

ABSTRACT

EGGLETON, SHARONDA RENEE. *The K-12 Experiences of African American Collegiate Women in STEM Majors: A Counternarrative*. (Under the direction of Dr. Jessica T. DeCuir-Gunby).

The purpose of this study was to explore the K-12 experiences of African American women who were majoring in a science, technology, engineering or mathematics (STEM) field, and the ways in which those messages and experiences contributed to their selecting and persisting within their STEM major. A narrative approach was used to depict the lived experiences of each woman. By using a counternarrative, a different lens is provided to understand the contribution of the selection of undergraduate STEM majors by Black women. Ten women from both historically Black colleges and universities (HBCUs) and predominately White institutions (PWIs) were interviewed, informing the studies counternarrative. Findings indicated that overwhelmingly African American women who had early exposure, particularly during their elementary and middle school years, not only continued to their interest, but were less likely to need outside support and encouragement to continue their STEM pursuits. The K-12 STEM experiences with teachers particularly during the formative years had an additional significant impact on the women and their selection of a STEM major. By understanding these K-12 experiences, the design of K-12 STEM programs both inside and out of the classroom can be informed, further influencing the selection and persistence of African American women in STEM undergraduate majors.

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The K-12 Experiences of African American Collegiate Women in STEM Majors:
A Counternarrative

by
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DEDICATION

“Ubuntu.” This word is more than a statement; it is a way of life. It is with this understanding that “I am because we are,” that I dedicate this, first to my maternal grandparents Sadie and Billy Adams who, although you are no longer present in the physical, your spirit continues to live with and guide me.

To every African American woman educator, including my very first one, my Mot-sa-Mia! You have loved me, challenged me and inspired me! I continue to carry a piece of each of you in on my own journey as an educator.

To every student that I have taught and that has taught me, thank you.

BIOGRAPHY

Sharonda Renee Eggleton was born and raised in Philadelphia, Pennsylvania. The only daughter of Randy and Sharon G. Eggleton, Sharonda is the middle child of two amazing brothers, Brooks A. Gregory and Randall L. Eggleton. Attending Philadelphia public schools, Sharonda graduated from G.W. Carver High School of Engineering and Science. Sharonda went on to complete her undergraduate and master's degrees at the illustrious North Carolina Agricultural and Technical State University. Sharonda has been an educator for over 11 years. In this time she has taught as an instructor at Bennett College for Women, Guilford Technical Community College, Virginia College and NC State University.

For 6 years Sharonda served as a classroom science teacher at Eastern Guilford High School in North Carolina. In that time she founded *Heart of the Matter*, an outreach program for girls, which promoted the development of healthy self-esteem and self-image through enrichment activities. She was the head girls track coach, and started the schools steps team, where she served as a coach and advisor for 5 ½ years. Currently Sharonda is in her 3rd year at Smith High School where she serves in leadership on several committees including the *School Improvement Team* and the *Parent and Community Engagement* committee.

An active member in her community, Sharonda is a daughter of the Embassy Church International where she has served for 5 years. She additionally enjoys active membership in Delta Sigma Theta Sorority, Inc. She has served as a member of the advisory team for the Alpha Mu chapter of Delta Sigma Theta Sorority, Inc. In addition to working as a high school science teacher, she successfully owns and operates, S.A.S.E., Students Achieving Success Early, a program that supports and empowers first time and returning students, and their families as they embark on their journeys towards higher education.

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CHAPTER I: INTRODUCTION

From as early as elementary school, I can remember positive and consistent exposure and experiences with science and technology. Continuing in this thread of early exposure I attended a magnet high school in Philadelphia where this interest in science was further cultivated. Attending G.W. Carver High of Engineering and Science provided me with a plethora of opportunities, all which solidified my desire and goal to pursue biology as my undergraduate major. Attending North Carolina Agricultural and Technical State University, a historically Black college and university (HBCU), I developed an appreciation for my role as an African American woman majoring in a field where African American women are underrepresented. However, while a supportive environment was propagated prior to and during my undergraduate experience, I altered my trajectory towards science education. “Two roads diverge in a yellow wood, and sorry I cannot travel both.” This line from Robert Frost’s (1995) poem, “The Road Not Taken” is representative of how I have viewed my life and my journey as an educator. As a science educator I began to understand even more the relevance and impact that I would have on future students as an African American woman in a field still dominated by White males.

