibited through altruistic behaviors or personal interest. The participants who stated that STEM was both a part of them and something that they were a part of matched the other two groups regarding personal interest and experience connecting STEM to them and the lack of personal interest and experience disconnecting them to STEM.

Altogether, these participants varied associations with STEM highlight the fact that these Black females come into their URE engagements with pre-dispositions to STEM that either espoused ways in which STEM was a part of their identity or not a part of their identity. Inferences drawn for the group of participants who stated that STEM was a part of their identity – either fully or partially – and whose conceptualization of their identity

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influences their perception of STEM and URE, challenge the notions presented in the literature regarding Black students assimilating or accommodating their identities to be successful in STEM. These students demonstrate an association with STEM that is possibly reinforced through their URE engagements. Additionally, inferences drawn for the group who expresses that STEM is not a part of their identity, and whose conceptualization of their identity also influences their perception of STEM and URE challenge the notions of Black students assimilating or accommodating their identities to be successful in STEM. This second group of students potentially demonstrate a reinforced resilient or revolutionary identity by embracing their self-determined goals and definitions of their identity in spite of the challenges created and support provided UREs. UREs, in both cases, were not transformative experiences – transforming students who were a blank slate or deficient as inferred by the literature – but rather contexts in which this group of Black females reinforced their conceptualizations of their selves or built upon their understandings of their identity and STEM.

Interestingly enough, among those who did not see STEM as a part of their identity – excluding those who perceived STEM as both – two participants believed that STEM could become a part of their identity through continued engagement over time. May shares, "I think I have a long way to go as far as learning and being passionate about it but…it's slowly becoming a part of me" (Interview #1). Like May, Charlotte disclose, "I guess for whatever reason I find STEM is something that I am a part of, but more and more, hopefully, scientist or STEM being a part of me, I will get closer to that point" (Interview #1). Both students express hesitations with embracing STEM as a part of their identity at the current moment. May's hesitations originate from her doubts, "I still have doubts about whether or not I really

want to stay in it umm sometimes I feel like there's other things I could be doing with my time" (Interview #1). Charlotte's hesitations derive from her perception and understanding of STEM culture as always having the right answer and her sometimes not knowing information – "sometimes I still feel, I know what I'm talking about, but sometimes if I don't know the answer" (Interview #1).

Part II: Discussion of the Findings

I use the components of PVEST – net vulnerability, stress engagements, reactive coping mechanisms, emergent identities, and life stage outcomes (Spencer, 2006) – to frame the discussion of the counter-story. Mapping the study's findings in relation to the PVEST framework outlines the way in which these participants' identity, their perceptions and conceptualizations of it, influence their responses to the challenges presented in their STEM and larger social context. These responses contribute to the display of a specified identity that can lead to their retention and matriculation in STEM (see Figure 6).

Net Vulnerability

According to PVEST, net vulnerability encompasses an individual's demographics or identifiers (e.g., race, gender, ethnicity, socioeconomic status, health, etc.) depicted as risks or protective factors for engagement. Whether the demographics or identifiers are a risk or protective factor depends upon, "the character of the context and the individual's history of experiences and even the group's history in the nation" (Spencer, 2006, p. 841). The most salient identifiers for this group of participants included their race (Black), gender (female), and religious identity (Christian and Muslim). Based on the study findings related to the participants' identity expression and the meaning they ascribed to it, I first discuss race and

gender identities in relation to PVEST's net vulnerability element, followed by religious identity.

Race and Gender Identity. This study found race and gender identities as salient identities for Black females in UREs, with the meaning of their race and gender identity being socially regulated but self-determined. The ascribed meanings of their identity as Black females were partially based on the participants' perceptions of society's stereotypes of Black females and their decision as individuals to resist or negate those stereotypes. According to French and colleagues (2006), identity involves a negotiation between one's perception of self and the value society assigns to one's group, a conceptualization supported by a portion of this study's findings. The Black females' awareness and acknowledgement of societal stereotypes foregrounding their understanding of their identity implicates race and gender as risks in terms of net vulnerability

In defining their racial identity, these participants used terms such as "Black" "African American" and "Black American." Despite theoretical differences of these terms (outlined in Chapter Two), these participants perceived them to be interchangeable and associated with their race. Two participants, Buttercup and Sara segregated the terms, making connections between a racial identity and an ethnic identity or nationality (Omi, & Winant, 1994). Even though their perception of their race and ethnic identity were distinct, like the others they too demonstrated their understanding of their racial identity to be a social construction uniting a group of people based on a shared history and ancestry (Haney López, 1994).

The shared history these individuals assigned was one fraught with oppression and struggle. These participants were cognizant of the trials and tribulations associated with the

Black race, from a historical and present day point of view, and felt a part of that racial group through their shared struggle. Evidence of their shared understanding and connection to the oppression and struggle stem from their stories and statements of racist experiences of the past (e.g., referencing slave mothers and Henrietta Lacks) and the present (e.g., stating that Black people are getting it hard right now and feeling like society sees Black women as baby mommas). Bringing this perspective into their URE context (e.g., statements of Black women in STEM), how these participants situate the history, shared experience, and societal attitudes associated with Black as a racial identifier possibly positioned race as a risk (Spencer, 2006).

Likewise, when using the terms "female" "woman" "cis-woman" and "lady," these participants implied biological sex. However, the participants' stories illustrated the meaning about the previously listed labels. Their stories highlighted gender identity. Gender identity encompasses a belief, acceptance, and practice of activities, roles and responsibilities that society assigns to a biological sex (Egan & Perry, 2001). Gender identity expression is contingent upon the individuals' "knowledge of membership…felt compatibility…felt pressure…attitudes" (Egan & Perry, 2001, p. 451). With the exception of one participant, Teresa, who explicitly equated her identity as a female to biological sex, these participants perceived their identities as females through a gendered lens. Society's gender stereotypes, especially in the domain of STEM, are central to their understanding.

Similar to the way in which they conceptualized their racial identity, these participants conceptualized their gender identity from a historical and present day understanding of struggle, thereby, possibly situating gender as a risk. Their identification of their gender as possibly being a risk, however, was insularly propagated like their racial identity. Despite revealing their gender identity and their presumed understanding, these

participants referenced the struggle equated to their identity from an intersectional point of view regarding their race and gender identity.

Intersectionality, as defined by Kimberlé Crenshaw acknowledges and examines both the presence and importance of multiple identities' combined, unique influence on an individual's perception and experience (Crenshaw, 1989). Intersectionality is more than a summative approach for looking at two or more identities (Crenshaw, 1989); it requires multiple identities to be conceptualized from a blended perspective where the perceptions and experiences of one identity are uniquely tied to and related to the perceptions and experiences associated with the other (Crenshaw, 1989). In their conceptualization of their identity as Black women, these participants provided information that was specific and unique to the Black woman experience.

Statements of society's perspective of Black women (e.g., not being a scientist or being sassy, loud, not intelligent) do not disaggregate the perceptions that are based on race from the perceptions based on gender. Rather, those statements present an interwoven view of race and gender. The same argument does not hold true to the perspectives surrounding race alone. These participants make statements that are specific to "Black people" as a group, inclusive of men and women, suggesting that their understanding of racial identity is distinctive enough to provide an insular point of view when it comes to race, with their understanding of their gender identity being intersectional. In this study, the participants emphasized the intersections between race and gender by continuously iterating "Black female." Equating their intersectional view of race and gender to the struggles they endured, possibly situates their intersectional view of identity as a risk factor in PVEST's net vulnerability (Spencer, 2006).

Outside of acknowledging challenges or conflict as part of the meaning behind their identity as Black women, these participants shared their identity also includes exerting the effort to overcome the challenges and conflict. In defining their identity as effort to overcome, these participants embrace a self-determined point of view as it pertains to their identity as Black women.

As discussed in chapter two, self-determination is using power to define and determine your own outcomes despite the challenges and oppositions faced (hooks, 1995). bell hooks (1995) juxtaposes a self-determined perspective against a victimized perspective, suggesting that during the civil rights era, Black people facing southern racial apartheid, "identified ourselves more by the experiences of resistance and triumph than by the nature of our victimization" (p. 52). In her explanation of self-determination, hooks recognizes resistance as a core function of the point of view. She states that resistance in self-determination is a form of oppositional thinking, believing that "white power was limited, that it could be challenged and transformed" (hooks, 1995, p. 57). Maintaining the perspective that as Black women they had control over their outcomes and destiny, and could dictate – despite the circumstances – how they were defined, these participants assumed a self-determined perspective regarding their race and gender identity. In embracing a self-determined perspective, these participants positioned their race and gender identity as protective factors for their continued engagement and participation in STEM URE.