As I began my journey as an educator teaching fulltime in a public high school, I joined a department that was representative of what many students experience in their high school science classes, a department that was majority White and female. This fact reflective of the educational system that too often largely employs White, middle-class, females, yet serves a growing population of students of color (Howard & Aleman, 2008). For the first 4 years of my teaching career I was the only African American in my department, let alone Person of Color. While this was my experience as an educator, this was not reflective of my

K-12 experience as a student. Up until I entered my sophomore year in high school, all of my science teachers were African American women, although the schools I attended were not predominately African American.

As such, it is through my own teaching experiences and knowledge of the beneficial impact that K-12 messages, experiences, and exposure have on African American women as they enter and persist as science, technology and mathematics (STEM) majors that this study emerged. The purpose of this study is to explore the K-12 experiences of African American college women who are currently majoring in a STEM field. By exploring K-12 experiences and messages, insight is provided about the eventual selection and persistence in a STEM major.

Operational Terms

The following are definitions of operational terms I use interchangeably within my study. The term African American is used interchangeably with the term Black to refer to individuals of African descent who identify as African American or Black. The term counterstory, counterstories and counter-storytelling are all used interchangeably with the term counternarrative. These terms are used to provide study participants with a voice. These stories or narratives provide a new lens through which to view the dominant held beliefs on the topics discussed within this study.

Background

Historically a male and White endeavor, attending a four year institution, let alone pursuing a degree in a field rooted in science, technology, engineering or mathematics was not often synonymous with women, let alone African American women (National Science Board, 2007). Yet the number of girls graduating high school and entering college continues

to increase, proving that there is still hope to increase the number of women entering STEM fields. This progression is important for the collective impact and increase of women entering STEM careers. However this orientation does not prove true for African American females.

While the number of African American female high school completers enrolling in college has steadily increased, growing from 48 to 69%, they are still less likely to complete full-time degree programs, completing at a rate of only 29% (US Census, 2012). Though the number of girls entering college continues to grow, the number of African American girls graduating is still lower than all other groups. Compared to all girls at 78%, African American girls fell below the national average with a rate of 66% when compared to their White counterparts at 83% (National Science Board, 2007). In addition, while the number of African American females entering undergraduate STEM programs has steadily increased, comparatively the number of African Americans females completing these same programs has not. African American female undergraduate freshman whose intentions are to major in a STEM field are at a rate of 35% compared to 31% of white females, and 34% of females overall (NSF, 2012a; NSF, 2012b). While African American females whose intentions are to major in a STEM field is a rate of 31%, the National Science Foundation (2012a; 2012b) notes that only 28% of bachelor's degrees awarded to African American women, were in STEM fields.

Theoretical Framework

African American women are critical to the pipeline for careers in STEM fields. As such examining theories that guide the understanding of these needs are a dynamic part of the change to ensure that the number of African American women entering STEM careers

continues to grow. Critical Race Theory (Ladson-Billings & Tate, 2006; Tate, 1997) and Black Feminist thought (Collins, 1986; 1997; 2000) serve as channels to understand the STEM messages and experiences of African American women and girls in STEM majors. Applying a critical race lens can provide an understanding of not only the experiences, but additionally provides a greater understanding of the historic and institutional structures in place affecting their persistence.

One false assumption is that the lack of African American women in STEM fields is due to a lack of interest in pursuing careers in these respective fields. Research supports that women of color are just as interested as their White peers in science based majors (Espinosa, 2011; Goldman, 2012; Oakes, 1990). Often overlooked are the institutions structural, social and environmental factors, which contribute to attrition rates from STEM majors. Scholars (Espinosa, 2011; Goldman, 2012; Powell, 1990) note that these institutional leaks are created through practices including large lecture based class sizes, unapproachable faculty, and often experiences of being isolated in group and lab settings. These experiences factored with the adjustment to their predominately White campuses provide additional challenges to the adjustment of African American women.

Critical Race Theory is an opportunity, as asserted by Howard-Hamilton (2003) to use a historic lens as a means of explaining why the experiences of African American women are different from other women and African American men. As victims of double (race and gender) and even triple (race, gender and socio-economic status (SES)) oppressions, African American women continue to experience oppression academically (Howard-Hamilton, 2003; King 1988). Smith (1978) says that “Black women’s existence, experience, and culture and the brutally complex systems of oppression which... [are shaped by] the ‘real word’ of white

and/or male consciousness beneath consideration... [leaving Black women] invisible [and], unknown” (p. 20). Therefore research that applies this approach delivers a unique perspective of the experiences of African American women, serving as tools to end further marginalization while providing a voice to the women it served to silence.

Defining Critical Race Theory

Finding its roots in legal studies, Critical Race Theory (CRT) focuses on the transforming power of race and racism. Pushing forward in the 70s, CRT draws upon critical legal studies (CLS). A paradigm shift from critical legal studies that is rooted in social justice and economic empowerment sought after in the 1960s, CLS and CRT serve as a means of analyzing dominant society. Beginning not just as a social movement, CRT is a movement with an academic purpose (Delgado & Stefancic, 2012). While both aid in analyzing how interest serve those in society with power, CLS does not address the experiences of people of color in the way CRT attempts to (Tate, 1997). As explained by Tate (1997) this caused a departure point for both theories, and while CRT finds its foundation in CLS, this break grew out of a scholarly need to expand the understanding of the effects of the racism and social justice inequalities on people of color. As an analytical framework critical race scholars (Bell, 1991; Crenshaw 1995; Delgado & Stefancic, 2012; Tate 1997) argue that CRT does the following:

1. Recognizes that racism is endemic in U.S. society, deeply ingrained legally, culturally, and even psychologically.

2. Is interdisciplinary in nature, CRT crosses epistemological boundaries. It borrows from several traditions, including liberalism, law and society, feminism, and Black Feminist thought, Marxism, post structuralism, and Black Nationalism.
3. CRT provides a critique of the legal system. It reinterprets civil rights law in light of its limitations, illustrating that laws to remedy racial inequality are often undermined before they can be fully implemented.
4. CRT seeks to reject dominant legal claims of neutrality, objectivity, color-blindness, and meritocracy as camouflages for the self-interest of powerful entities of society.
5. The recognition of the experiential knowledge of people of color and their communities of origin in analyzing law and society.
6. CRT seeks to eliminate racial oppression by drawing a clear line to other forms of oppression.

Although there are six components to CRT, this study uses three components including its interdisciplinary nature, rejecting the dominant ideology, and the need to focus on experiential knowledge. While all tenets are used to highlight nuances that emerged from the study, the counterstories were focused under the tenets: rejecting dominant ideologies and the experiential knowledge of Black people. The remainder of this section focuses on these three tenets.

Interdisciplinary in Nature, While Working to Eliminate Broader Aspects of Racial Oppression

While CRT proposes that race is endemic in nature, it additionally borrows from traditions rooted in liberalism, Marxism, Black Nationalism, feminism, law and society, poststructuralism (Lynn, 1999; Lawrence et al., 1993). As such it is an attempt to incorporate

aspects of other methodologies while maintaining a critical stance. These traditions provided gateways for critical race theorists to move and support their understanding of race and racism as historic and social constructs. From this vantage critical race theorists have been empowered to engage in discourse that brings attention to the current state and challenges facing marginalized people, all while challenging engrained dominant ideologies.