Religious Identity. These females also described their religious identity as being salient and influential on their everyday engagements. These participants acknowledge their religious identity by self-identifying as "Christian" and "Muslim," or describing their religious practices and behaviors (e.g., praying, reading the bible). A group of these

participants, represented by Nyla in *Sisters of the Struggle*, reveal their religious identity

functioned in their pursuit of STEM given their purpose in life driving their decision to

pursue STEM. Additionally, in describing the religious practices in which they partake, all of

the participants described their religious activities as mechanisms to address a struggle or

challenge faced. In these instances, their religious identity is not only a dominant identity, but

it is also influential regarding their perception and engagement.

Unlike their race and gender identities, these participants did not situate the

understanding of their religious identity within a larger, historical context. Rather, they

positioned their religious identity to function more so as a tool utilized to orient their path as

well as assist with navigating the terrain. The participants who expressed their religious

identity to be "Muslim" described discriminatory or negative experiences because of her

religious identity. The discrimination faced created a context to develop a self-determined

perspective (hooks, 1995), an understanding of identity that combatted challenges. In the

case of these participants, religious identity acted as a protective factor.

Summary. Race, gender, and religious identities were the most salient identities

expressed among the participants as a collective. These identities with race and gender being

the most salient, influenced their STEM URE engagement, and thus all functioned as either a

risk or protective factor per the net vulnerability of the PVEST framework. When viewed in

terms of the oppression and stereotypes (Benitez, 2010; Harper, 2012; Steele, 1997), racial

and gender identity can be classified as a risk contributor for this study participants' STEM

URE engagement and retention. However, the self-determination perspective assumed by the

participants counteracted this positioning of racial and gender identity as risks and

repositioned them as assets and strengths.

Stress Engagement

Stress engagements, according to PVEST, are stage-specific developmental task presented as challenges to an individual that mediates their vulnerability (i.e., identity) and their responses produced (Spencer, 2006). Stress engagements are "actualized risk" that can "impinge on an individual's well-being" (Spencer, 2006, p. 848). In the context of this study, stress engagements are not so much developmental task as they are the challenges and tasks these Black females face while engaged within STEM and their undergraduate research experience. Seeking to understand their identity positioning in their URE, these participants revealed the various challenges they faced within their URE and the manner in which they addressed them.

The types of challenges these participants faced within their URE varied. These participants experienced research specific challenges such as troubleshooting experiments, content discrepancies where they shared they had very little knowledge of the concepts, and identity related issues that involved confrontations associated with their identity as Black females. The first two challenges, research and content, are challenges consistent with the undergraduate research experience in general (Laursen, Hunter, Seymour, Thiry, & Melton, 2010). In developing UREs, it is expected for students to experience struggle and challenges in developing research skills and competence given UREs are constructed in a way that requires, "students do more than 'know' something; it requires that they use their knowledge to 'do' something" (National Academies of Science, Engineering, and Medicine, 2017, p. 1-10).

What is different from the normal challenges that all students typically face in a URE are the challenges associated with their identity as Black females. For example, as a Black

female in a predominately White space, one participant highlighted she felt as if she had to serve as both the voice and face of Black people within her research project space. As the voice, she felt as if she had to speak on behalf of all Black people to educate others on their experience as it relates to STEM (i.e., referencing the use of HeLa cells and explaining the story of Henrietta Lacks). As the face, she felt as if she represented all Black females, and exerted great effort to ensure that she made a positive, lasting impression so in the future, other Black females could participate in the research lab. In both instances, this participant produced what she felt was the appropriate manifestation of a Black female – that manifestation being one who is strong and "always right" – when conducting research as a way to deflect negative associations about Black females in STEM.

Stress engagements often induce reactive coping mechanisms. Her responses to the identity-based challenges are an example of such coping, the next component of PVEST.

Reactive Coping Mechanism

Reactive coping mechanisms are defined as the responses generated to the stress engagements encountered (Spencer, 2006). Like the previous components, reactive coping responses are contingent upon the individual's net vulnerability expressed, their perception of their stress engagements, and the presence or absence of support systems (Spencer, 2006). Theoretically, reactive coping mechanisms are behavioral responses generated to the situations experienced. For these participants, the reactive coping mechanism utilized seemed to conceptually correspond to the self-determined identity they displayed (reticence or resistance).

Self-determined identities manifest in the form of resistance (hooks, 1995), of which there are different versions. Displaying a sense of resistance, Black females are able to

operate within a white world, understanding how others perceive them (Collins, 2000). In their operations, Black females recognize the flaws within the overall structure of society and what is deemed as "truth;" through opposition, they negate the dominant perspective to redefine their "truth" (Collins, 2000).

Several different versions of resistance exist. Solórzano and Bernal (2001) highlight four types: reactionary behavior, self-defeating resistance, conformist resistance, and transformational resistance. The extent to which individuals embrace one of the four forms is contingent upon their critique of social oppression and their social justice motivation. Reactionary behaviors are neither motivated by social justice nor critique, whereas transformational resistance does both (Solórzano & Bernal, 2001). Similarly, Robinson and Ward (1991) identify two types of resistance, resistance for survival and resistance for liberation. Resistance for survival is self-explanatory; it entails behaviors generated as short term solutions to situations (Robinson & Ward, 1991). Resistance for liberation is classified as, "resistance in which Black girls and women are encouraged to acknowledge the problems of, and to demand change in, an environment that oppresses them" (p. 89). As presented in part one, the participants in this study displayed a self-determined identity of resilience or revolution.

Their decision to continue in the face of adversity marked their resilient identities (O'Connor, 2002). Resilience acknowledges the adversity present, but maneuvers in ways that allow the individual to continue in their activities and engagement (O'Connor, 2002). In the case of this study, resilience incorporates aspects of resistance, though not specified as to what form of resistance is displayed. A revolutionary identity builds on a resilient identity, where resilient participants also exert conscious efforts to address, change, or invalidate

stereotypes and stigmas associated with Black females (Lorde, 2007). Revolutionary identities relate to Solórzano and Bernal's transformational resistance (2001) and Robinson and Ward's resistance for liberations (1991) as these Black females are aware of their adversity, are critical of their adversity, and consciously work to address the adversity as a way to create a socially just situation for future Black females.

Resilient or revolutionary identities are enacted through a variety of tools these participants used to address their challenges. Such tools included persistence, determination, problem solving skills, and creativity. I intentionally use the word "tools" to describe the constructs of persistence, determination, creativity, and problem-solving to capture these participants referring to them as objects they applied in their URE to specifically address their challenges. Based on the participants' description of how they applied persistence, determination, problem-solving, and creativity, these constructs constitute what Vygotsky describes as tools – the use of objects oriented outwardly to change the environment while subsequently changing yourself, as a way to mediate activities and engagements within a context (1978).

Embracing and addressing the challenges presented in their URE context, these participants reported instances of "not wanting to give up," "sticking with it," and "using their resources" as a means to address the challenges they faced in their URE. In their statements, these participants attributed the tools they used as being a characteristic they have always maintained (e.g., being persistent for as long as they can remember) or as objects used in response to a larger social issue (e.g., continuing in their engagement as a way to prove that Black women can be successful). The extent to which they attributed their tools to either their characteristics maintained or the larger social issue delineates whether or not these

participants' response to challenges were based on a resilient identity or revolutionary identity.

Emergent Identity

Emergent identities are the fourth component of the PVEST framework, representing the stable coping mechanisms that are expressed when an individual produces the same response to the same challenge over and over (Spencer, 2006). Through continued, consistent responses, PVEST suggest that those coping responses displayed become the individual's perceived identity (Spencer, 2006). Based upon the existent research on URE, the expected emerging identity for this group of participants is a STEM identity.

According to the dominant narrative presented in the research literature, a STEM identity is strong associations or affiliations with STEM that are exhibited by competence, efficacy, and confidence in STEM content and procedures. Individuals' STEM performances and recognition of those performances from STEM professionals confirm the identity (Adedokun et al., 2013; Carlone & Johnson, 2007; Hunter et al., 2007; Hurtado et al., 2009; Perez et al., 2014; Seymour et al., 2004; Thiry et al., 2012). Researchers state the environment in which an individual engages with STEM is pertinent to the development of a STEM identity, with UREs being optimal because of the resources they provide (Good et al., 2001-2002; Hurtado et al., 2009; Palmer et al., 2011; Pender et al., 2010; Tsui, 2007). For Black students, the URE context presumably transforms their identity into a STEM identity, as it functions to "shape students' learning but also shape their identity as a STEM researcher" through "academic enculturation" (National Academies of Science, Engineering, and Medicine, 2017, p. 3-4). The dominant perspectives places Black students at a deficit, suggesting that the assimilation or accommodation of their identity to societal-influenced

STEM norms occurs due to discrepancy – and the feeling to correct it – between their racial identity expression and societal power structures and norms replicated in STEM context (Marlone & Barabino, 2009).

For this group of participants, rather than exhibiting signs of an emergent STEM identity – a STEM identity resulting from their participation in their URE programs – what appears to emerge is a reinforced identity that pertains to their race-gender intersection, or a reinforced STEM identity where their intersecting race-gender identity associated with STEM prior to their URE engagement.

Evidence of a reinforced identity trace back to the basis of their identity as Black females being protective factors over risk contributors. Conceiving their identity to be socially regulated but self-determined has oriented their perceptions, behaviors, and responses throughout their URE experience. The shared historical and present day understanding of their race and gender identity through the lens of struggle combined with their behaviors – coping mechanisms – being a product of understandings they have ascertained from previous engagements, suggest that their identity displayed within their URE context is not an "new" identity but one that has been developed over time. UREs, in this equation, serve as another context to further their progress – being a resource, opportunity, or tool used to transition to the next phase of their journey. Thus, the identities that emerge from this experience are identities that are reinforced rather than transformed.

Students' associations with STEM serve as the additional variable that separates a reinforced identity from a reinforced STEM identity. When prompted to respond to "How do you see yourself as it relates to STEM? Is STEM a part of you or something you are a part of?" these participants produced varied responses. The categories of responses were (a)

STEM is a part of my identity, (b) STEM is not a part of my identity, and (c) STEM is both a part and not a part of my identity. For those who found STEM to be a part of their identity, including those who saw STEM as both a part and not a part of their identity, these participants revealed STEM to associate with them via their personal interest, being significant in their life. Those who did not see STEM as a part of their identity, including that same group who saw STEM as a part and not a part of their identity, reported STEM to not be a part of their identity because of their lack of passion for or personal connection with STEM. STEM in their case, was just an activity in which they participated.

In all three cases, these participants acknowledged maintaining a predisposition to STEM that was developed prior to their URE engagement. For those who associated STEM as being part of their identity, participating in URE functioned to reinforce what they already exuded. Interestingly enough, two participants did state that though STEM was not a part of their identity at the moment, it could become a part of their identity later on through continued engagement and participation in STEM activities. Their concerns stopped them from perceiving STEM to be a part of their identity. One concern expressed was not knowing if STEM was truly the path for them, given the fact that they could pursue other paths and still be content with their choice. The other concern was believing they did not possess enough knowledge in STEM given their perception of STEM being disciplines in which the individual had to "always be right." In their cases, UREs could facilitate the development of a STEM identity, however, not through a transformative experience. These two participants still brought their own predispositions to STEM into the URE context, still conceptualized their identity from a self-determined point of view, and was driven by altruistic behaviors as a result of and their reason for pursuing STEM. UREs, in the case of these individuals,

therefore facilitate a STEM identity by building on and expanding their foundational

knowledge and perspective.

Life Stage Outcome

Life stage outcomes is the last component of PVEST. According to the theory, it is

the result of an on-going, recursive, problem solving and decision making process (Spencer,

2006). Like other components of this theory, life stage outcomes are influenced by the

previous stages, and has the potential to shape and influence an individual's net vulnerability

(see Figure 6). Outcomes are beyond the scope of this study. In accordance with the

problems that served as an impetus for this study, retention in STEM would be the major life

stage outcome of this particular study, given the layout of the literature and the proposition

that undergraduate research experiences contribute to STEM retention. In the existent

literature, life-stage outcomes also include enrollment in STEM graduate programs or careers

post undergraduate education (Bauer & Bennett, 2003; Carter et al., 2009; Lopatto 2004).

Investigating the extent to which students' perception of their identity influences their

graduation in a STEM major and enrollment in a STEM graduate program or career is a

concept worth exploring.

Figure 6. PVEST in URE
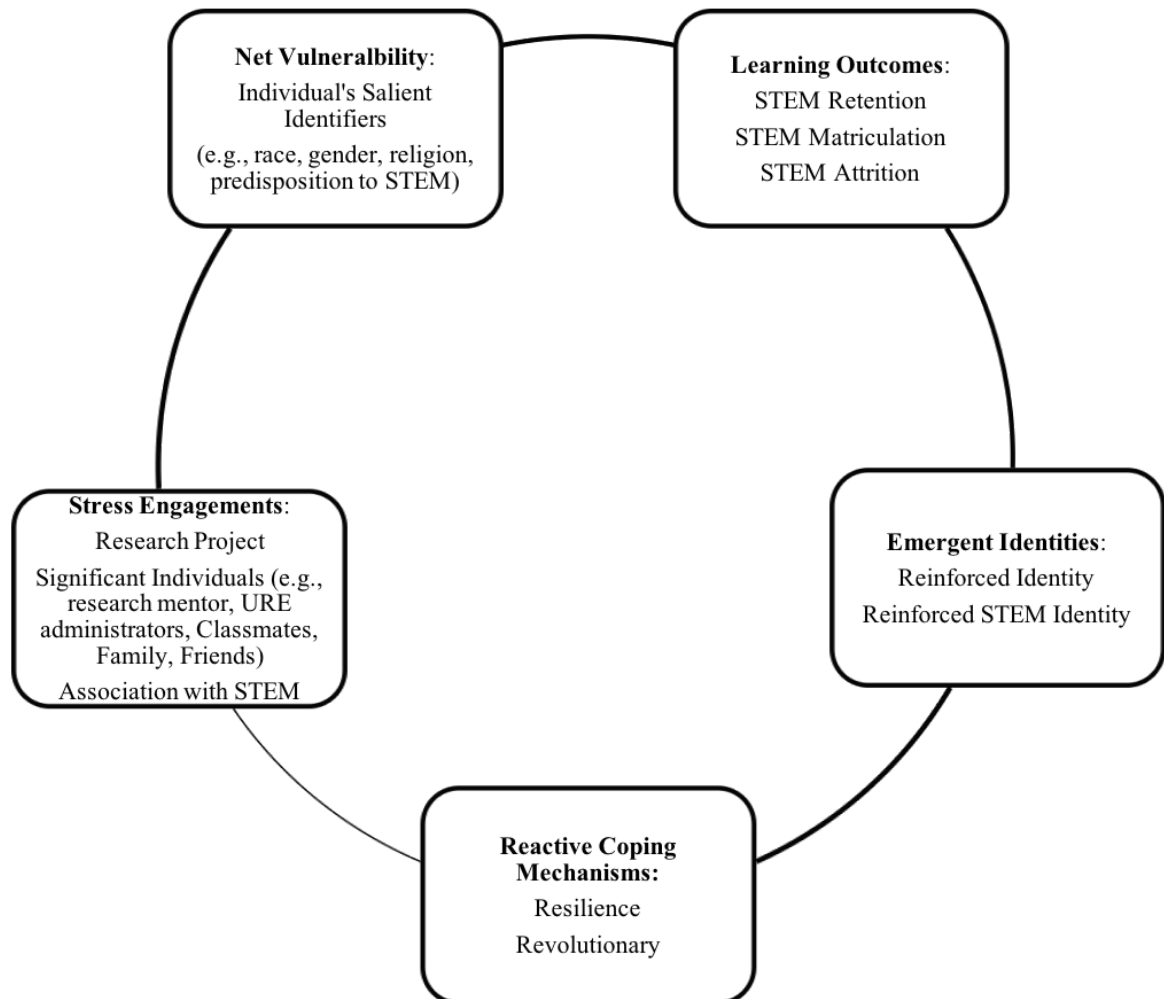
Figure 6. Modified model of PVEST to demonstrate influence of salient identifiers on the development of a STEM identity and continued partition in STEM. Each of the five boxes represents a stage of the PVEST model where the subsequent text outlines potential components that would fit within those constructs.

Chapter 4 Summary

Chapter four presented the findings for the study questions. Each question and its finding laid the foundation for the following question. Question one addressed the conceptualization of these Black Females' race, gender, and salient identity in STEM URE. I found that their race, gender, and religious identities were most salient within the group. Collectively, their understandings of their identity were socially regulated, self-determined, or vicariously defined. These understandings primarily involved the effort they put forth and decisions they made to negate negative perceptions and stereotypes of Black women.

Question two addressed the positioning of their conceptualizations, revealing that they see their identity as a source of strength or asset within their STEM URE. Their identity as Black females serves as a source of strength, exhibited as resilient or revolutionary because of their identified purpose and display of persistence and determination. Their identity also serves as a source of strength because their presence in STEM UREs signifies success and achievement, motivating them to continue. Their identity serves as an asset, granting them access to opportunities like their URE because of the underrepresentation of Black females in STEM. When among other Black females in similar situations or among Black females who have already succeeded in STEM, their identities provide access to sources of empowerment and inspiration.