CRT is not only interdisciplinary in nature but serves as a space where race/ethnicity, gender, social class and other forms of oppression intersect and can be explored. Working toward eliminating oppression in the broader context, CRT has expanded beyond the Black/White binary. In this expansion “LatCrit, TribalCrit and AsianCrit are branches of CRT, evidencing Chicana/o, Latina/o, Native American and Asian American communities’ ongoing search for a framework that addresses racism and its accompanying oppressions beyond the Black/White binary” (Yosso, 2005, p. 72). In spite of the Black/White binary still being present, CRT attempts to go beyond these boundaries and draw “both historical and contemporary boundaries” (Yosso, 2005, p. 72) as a means of challenging dominant ideologies. LatCrit, TribalCrit, AsianCrit and even FemCrit serve as a lens to critically look at how the legal systems inhibit groups based on gender, ethnicity, culture, and social status, while providing a discourse and a voice centered historically on the people it intends to serve (Chang, 1993; Crenshaw, 1991; Lopez, 1997; Brayboy, 2005).

One such challenge to this status quo is in understanding the role of intersectionality. Cole (2009) posits that intersectionality requires a paradigm shift in order to fully understand the historic and social meaning associated with groups. Drawing from a Black feminist approach, Crenshaw (1989) demonstrates how people within the same social group, such as African Americans are vulnerable to discrimination as a result of the intersection of gender,

race and class. In her work she reveals the male centered nature of anti-racist politics, the White-centered nature of feminist theory, and the shift towards sex-centered or race centered antiracist system. Crenshaw (1989) posits that this focus on “the most privileged group marginalizes those who are multiply-burdened” (p.140). In another example Carbado and Gulati (2013) use the foundation of Crenshaw’s work to further their claims of the effects of intersectionality. In their critique they analyze similarly several examples in which racial discrimination and sex discrimination claims are examined as separate entities and the failure of this examination to use a necessary intersectionality approach. The core of intersectionality is acknowledging that individuals possess multiple identities, and that these identities (race, gender, class, sexual orientation, etc.) intersect and shape the range of discrimination experienced (Carbado & Gulati, 2013; Crenshaw, 1989).

Experiential Knowledge of People of Color

Freire asserts, “It is absolutely essential that the oppressed participate in the revolutionary process with an increasingly critical awareness of their role as subjects of the transformation” (2000, p. 127). The transformation asserted by Freire can only occur when the stories and perspectives of those who are living these experiences are shared. Storytelling is not only an opportunity to express the experiences and emotions of a lived experience, but is an opportunity to articulate traditions, circumstances and a history that has shaped the oppressed. Coleman and Johnson (2009) explain that by exploring and understanding the challenges that faced those who preceded them, a salient understanding of their area of study can be gained. This same concept can be applied to understanding and therefore countering

future acts of oppression. It is therefore by understanding the roots of oppression, that they can be pulled up and destroyed.

Storytelling has traditionally played an important role in the lives of people of African descent. From this, a similar tradition has taken root in the form of legal storytelling and narrative analysis. As such, where the “rich contextual detail[s] the law excludes...[legal storytelling and narrative analysis] seek[s] to convey the full range and depth of feelings (Lawrence, 1995, p. 343). An example of this necessity is examined by Delgado and Stefancic (2012), in which they provide a scenario of the narrative of American slavery told from a majority viewpoint. In their illustration they provide an over simplified, lacking details, safe account of the history and transition of U.S. slavery. To expand their scenario, they present a counterstory. In this example they present the same story using evidence from historian and legal scholar Derrick Bell. In this example a vivid and detailed account of American slavery, including statistics and other relevant details are presented. The latter is an example of the use of a critical race lens as a counter to the dominant story, which may misrepresent the true experience. Narratives are an essential part of the CRT framework because they are an opportunity for a shared reality to be formed and a place where mindsets are reconstructed (Delgado, 1989).