Question three addressed student perceptions of STEM and their URE, in addition to how their identities informed those perceptions of STEM and their STEM URE. Findings reveal that these participants saw STEM as the appropriate channel or pathway used to reach their goal or fulfill their purpose. This perception was based on their initial intentions for pursuing STEM – addressing a family medical crisis, fulfilling a purpose, or coupling interest

with a career. Majority of the students expressed altruistic behaviors affiliated with their decisions to pursue STEM. These behaviors were either developed over time or expressed at the onset of their journey. The findings also reveal that these participants perceived their URE to be an opportunity, resource, and tool utilized to achieve their expressed desires characterized by their initial intentions. The network, experience, and support (i.e., financial and other) associated with UREs are the key features that these Black females find most beneficial, and are utilized in their navigation of STEM. Their perceptions of STEM being a conduit and UREs being a resource, opportunity, or tool were influenced by their conceptualizations of their identity as Black females.

Question four addressed the perceived association between their identity and STEM. The participants' associations with STEM varied from STEM being a part of them, them being a part of STEM through activities, or a combination of both. Their reports of their association with STEM demonstrate that these participants brought pre-dispositions into their URE environments that were primarily reinforced, although some students did perceive their STEM engagements to function in furthering the association between STEM and their identity.

The next chapter, chapter five, discusses the study findings in relation to the current literature regarding Black student retention in STEM, undergraduate research experiences, and STEM identity. Additionally, chapter five examines the study findings and analysis to discuss the outcomes of the study. I contemplate the importance of concepts such as purpose, intersectionality, relatedness, and self-determination as it relates to Black females' identity and their continued participation and engagement in STEM through undergraduate research experiences. Chapter five discusses implications for the design and implementation of

undergraduate research experiences, the definition of a STEM researcher, Black females'

identity expression, and theories used in STEM educational research. Future

recommendations for research and practice are also provided.

Chapter 5: Implications

The goal of this research study was to explore the influence of race, gender, and other salient identity expression and the experiences of Black females participating in STEM undergraduate research experiences. This chapter summarizes and discusses the research problem and study findings. I compare the study findings to the current literature regarding Black student retention in STEM, undergraduate research experiences, and STEM identity, demonstrating ways in which my findings support, critique, and counter the present literature. In displaying the relationship between the study findings and the dominating narrative, I present a counter-story pertaining to the influence of race, gender, and religious identities on Black student retention in STEM through undergraduate research experiences. I address limitations with my study and provide implications for future research and undergraduate research experience programmatic development.

Chapter one introduced the problem related to STEM workforce demands. To meet the growing needs of science and technology business sectors by increasing the STEM graduation rates by 34% annually (U.S. Department of Commerce Economics and Statistics Administration, 2011; President's Council of Advisors on Science and Technology, 2012), the U.S. invested in STEM engagement and retention efforts for underrepresented students (i.e., Black/African-American, Hispanic, Latinx, Native American, and Women). The targeted efforts included the undergraduate research experience (Hurtado et al., 2010; Palmer et al., 2010; Perna et al., 2010; Hernandez et al., 2013; Thiry et al., 2011). The existent

literature portends the development of a STEM identity by way of the undergraduate research experience (URE) as a primary element in enhancing student retention via student persistence (Hurtado et al., 2009; Palmer et al., 2011; Pender et al., 2010; Merolla & Serpe, 2013; National Academies of Science, Engineering, and Medicine, 2017). UREs are positioned as optimal environments for STEM identity development due to the resources they afford to the students (National Academies of Science, Engineering, and Medicine, 2017), implying STEM identities to be primarily contingent upon external influences. Researchers with an interest in UREs have under-investigated individual contributions to the development of a STEM identity within URE spaces, including the influence of students' predispositions to STEM and conceptualizations of their identities (i.e., race, gender, socioeconomic status, etc.).

Focusing specifically on Black students, there is very little empirical research on these students' individual contributions – race, gender, other identities, predispositions – to the development of STEM identities, and subsequently to retention by way of student persistence. Researchers who have investigated the influence of race on STEM identity for Black students suggest they must assimilate or accommodate their racial identity to societal and STEM-specific norms, as society requires it for access to opportunity because of the reinforcement of overarching power structures in STEM research (Marlone & Barabino, 2009). Equating the assimilation or accommodation of Black racial identity to STEM success inadvertently positions Black racial identity as a deficit that Black students bring into their STEM research experiences. In promoting UREs to be optimal for STEM identity development for Black students, researchers implicitly suggest UREs to be transformational contexts that address the "deficiencies" associated with being Black.

Through this study, I have addressed some of the limitations within this dominant narrative pervasive in the existent literature by empirically investigating the perceptions of Black females involved in STEM undergraduate research experiences. I examined the perceptions, conceptualizations, and influences of Black females' race, gender, and other salient identities on their STEM undergraduate research experience. This study addressed the following research questions:

1. How do Black female students participating in STEM undergraduate research programs conceptualize their race, gender, and other salient identities within their STEM experiences?

2. How do Black females in STEM undergraduate research experiences position their race, gender, and other salient identities? Does their identity positioning inform their persistence in STEM? If so, how?

3. How do Black females in STEM undergraduate research programs perceive STEM and their STEM undergraduate research experience? To what extent does their identity inform these perceptions?

4. To what extent does Black females' conceptualization of their race, gender, and other salient identities inform their expressed association with STEM?

My positionality as a Black, African American male from the sciences with a critical race theoretical lens, informed this study. The influence of critical race theory is evident in several ways: (1) starting with the premises related to racial realism (e.g., racism exists), (2) using counter narratives to frame the study's findings, (3) being sensitive to the intersectionality of identities, and (4) using phenomenology to foreground and validate the experiences of people of color (i.e., Black females). I employed hermeneutic phenomenology

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(Sloan & Bowe, 2014) as the methodological approach and characterized the perceptions and conceptualizations of the participating Black females. Within hermeneutic phenomenology, the researcher plays an active role in the research process by contributing to and interpreting the essence of the phenomena of interest (Sloan & Bowe, 2014). I conducted this study within a transformative paradigm; a primary purpose was to elucidate the influences of social identifiers overlooked or ignored in the existent literature and to inform research and programmatic efforts devised to increase the underrepresentation of groups historically excluded from STEM.

I used qualitative methods – interviews, journal prompts, and observations – to provide an in-depth view of these participants' experiences. All participants in this study identified as a Black female, were enrolled in a four-year university, majored in a STEM discipline, and were members of a structured undergraduate research program. Their undergraduate research program provided financial aid, research experience, academic support, and a cohort of peers. Ten participants made up my sample, with five of them attending a Predominantly White Institution (PWI), and the other five attending a Historically Black College and University (HBCU).

I characterized the experience of Black females participating in STEM undergraduate research experiences. In this portrayal, I specifically highlight their perception, conceptualization, and professed influence of their race, gender, and religious identity on the perception and influence of UREs as transformative sites for STEM identity development.

Story/Count(h)er-Story

The dominating narrative regarding Black student retention in STEM, STEM identity, and UREs is a tale that lauds the research environment while tacitly diminishing a Black

racial identity – both isolated from and intersectionally linked to other identities. This narrative is interwoven within and among research studies and general attitudes surrounding UREs and their ability to address issues with STEM retention.

As highlighted in the recently published book on UREs by the National Academies of Science, Engineering, and Medicine (2017), the research literature consistently points to the resources and opportunities provided by UREs as significant factors for the development of a STEM identity, thereby enhancing STEM retention. As indicated in chapter two, I reveal the narrative of UREs being transformational environments for Black students' STEM identity. The National Academies of Science, Engineering, and Medicine supported my inference in their most recent publication on undergraduate research experiences (2017). In their publication, the authors position UREs as transformational sites for "historically underrepresented students [as] academic enculturation through UREs may help to not only shape students' learning but also shape their identity as a STEM researcher" (National Academies of Science, Engineering, and Medicine, 2017, p. 3-4). Within their report, the National Academies of Science, Engineering, and Medicine discuss the importance of culture for "nondominant" students in supporting their STEM identity (2017). The acknowledgement and inclusion of "nondominant" students' culture and experiences within URE were mitigated by how the students' cultures were positioned: the students' cultures were situated as stepping stones for assuming an identity deemed to be more valuable. The National Academies of Science, Engineering, and Medicine reference the culture and experiences of non-dominant students as gateways to "learn a great deal about the nature of research and their identity as investigators" (2017, p. 3-5). Inevitably, even in its attempt to address issues

pertaining to underrepresented students, the research literature constructs a narrative that further minoritizes their identity within STEM UREs.

The study findings present an alternative narrative regarding race, gender, and religious identity for Black females in STEM UREs. This narrative primarily counters the dominant narrative presented in the current research literature.

Contributions of the Study

To truly determine the influence of undergraduate research experiences and support a statement that its context serves as a site for identity transformation for underrepresented students, one must investigate underrepresented students' experiences, predispositions, and contributions to the story. Without representing all sides, exploring both the context and the individual, a skewed perspective on the contributions of the other is more likely to occur. This study contributes to the overall narrative of Black student retention, undergraduate research experiences, and STEM identity by investigating the identities, experiences and perceptions of the individual.

Positioned as a count(h)er-story, this study, in comparison to existent literature, provides more detail about Black females' participation in the undergraduate research experience, and the extent to which their race, gender, and religious identity shapes that experience. Data obtained from interviews, observations, and journal prompts support the inference that Black females' race, gender and religious identity is socially regulated and self-determined. Additionally, their identities serve as a source of strength and as an asset for their participation in STEM. Current literature investigating race as it relates to a STEM identity and STEM research infer race to be a deficit that Black students overcome via assimilation or accommodation to be successful in STEM (Marlone & Barabino, 2009). This

study's findings counter what the current literature presents, and even suggest Black females' identity manifest as resistance or revolutionary to address and overcome challenges. Resilience and revolution counter assimilation and accommodation.

Current literature also positions undergraduate research experiences to be transformational experiences for STEM identity development of underrepresented student (Hurtado et al., 2009; Pender et al., 2010; Merolla & Serpe, 2013; National Academies of Science, Engineering, and Medicine, 2017). This study finds for Black females, UREs are perceived as resources leveraged to address their goals and fulfill a specific purpose. Their identity influences their perceptions of STEM and URE, positioning UREs to be contexts that reinforce their pre-determined identity in STEM. Reinforcement counters transformational.

This study also reveals the importance of constructs such as self-determination, goals, interest and purpose for the continued participation of Black females in STEM undergraduate research experiences. Currently in the research literature, development of a STEM identity for Black females is defined by the constructs competence, recognition by others, and performance (Carlone & Johnson, 2007). These constructs explicate that the development of a STEM identity is contingent upon the knowledge individuals obtain, both content and procedural, their ability to "perform like scientist," and validation from others (Carlone & Johnson, 2007). Taken together, these constructs imply that a STEM identity is externally defined as knowledge, performance, and recognition. In addition, it appears these constructs are based in the STEM environment and the other people present within it. This framework acknowledges the influence of race and culture on developing a STEM identity for Black females, but it does not fully explore the participants' views of their identities.

This study specifically explores the influence of race and gender on STEM identity for Black females. The findings show that in addition to developing competence, performing STEM, or obtaining recognition from other individuals discussed in the existent literature as relevant to developing a STEM identity, Black females emphasized affordances. A personal connection to STEM appears to be necessary for STEM to be a plausible part of Black females' identity. Furthermore, despite outside perspectives regarding their identity, Black females' identity is self-determined, where they determine the outcomes.

This study gives voice to Black females in STEM undergraduate research experiences. Rather than focus on the environment, and give credit to the resources undergraduate research experiences provide, this study focuses on the individual and the individual as part of a collective, and explores their strengths. This study is an appropriate first step in determining how Black females contribute to their education and retention in STEM through undergraduate research experiences.

Limitations

This study is based on interviews, observations, and journal prompts gathered from these participants. Two interviews, five journal prompts, and one observation constitute the data obtained. I collected data from multiple sources to not only address the research questions, but also as a way to enhance the trustworthiness of the study through addressing issues with credibility (Guba, 1981). Although I collected multiple sources of data, I conducted only one observation. To enhance the credibility of the findings, specifically those regarding the influence of identity on STEM engagement, additional observations conducted over a longer period of time in different contexts would have enhanced the study. These observations would delineate students' performance of their identity in their STEM URE, a

source to further explore the perceptions and experiences they described. Observations in their courses, research labs, group meetings, and peer engagements would provide a more well-rounded perspective of their identity performance.

Additionally, the size and variation of the sample create limitations for this study. Using a sample of ten participants, five per institution, potentially limits the group's salient identities expressed. A larger sample could potentially reveal that other identities, such as the first-generation college student status or SES reported by a few of the participants, are more salient within this particular population compared to race and gender. Additionally, within one particular research context, Hurston University, a majority of the sample maintained the same classification (e.g., third-year). Although these participants produced different narratives regarding their experience and engagement in STEM URE, it is possible that being in the same cohort influenced their expressed perceptions. More variation in the students' classification could have shifted the dynamics of this study's findings.

Implications

Previous research suggests the undergraduate research experience increases STEM engagement and retention for underrepresented students because of its ability to facilitate the development of a STEM identity through its provided resources (Hurtado et al., 2009; Palmer et al., 2011; Pender et al., 2010; Merolla & Serpe, 2013; National Academies of Science, Engineering, and Medicine, 2017). UREs are positioned as optimal learning environments for the development of a STEM identity (National Academies of Science, Engineering, and Medicine, 2017), and are perceived as transformational sites for underrepresented students' STEM identity development (Hurtado et al., 2009; Pender et al., 2010). Despite the many successes attributed to the undergraduate research experience in helping to retain

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underrepresented students in STEM, Black students still have the highest STEM attrition rate among all other populations (Chen, 2013). This study characterized the experience of Black females' participating in STEM UREs, uncovering the perception, understanding, and influence of their race, gender, and religious identity on their STEM and URE engagement. In investigating their experiences from a race and gender perspective, this study provides several insights on STEM persistence. These insights may be useful for the undergraduate research experience and STEM education researchers.

First, this study finds Black females draw strength and empowerment from their race and gender identities, where if they are able to make a personal connection between their identity and STEM, they are more likely to associate STEM with their identity. If STEM associations developed through the URE are believed to be a significant component for STEM retention (Carlone & Johnson, 2007; Eagan, Hurtado, Garibay, Herrera, 2012; Meyers, Silliman, Ohland, Pawley, & Smith, 2012; Rosenthal, London, Levy, & Lobel, 2011; Solomon, 2007), then undergraduate research experiences should find ways to allow Black females the opportunity to explore their identities through research. Traditionally, undergraduate research experiences are constructed where its participants work in a lab with a PI who conducts research on a topic of interest to the student. The student joins the lab and begins working on a project that has already begun and learns how to conduct research through working on the pre-defined project. If undergraduate research experiences were constructed in ways that students were allowed to pursue projects of their own interest under the guidance of their PI, these students would have the opportunity to establish a personal connection with STEM and research. For Black females, as well as other underrepresented students, creating their own research project would give them the opportunity to include their

race, gender, and cultural identities, reframing the narrative of STEM as being oppositional to their beliefs and ideologies.

Although reports of the participants' STEM URE experiences as a result of their institutional culture were not included as part of the narratives generated, there were institutional specific practices that influenced the students' engagement in their STEM URE. One such practice was the autonomy to design and conduct their own research project. Shakur University, the HBCU, gave some of their students the opportunity to design and conduct their own research project under the guidance of a research mentor. Being able to personalize their projects, overall, the students from Shakur expressed a stronger personal connection to their research project. The same sentiment was not true, however, for Hurston University, the PWI. Combining the concept of developing personalized research projects that connect with students' goals and purposes with the differences in how the URE programs functioned across the two institutions provide further implications for (re)constructing the influence of the institution's culture on the structure and design of UREs.

Research literature supports the concept of investigating and either supporting or reconsidering how the institutional culture shapes STEM URE as it purports HBCUs to be more cooperative, collaborative, supportive and encouraging of Black students in STEM (Brown et al., 2005; Essien-Wood & Wood, 2013; Perna et al., 2009). PWIs should look to re-create the elements provided by an HBCU environment for its Black females in STEM by retracting cultural norms that promote assimilation and accommodation of a Black racial identity. Such a concept would require PWIs to take a CRT approach: examining, exposing, and removing elements that support racism and meritocratic ideologies and practices (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995). Beyond institutional specific

approaches to re-conceptualizing STEM UREs, to promote increased retention and matriculation by way of facilitating stronger associations with STEM for Black females, the system of STEM education must also examine, expose, and remove elements that support racism and meritocratic ideologies as well. Such a concept would require system-wide changes created and enforced by educational policies that focus on equity.

Second, this study finds Black females draw on a variety of tools (e.g., problem solving, creativity, persistence, and determination) to address research specific, content-based, and identity-based challenges they face in their undergraduate research experience. The tools they utilize are developed from previous experiences. Many of the tools these participants share are in fact necessary for conducting research and navigating STEM, such as embracing failure and using critical thinking. In recognizing the connection between the tools Black females utilize and the tools common for STEM learning and research, undergraduate research experiences, STEM professionals, and STEM researchers can reframe what it means to be a "STEM researcher." The reframing process should incorporate the language and experiences that resonate with the language and experiences of Black females and other underrepresented students. In reframing what it means to be a "STEM researcher," using their words and experiences, underrepresented students can recognize that many of the skills and ideologies they already possess translates to the skills and ideologies of conducting STEM research. Recognizing the connections between their own capabilities and STEM will uncover the pre-existing association with STEM that they already maintain.