History has served to silence people of color, but the narrative experience serves to give people of color back their voice. While Delgado (1989) states counterstories “shatter complacency and challenge the status quo” (p. 2414), counterstories are not just for “outgroup”, (e.g. people of color), but are important resources in which “members of the majority race should listen to stories, [these serve to enrich the majority race.] Reality is not fixed, not a given. Rather, we construct it through conversations, through our lives together.”

(p. 2439). As such, counterstories can be used to challenge the majority story or stock story. An example of this challenge is Aguirre's (2000) challenge of the stock story of affirmative action in academia. In his story, he argues that affirmative action can be implemented in a manner where it does not benefit the minority. He explains that the purpose of his story is to draw awareness, urging faculty both minority and majority, who support affirmative action to review the ways in which these programs are implemented in their academic environments. As Delgado states, "Listening to stories make the adjustment to future stories easier; one acquires the ability to see the world through others' eyes" (1989, p. 2439).

Rejecting Dominant Ideology

The final tenet is one that rejects the dominant legalistic claims of neutrality, objectivity, color-blindness, and meritocracy. The American legal system boast that it is one built on equality and justice for all people, yet equality as Iverson (2007) explains, while the foundation of democracy, it can been contested looking back through history. Pettigrew (2004) furthers this sentiment stating, "The hesitant steps forward and the many steps backwards highlight how deeply embedded racism is in the U.S. institution" (p. 521). The constitutions claims of being color-blind perpetuate the ideology of neutrality, and thus by claiming not to see color, create an atmosphere where Whites and even Blacks believe that racism has been eradicated (Bell, 1991). Bonilla-Silva and Dietrich (2011) point out that although it has become a central theme to claim that race is no longer relevant in America, in spite the election of the country's first Black president, America is still quit separate and unequal.

Taking a color blind approach only serves to further perpetuate the endemic system of racism. By not acknowledging the role history plays, it opens the door for history to continue its behavior as a system of oppression (Gontanda, 1991). While some argue that a colorblind approach can prove beneficial when working to help those who may be in need, Delgado and Stefancic (2012) assert that while the former may be admirable, it does not account for the endemic and deeply engrained discourse of racism which has already affected society. As such it is necessary to acknowledge color, as an effort to work against further disenfranchisement.

While neutrality and color-blindness are dominant ideologies, another is the myth of meritocracy. In an attempt to present both sides of the meritocracy argument, Young (1958) explains that historically I.Q. added to effort equals merit. This concept is not a new one, and McNamee and Miller Jr. (2009) suggest that there are four tenets of the American dream which support meritocracy. Presented as who, what, how and why, they suggest that everyone who maintains hope can achieve, and based on the merits of their own actions can achieve the level of success they desire. These tenets assume all things are equitable and do not factor in societal inequality. Tierney (2007) posits that the concept of merit in fact has no meaning and is determined by the institution applying the term. McNamee and Miller Jr. (2009) explore the concept of merit further discussing ways in which merit acts as a means of social mobility. However those proposing meritocracy is a myth, assert that meritocracy is an indicator of racism. Scholars (Bell, 1991; Gotanda, 1991; Lawrence et al. 1993; Peller, 1990) argue that merit alone is not enough to shift minorities out of the entrenchments of the beliefs of White superiority. The problem with meritocracy is its false assumption that all things are equal, and the claim that everyone receives the same opportunities.

Each of these tenets is an attempt to deconstruct the multiple layers of race and racism and their many emergent forms endemic in society. While critical race theory scholars argue multiple theoretical perspectives, their goal is not “to be everything to everyone” (Ladson-Billings & Tate, 2006, p. 26); instead their goal is to draw attention to the large scale structures of racism, drawing attention to its deeply ingrained presence.