Reframing the narratives around what constitutes a "STEM researcher" and "STEM knowledge" also requires a paradigmatic shift in institutions of higher education and the system of STEM education. Both systems would have to reject notions of racism and

discrimination embedded within the culture of STEM education and take an equitable approach towards supporting and educating students. A paradigmatic shift would require changes in educational policy and practices at the local, state, and national level.

Thirdly, this study finds that Black females face identity-based challenges within their STEM URE. The challenges they face involve the concept and power of stereotypes, as emphasized through these participants' conceptualization of their identity as Black females. Research surrounding stereotypes and their psychosocial implications include stereotype threat. Stereotype threat is "the social-psychological threat that arises when one is in a situation or doing something for which a negative stereotype about one's group applies" (Steele, 1997, p. 614). Individuals experiencing stereotype threat believe that their identity will be "reduced to the stereotype" (Steele, 1997, p. 614). Research shows anxiety and concern over being stereotyped impede engagement and performance (Steele, 1997). Research specific to STEM retention and stereotype threat suggest that Black students have higher group performance anxiety as a result of stereotype threat, causing higher STEM attrition rates for Black students as compared to White students (Beasley & Fischer, 2012). Research on stereotype threat among women in STEM also suggest that stereotype threat plays a role in women's STEM performance and engagement (Smith, Brown, Thoman, & Deemer, 2015). Stereotypes, by way of stereotype threat, have the potential to negatively impact these Black females' persistence in STEM.

In response to the stereotypical challenges they endure, Black females feel the need to exert effort to overcome and negate those perceptions. In doing so, they present a "strong Black woman" identity where they feel that they must take on all of the stereotypes and overcompensate to prove them wrong. Consistently maintaining a "strong Black woman"

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identity has detrimental outcomes for their psychosocial and physical well-being (Harris-Perry, 2011). As well, it is possible that their belief of having to overcompensate to prove their capabilities could hinder them from seeking assistance or interacting with others in their research projects for fear of being perceived as incompetent (Steele, 1997). Undergraduate research experiences and the individuals involved in developing them must be consciously aware of the larger societal influences on UREs, and intentionally work to address issues of racism and discrimination that can be attenuated in these spaces.

Addressing racism and discrimination can come in many forms. In revealing that these participants find empowerment from being with similar others, one way in which the undergraduate research experience can address issues of race and racism is to incorporate more Black females into their program structures, both as participants and as research mentors. Although Black female mentors may be scarce, they do exist. Access to Black female mentors in STEM from other regions, both locally and nationally, is possible via the many technological social platforms that exist. There are many movements taking place via social networks to connect, empower, and praise Black females. One example of how technology is used to create a community among Black females is emphasized in the title of this research project, *#BlackGirlMagic*. *#BlackGirlMagic* is a popular hashtag (e.g., interface that allows you to search multiple posting with the same statement attached) used on a variety of social media platforms to feature Black females in positive, encouraging ways. The incorporation of this hashtag demonstrates one way in which technology and social media can be used as alternative ways to support, expand, and facilitate Black females' network. Additionally, the dissertation title is appropriate given the study's findings of race, gender, and religion (i.e., Black – Girl – Magic) as being salient identities.

Being intentional with inclusion and specifically targeting underrepresented racial populations to participate in all levels of the undergraduate research experience can address issues of racism and discrimination. Additionally, having race-based trainings for the faculty, staff, and students involved with the undergraduate research experience can address issues of racism and discrimination. Educating everyone on the elements and influence of race and racism present a racial realistic perspective regarding acknowledging racism's existence and the need to combat it (Bell, 1992).

Lastly, an implication of this research study, particularly for STEM education researchers, is the need for using theoretical framings specific to people of color in general and Black females, specifically. The use of CRT informed my positionality as a researcher and thus oriented the way in which I assessed the literature, determined a problem, and set up the research design to address the problem of interest. Based on my CRT informed perspective, I was able to discover a count(h)er-story related to the experiences of Black females in STEM that I believe furthers STEM education research, specifically STEM retention of underrepresented students. Reframing the narrative regarding the STEM identity and STEM retention to include student contributions, redistributes the power regarding who and what can determine student success. Acknowledging, supporting, and incorporating students' efforts not only gives voice to their perceptions, but it validates their experiences as real, important, and necessary in addressing socially just issues in transformative ways (Mertens, 2010).

Recommendations and Future Research

Future research should continue to characterize the experiences of Black females in STEM undergraduate research experiences, extending these findings to further explicate the

impact of their perceptions and conceptualizations of their identity. This study focused on student perceptions and understandings of their identity. Determining impact of their identity would require examining the students' identity performances, investigating other people's perceptions of their performance in their URE, and assessing students' long-term outcomes (i.e., whether or not the remained in a STEM field past their undergradual studies). Future research could also investigate developmental differences among these Black females regarding their understandings and perceptions. As emerging adults (Arnett, 2000), their identity fluctuates. Determining the extent to which their perceptions and conceptualizations of their identity change over time would be vital in determining the impact of identity on STEM retention. Future research should also seek to determine correlations between these individuals' understanding of their identity, sense of purpose, goals, and interest, STEM majors, research experience and STEM retention. This information would help further demonstrate the power of perceptions and conceptualizations of identity on STEM retention. Future research should look to reconstruct the undergraduate research experience to ascertain the optimal environment for Black females' retention in STEM. Using designed based research (Easterday, Lewis, & Gerber, 2014; McKenny & Reeves, 2012) STEM researchers and professionals can construct and reconstruct the optimal undergraduate research experience that is informed by empirical research.

Lastly, future research should consider theoretical orientations specific to people of color, in general, and Black females specifically when investigating these populations' STEM engagement and retention. Self-determination, a major finding for this study, relates to Black feminist literature – a theoretical orientation specific to Black women (Collins, 1989, 2000; Crenshaw, 1989, 1991; hooks, 1981, 1995; Lorde, 2007). Use of theoretical

orientations specific to people of color, or Black females in research can uncover ways to characterize and better understand lives and experiences of these populations (Parsons & Moore, 2010) or ways to enhance their lives and experiences through educational practices (Howard-Hamilton, 2003).

APPENDIX A: OBSERVATION PROTOCOL

Monitoring student behavior and demeanor as it relates to the activity they are engaged in, the role they assume in the activity, and their interaction with others during the activity

Institution:	Program:	Date:	Participant:
Physical Setting: (Appearance, Color, Shape, Smell, Feel)			
Number of People and Description (Race, Gender, Age, Position of Power):			

Time	Participants' engagement in activity (behavior, body language, verbal language)	Participants' roles and responsibilities in activity (power dynamics and agency in relation to others)	Participants' interactions with others during activity (responses generated from others towards participant and associated behaviors – verbal, physical, subtle)

APPENDIX B-1: INTERVIEW PROTOCOL 1

Semi-structured Interview Protocols
The semi-structured interview guide provides questions posed to all participants. Additional
questions are added as a response to the participants' replies.

Introduction Script before each interview:

Welcome! Thank you for agreeing to participate in this research study with a focus on
understanding Black students' experiences and identity development in STEM. You were
recruited to participate in this study because of your participation in the STEM programs at
your institutions. As you may already know, these programs are structured to help facilitate
and enhance your experience in STEM throughout your undergraduate career, leading to
either graduate studies or a professional career in STEM.

This interview will be the first interview of three. The interviews will explore your feelings,
thoughts, expectations, and experiences with STEM, this program, research experiences, the
institution you are attending, and other contributing factors that have impacted you in your
STEM pathways. This first interview is designed to gain a better understanding of your
background; who you are, where you come from, and why you are here. Participation in this
project is completely voluntary, and if at any point you no longer wish to be included in the
study, you may choose to leave.

Your responses will remain confidential. Nothing that you share will affect your participation
in the STEM programs or your enrollment at your respective institution. Your identity will be
protected! In reporting any findings, a pseudonym will be used in place of your name, and all
identifiers (be it the names of a person, location, or thing) that can be traced back to you will
be masked (e.g., use of numbers in place of names like friend #1).

This is a completely informal interview. Please be as relaxed, open, and honest as possible.
If at any time you feel uncomfortable with sharing, you may choose to skip the question. This
interview should not take any longer than 1.5 hours.

First Semi-Structured Interview Guide

Background Information:

1. What is your name, your classification, and what are you majoring in or intending
   to major in here at (institution name)?
2. How do you identify? (Examples will be provided if necessary: race, ethnicity,
   and gender) Do these identifiers impact your life at your institution in any way?
   If so, how? Do these identifiers impact your STEM participation in any way? If
   so, how?

3. How would you describe your immediate family's (the people in your current household) socioeconomic status? (Additional questions will be provided if the question is too open-ended: How many people were in your house? How were they related to you? In the case of siblings or cousins, or peers, where did you fall age-wise? Are you the first person from your immediate family to go to college? If not, who in your family went to college and what did they or are they studying? What about extended family (e.g., cousins, aunts, uncles)? What do your parents or primary caregivers do for a living? How long have they been working in that job or career?)

4. Describe some of your sources of support. (Examples will be provided if too open-ended: People, experiences, lessons, etc.) What are they and how do they support you?

5. Tell me about some great experiences, if any, you have had as a student on your campus. What are they and what made them great? Have these experiences impacted your view of your campus? If so, how? Have these experiences impacted your view of your [student major]? If so, how? Have these experiences impacted your view of yourself? If so, how? Have these experiences impacted your view of yourself in your [student major]? If so, how?

6. Tell me about some challenges or negative experiences, if any, you have had or are dealing with as a student on your campus. What are they and what do you consider to be their potential causes? How are you dealing with these situations? Have these experiences impacted your view of your campus? If so, how? Have these experiences impacted your view of your [student major]? If so, how? Have these experiences impacted your view of yourself? If so, how? Have these experiences impacted your view of yourself in your [student major]? If so, how?

7. Tell me about some challenges or negative experiences, if any, you have had or are dealing with as a student in [student's major].

8. Tell me about your home community (neighborhood, church, community center). What was it like growing up there? Please provide one or two experiences that stand out the most for you.

9. Describe the people and level of support you received from your home community. Who are some of the people that influenced you the most? How and why did they influence you? What did they provide you and it what ways did it help (or hurt) you?

10. Tell me about your school experiences in STEM prior to college. Please describe one or two experiences that are the most memorable.

11. Describe the people and level of support you received from your school. Who are some of the people that influenced you the most? How and why did they influence you? What did they provide you and it what ways did it help (or hurt) you? Are any of these people the same people you identified from your home community?

12. In what ways have your experiences before college influenced who you are today, your ambitions, and your decision to pursue STEM?

STEM Predisposition:

13. How do you define or describe STEM to someone who does not know what STEM is? What disciplines do you consider to be included in STEM? What are the beliefs, values, and expectations associated with STEM? Who (what type of person) typically participates in STEM? Research shows that there are very few African Americans in STEM. Why do you think this is the case? Some research indicates that challenges associated with race are among the factors for why few African Americans are in STEM. How might race play a role in the low numbers of African Americans in STEM? Have you experienced any of these personally? If so, would you like to share more? What are some of the possibilities one could achieve from being in STEM?

14. Describe the time when you realized you were interested in STEM. (Follow-up questions are provided if the question is too open-ended: When was this (age/grade)? Where were you? What were you doing at the time that made you realize you were interested?)

15. Tell me about any influential people (parents, teachers, friends, family, others) that supported your interest in STEM. (Follow-up questions are provided if the question is too open-ended: Who were they and what role did they play in helping you become interested?) How did their actions influence your decisions and interest?

16. Describe any activities or events that you participated in prior to college that supported your interest in STEM and your desire to major in a STEM field. (Follow-up questions are provided if the prompt is too open-ended: Were they school based activities or informal (out of school) activities? Please describe. Are these activities that you sought out on your own, or were you referred to them? If by referral, who referred you to them? Please describe some of the activities you engaged.

17. Describe the level of support you received from your family regarding your interest in STEM. (Follow-up questions provided if prompt is too open-ended: In what ways did your family help support (or thwart) your interest and aspirations? Who in the family? What did they do-enroll in programs or camps; help with STEM work or projects; take you to museums, tours, community functions that were STEM based; give encouraging, empowering or motivational speeches? When did they do it?)

18. Describe the level of support your home community provided you regarding your STEM and educational endeavors. (Follow-up questions are provided if the question is too open-ended: Community resources, daily lived experiences. scholarships to college, etc.) Were there others in your community that you connected with that were equally interested in STEM as you?

19. Tell me about a time, prior to college, when your interest in STEM was challenged. Why do you think it was it challenged? Who challenged it? What was said or done? How did it make you feel and why? What was your response?

20. Describe your current feelings about STEM. What do you want to do (be) in STEM? Why?

21. How do you see yourself as it relates to STEM? Is STEM something that is a part of you now? Or something you can be a part of or obtain later?

22.   Earlier you said that you are majoring (or intending to major) in ------Describe how did you came about choosing this major? What and who influenced you to make this decision? How? What do you want to do with your major, immediately after college, career/ professionally?

23.   How do you see your major connecting to or being considered a part of STEM?

Undergraduate Research Experience:

24.   Why did you choose to attend (institution)? What are your expectations of the institution? What do (did) you anticipate will (would) happen while you are here? Thus far, how does your anticipation correspond to your experiences? What are your fears or anxieties about attending?

25.   Why did you choose to participate in the STEM Program? How many years have you participated in the program? Tell me about your expectations and anticipations for the program. What do (did) you expect of the program, short term and long term? What do (did) you anticipate you will do in the program? How does your anticipation and experience line up? What do (did) you anticipate will (would) happen while participating in the program? How does your anticipation and experience line up? What do (did) you anticipate you will receive from the program? What have you received from the program (perks, knowledge, benefits, resources, experiences)? In what ways do you think participating in this program will help you achieve your goal during college and after college?

26.   What aspects of your identity are most important to you? Do you believe these aspects that you value will influence or have influenced your experience in the [name of STEM program]?

Wrap Up:

27.   Is there anything additional you would like to share about your background, your thoughts about STEM or research that I have not covered?

Before our next interview, it is important for you to complete the electronic journal prompts. Our next interview will focus on the experiences you've had since this interview.

Thanks for your participation!

APPENDIX B-2: INTERVIEW PROTOCOL 2

Second Semi-Structured Interview Guide

Program Thoughts

1. Describe your experience in STEM Program since our last interview (provide date). What was the overall experience like? What types of activities did you participate in since the last interview? (i.e., research, team building, trips, coursework, etc.) What did you enjoy most? Why? What did you enjoy the least? Why?
2. Of the activities you described, what did you find to be most beneficial to you? How and why was it beneficial?
3. Of the activities you described, what did you find to be the least beneficial to you? How and why was it not beneficial? What could have been done to improve it to make it beneficial for you?

Research Experience

4. Describe your research experience. What was it like to participate in the research? What feelings would you associate with the experience? Why these feelings?
5. Tell me about your research. (Follow-up prompts will be provided if the prompt is too open-ended: What facility? What was your project? What were your duties?)
6. Describe the people that worked directly with you on your research project. What were there titles/roles? What did they do in terms of the research project? Describe your relationship with them.
7. In what ways did you engage with these people from your research experience? In what ways, if any, did they assist you? (personal, academic, social) Did you find their assistance meaningful? How so and why (what gave it meaning)?
8. Tell me about a time, if applicable, in which you felt a strong sense of connection in your research experience. When was this time? What occurred that made you feel connected? Do you still feel the same way or did your feelings change? If feelings changed, what contributed to that change?
9. Tell me about a time, if applicable, where you felt disconnected in your research experience. When was this time? What occurred that made you feel disconnected? Do you still feel the same way or did your feelings change? If feelings changed, what contributed to that change?
10. Describe your feelings toward your research project. Was it something of interest to you? In what ways, if any, did you feel connected to the project? Was it interesting? Did you find it relevant and relatable to you? How?
11. Tell me about any challenges you faced regarding your research project. What were some of the challenges? Where did the challenges originate? How did they make you feel about yourself? About research? About STEM overall?
12. Tell me about a time in which you felt out of place as it pertains to the research project (if applicable). When did you have this feeling? Why did you feel this way? What contributed to you feeling like this? Do you still feel this way or has your

feeling changed? Was there something or someone that helped you get over this feeling? Who or what? What was done or said that helped you and how did it help?

13. Describe any strengths or assets that you brought into the research environment. What were they? Why were they a strength or asset to you? How so? Where did those strengths or assets come from (lessons learned from home, lessons learned from life experiences, etc.) Would you say they were associated with your identity? If so, what aspects of your identity? Why?

Campus and Larger Community

14. Describe your overall experience on the campus. What did you enjoy most about the campus? What did you enjoy the least? What is the campus environment (culture) like? Do you feel a part of the campus? Why or why not?

15. Tell me about any sources of support that you had on campus. What are they and how do they support you? Have you used them?

16. Tell me about any challenges you dealt with while on campus. What were they and where did they come from?

17. Tell me about the people you interacted with outside of your research experience. Who were they? (Follow up if needed: friends, parents, counselors, teachers, program peers.) Were they a part of the program too? Where did you meet them? What were their roles or titles in relationship to you?

18. In what ways did you engage with the people outside of your research experience? What types of activities did you all do? Where were these activities located?

19. Describe your relationship with these people outside of your research experience. How would you classify them (e.g., peer, mentor, teacher, friend)? Why? What does those classifications mean to you? (Follow up if needed: If you say friend, how do you define friend, or if you say mentor, how do you define a mentor?) What all did they provide you?