Black Feminist Theory

As a means to represent legal, gender, racial and social injustices, scholars have used CRT to explain the social injustices experienced by African American women. However conceptually, Black Feminist thought (BFT) is a link which provides a voice for the unique perspectives of African American women and the “the brutally complex systems” (Smith, 1978, p. 20) in which they exist. These perspectives are critical in understanding how to better serve girls and later women in STEM fields. While Critical Race Theory attempts to understand the social contexts of racism and the power relationships, BFT centers these experiences on the social realities of African American women (Collins, 1986; 1997; 2000). Black Feminist theory authenticates the personal experiences of African American women by empowering the authentication of their voices. Making salient the experiences of African American women through the use of BFT, scholars suggest that African American women have historically existed in the margins of academia (Collins, 1986, 1989; Howard-Hamilton, 2003; Smith 1978). As explained by Collins (1986) this view was often as an “outsider within”, placing African American women as invisible workers alongside the dominant group. Due to African American woman’s positional development as an outsider, a sense of belonging cannot be established, and therefore “there is no place, space or stance provided

for this cohort” (Howard-Hamilton, 2003, p.21). However, using Black Feminist thought, the experiences of the African American woman can be understood.

Studying the experiences of African American women, according to Battle-Baptiste (2011), is the most reliable resource when developing a clear dialogue about their experiences. When the experiences of African American women are viewed through the singular lens of feminism, the connection between African American women and their struggle is lost (Battle-Baptiste, 2011). Black Feminist theory provides a salient way of viewing and understanding the historic context of the African American woman’s experiences. This theoretical lens is specific in its attempt to integrate and validate the realities unique to Black women. Black Feminist thought provides a challenge to the positivist approach of studying social sciences with three key themes emerging as a means to challenging the status quo and providing a voice for women (Collins, 1986, 1989, 1990; Howard-Hamilton, 2003; King, 1988). These three themes include the acknowledgment that both race and gender work together to serve and thus must be centralized through a collective perspective; the acknowledgement of the collective and intersecting nature of the experiences of Black women, recognizing the universal nature of experiences that shape Black experience; and finally the acknowledgement that there are commonalities among Black women and their experiences and because of these commonalities there are many contexts through which Black women’s experiences can be revealed and understood (Collins, 1986, 1990; Howard-Hamilton, 2003; King, 1988).

The first key theme helps position why it is necessary to study African American women through a specialized lens. This first theme acknowledges that both race and gender work together, providing a unique perspective and therefore the experiences produced by

African American women must be centralized through the collective perspective (Collins, 1986, 1990; Howard-Hamilton, 2003; King, 1988). The second key theme acknowledges the collective and intersecting nature of the experiences of Black women, recognizing the universal nature of experiences that shape Black women as a group (Collins, 1986; Howard-Hamilton, 2003). While there are commonalities among Black women and their experiences, the third theme asserts that there are many contexts through which Black women's experiences can be revealed and understood. Using the three themes suggested by Collins (1986) is a starting space for dialogue and a movement towards understanding the experiences of African American women. Through this frame Black women are given a voice to challenge "the political knowledge-validation process that has resulted in externally-defined, [and] stereotypical images of Afro-American womanhood" (Collin, 1986, p. 16).

Applying a Critical Race and Black Feminist Thought Lens

Set forth as a challenge to the positivist approach to research, Black Feminist thought is defined as a means to challenging the status quo, and providing a voice for Black women (Collins, 1986, 1989, 1990; Howard-Hamilton, 2003; King, 1988). Critical Race Theory similarly growing out of the challenge to civil rights, CRT finds its roots in Critical Legal Studies. This break from the early focus on legal issues grew out of a scholarly need to expand the understanding of the effects racism and social justice inequalities have on people of color (Tate, 1997). These two theories offer a supportive lens to view and understand the experiences of women in STEM fields. While the previous sections served to define and frame the role of Critical Race Theory, and Black Feminist thought, the following section will act as a channel for merging CRT and BFT. There are three themes that provide a

theoretical link for both CRT and Black Feminist thought. Each lends its support to understanding the experiences of African American women in STEM fields: voice, the intersectionality of race and gender, and the history by which these experiences are framed, all serve as a guide for my work (See Table 1).