20. In what ways did your connection with your family and/ or home community change or stay the same during the research experience? With whom did you talk and how frequently? What did you all talk about? What advice or comments did your family provide you? How did you handle the commentary or feedback from your family?

Connections to STEM

21. Describe your current thoughts, feelings, and connections with STEM. In what ways have they changed (or stayed the same) since you've joined in this program? What components of the program have contributed to you feeling this way? In what ways did they contribute? How did they influence your feelings? In what ways have your thoughts, feelings, and connections with STEM changed (or stayed the same) since you've been at the institution? What is it about the institution that has contributed to your thoughts, feelings, and connections with STEM?

22. Of the people you identified earlier, in what ways did they influence your current thoughts, feelings, and connections with STEM? Who in particular had the most influence on your current conceptions of STEM? How did they lead you to those thoughts and feelings?

23. In light of the aspects of your identity that you previously stated were important to you, in what ways, if any, has program participation influenced your thoughts, opinion, feelings, and perceptions about individuals valuing the same aspects of identity being in STEM?
24. In light of the aspects of your identity that you previously stated were important to you, in what ways, if any, has the research experience influenced your thoughts, opinion, feelings, and perceptions about individuals valuing the same aspects of identity being in STEM?
25. In light of the aspects of your identity that you previously stated were important to you, in what ways, if any, has enrollment at this institution influenced your thoughts, opinion, feelings, and perceptions about individuals valuing the same aspects of identity being in STEM?

Wrap Up

26. What did you take away from participating in the research project, so far (lessons, motivation, ideas)? How are you applying those lessons to your actions and decisions today? How do you intend to apply them in the future?
27. In what ways has participation in this program influenced your future plans? Do you intend on staying in STEM? Why or why not? If leaving, what do you intend on majoring in? Why? What STEM based extracurricular activities will you engage in the near future? Has participation in this program influenced your decision to participate in any additional STEM extracurricular activities? Why?
28. Is there anything else that you would like to share regarding your experience thus far or current thoughts and feelings about STEM that I did not cover?

Electronic Journal Prompts

Welcome! Thank you for agreeing to participate in the research study seeking to understand Black students' experiences in STEM preparation. You were recruited to participate in this study because of your participation in the STEM program. As you may already know, this program is structured to help facilitate and enhance your experience in STEM throughout your undergraduate career, leading to either graduate studies or a professional career in STEM.

Over the course of this project you will receive a total of 5 prompts where you will be asked a general question regarding your experiences. Please be as open, honest, and as **DETAILED** as possible. This journal is a **SAFE SPACE** for you to communicate your thoughts, opinions, and feelings without any repercussions.

Participation in this project is completely voluntary, and if at any point you no longer wish to be included in the study, you may choose to leave. Your responses will remain confidential. Nothing that you share will affect your participation in the STEM program or your enrollment at your respective institution. Your identity will be protected! In reporting any findings, a pseudonym will be used in place of your name, and all identifiers (be it the names of a person, location, or thing) that can be traced back to you will be masked (e.g., use of numbers in place of names like friend #1).

Journal prompts will be sent via personal emails from the research assistant. Included in that email will be a link to an online forum that will allow you to respond confidentially. You may either type directly into that forum or upload a document to the forum. Again, your identity will be protected during this process. You will have your own personalized link to submit your responses, where no one but the research assistant and PI will have access to your submissions. We ask that you complete your prompt by due date indicated in the email.

1. Prompt 1: Tell me about yourself! Who are you? Where are you from? What do you like to do? What do you want to be later in life, and why? Why are you participating in this program, and what do you anticipate to gain from your experience? What is something that you are excited about regarding this experience? What is something that you are nervous or fearful about? Why?

2. Prompt 2: Please describe in detail one experience thus far that has impacted your journey in your STEM preparation. How has this experience impacted you? Why do you think it has impacted you the way that it has?

3. Prompt 3: Tell me about your networks! Who have you connected with during this program and what type of connections do you all have? What do you do with these various groups? Describe any thoughts, opinions, or feelings you have about these connections.

4. Prompt 4: Tell me about your experience to this point in the program! What have you enjoyed the most and why? What have you enjoyed the least and why? What have you found to be the most challenging aspect of the experience at this point? How have you dealt with it? What is something that you have learned from the challenging experience that you will apply in the future? How do you think you will apply it?

5. Prompt 5: Tell me about your plans! After having your experiences thus far, what is something that you anticipate or look forward to regarding participation in the program, your major, or school in general? Why are you anticipating this experience? What is something that you learned thus far that you intend to apply in the future? Why did you choose that lesson over others, and what benefits do you anticipate from what you've learned?

Name: External Auditor, PhD
Professional Responsibility: Overseeing undergraduate retention efforts

Methods and Data Collection
1 Do the research methods align with the structure and purpose of the research project? Yes
    a. Comments:
2 Are the methods appropriate for gathering sufficient data to address the research questions? Yes
    a. Comments: The study seeks to describe the lived experience of Black female students. Qualitative methods are appropriate for this descriptive and exploratory research.
3 Was data collected according to IRB protocols?
    a. Are the participants' identity protected? Yes, pseudonyms are used and any information that could be linked to participants is masked.
    b. Was data collected by approved researcher? Yes
    c. Was data stored in the appropriate manner? Yes, on secure server and file name.
4 Was the information obtained via the observation protocols a credible source of data? Yes
5 Was the information obtained via the journal prompts a credible source of data? Yes
6 Was the information obtained via the interviews a credible source of data? Yes
7 Did the researcher utilize analyses from the observations and previous interviews appropriately to guide questions in future interviews? Yes, questions in the second interview were informed by observations, previous interviews, and journal prompts.
8 Did the researcher conduct appropriate interviews, or were the questions presented leading? The researcher asked interview questions that provided the opportunity for study participants to describe their experience. The questions were not leading.
9 Did the researcher obtain multiple sources of data that can be triangulated? Yes

Data Analysis
1 Are the codes used understandable and cogent? Yes
    a. Comments: Detailed table with quotes for each code is compelling.
2 Do the codes fit the data, appropriately? Yes
3 Are the codes organized in appropriate categories? Yes
4 Are themes generated comprehensive of the data analyzed (journals, observations, interviews)?
    a. Comments: I do not think I saw all of the themes that were generated. Of the 2 that I did see (STEM as Conduit, URE as Resource or Tool), I believe they were comprehensive.
5 Were the strategies used to analyze the data appropriate for this research study?
    a. Comments: Yes.

6   Did the researcher satisfy the necessary criteria to establish trustworthiness of the study and findings? Yes
    a.   Comments: Multiple data sources and clear description of methods.

Auditors Overall Review:
1   Was this research project conducted along the lines of an acceptable qualitative research study? Yes
    a.   Comments: Researcher draws upon relevant literature to determine best qualitative methodologies then describes application of each method in the current research study.

APPENDIX E: MEMBER CHECK REPORTS

Participants of this research project provided the following statements after reviewing the data analysis and interpretation I constructed. These statements are an additional way in which I enhance the credibility of this dissertation project (Gall et al., 2003). Nine participants are represented here. One participant, Buttercup, withdrew from the institution due to medical reasons and I was unable to gather her response.

Responses

"Wow! This is really nice. I am reading along and I am like, 'yep, that's me. Yep, I said that. Yep, that relates.' I can definitely hear my voice and see how you included my story. I also see and hear myself in relation to the other Black females." (Charlotte)

"You did a good job capturing my perspective. As I was reading, I was thinking back to what I said, and you definitely represented my story well." (Teresa)

"I like it. I can hear my voice, and I feel like you adequately represented me. I really like *TENACI-SHE*. That was really good. Is there any way you can email that picture to me?" (Nicole)

"Definitely! I love it! Can I have a copy of that poem? I feel like that is exactly, if I had to put my story as a picture, that is exactly what it would look like. I can definitely see myself saying this stuff. That's real. That's real. Yes, you have adequately represented me. I can hear my voice!" (May)

"This is really good. Especially with the doubt, that is me. The opportunity with the program, the perseverance. Yes! You represented me well. I can hear my voice." (Ginnette)

"I can see what's me. You have captured my story. Especially the parts relating to STEM. I really like this. This sounds legit. I would say you represented me well." (Sunshine)

"I think this represents me very well! I can see how it relates to my personal story and what I want to do and why I want to do it. Especially with *Sisters of the Struggle*. Kadence's story resonates with my experience with my dad. It was like I had a personal vendetta out against cancer, and you captured that very well." (Jenny)

"Yes! You captured my voice really good. I like *TENACI-SHE*! I feel like it speaks to my experience. I feel like I am tearing down the bricks and working really hard to fulfill my purpose." (Sara)

"Yes, this sounds familiar. I can definitely hear my voice. I really like the ending, it accurately depicts Black women in STEM. I love *TENACI-SHE*, I would love to have this blown up and put in my classroom. This captures my story." (Lexi)

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