Table 1
Critical race and Black feminist thought tenets and themes with examples of their application to STEM fields.

<i>Critical Race Theory (CRT) Tenets</i>	<i>Examples of Shared Perspectives as Applicable in STEM Fields</i>	<i>Black Feminist thought(BFT) Themes</i>
<p>1. CRT is interdisciplinary in nature and crosses epistemological boundaries. It borrows from several traditions, including liberalism, law and society, feminism, and Black Feminist thought, Marxism, post structuralism, and Black Nationalism.</p> <p>2. CRT provides recognition of the experiential knowledge of people of color and their communities of origin in analyzing law and society.</p>	<p>Example 1: <i>The presence of African American women in STEM fields has steadily increased over the past decade, but this number has not increased in fields traditionally White and male (Malcom & Malcom, 2011a).</i></p> <p>Using a critical race lens this example can be viewed as a means to understanding the historic and social construct of race and racism. This example calls into question the current state of African American women in STEM fields and the historic challenges facing these women. These challenges are interdisciplinary in nature and highlight the intersectionality of race and gender.</p> <p>Example 2: <i>By providing a voice for African American women in STEM fields, as noted by Tate and Frierson (2011), the perpetuation of the incomplete narrative about policy, research needs and possible solutions are stopped.</i></p> <p>Using a Black feminist thought lens provides the recognition that African American women provide a perspective unique to their experience that no one else can provide for them. Similarly this same lens is provided through CRT, using a counterstory to the dominant ideology.</p>	<p>1. Black Feminist thought acknowledges that both race and gender work together to serve a unique perspective and thus the experiences produced by African American women must be centralized through the collective perspective.</p> <p>2. Black Feminist thought acknowledges the collective and intersecting nature of the experiences of Black women, recognizing the universal nature of experiences that shape Black experience.</p> <p>3. Black Feminist thought recognizes commonalities among Black women and their experiences, and that because of these commonalities there are many contexts through which a Black woman's experiences can be revealed and understood (Collins, 1986, 1990; Howard-Hamilton, 2003; King, 1988).</p>

A different role in each theoretical perspective, voice plays a central role in its ability to offer opportunities for unique insights on social inequalities and the experiences of African American women (Collins, 1998; Dixson & Rousseau, 2005). The articulation of these experiences can only be expressed by someone who has lived these experiences. Used as a means to challenge race, gender and other oppressive actions, voice serves as a tool of empowerment (Collin, 1990). In this instance, voice is used as evidence to support the impact of legally supported racism on the lives of people of color (DeCuir & Dixson, 2004). Voice is “the assertion and acknowledgment of the importance of the personal and community experiences of people of color as sources of knowledge” (Dixson & Rousseau, 2006, p.35). The knowledge gained from the experiences of people of color is used to create necessary counterstories. Counterstories shift often incorrect assumptions maintained in dominant discourse, while placing people of color at the center of scholarship. Black Feminist thought uses voice by allowing Black women to make meaning of their lives, transforming their experiences of domination and oppression, into a means of empowerment by giving voice to those who were silenced.

The use of voice places African American women in a position of power in their STEM fields, giving each woman the opportunity to explain how their lives have been affected. This theoretical lens attempts to integrate while confirming the realities distinct to Black women. Maton and Hrabowski (2004) take this position in their research exploring the successful completion of African American women in STEM PhD programs. Rather than focusing on the alarming disparities behind the low numbers of women in this program, their research takes a strength-based approach at how Black women succeed in graduate school. This departure from the stock story is an example of capturing back the African American

woman's voice. As noted by Tate and Frierson (2011) using the narrative is a way of addressing human capital challenges. In this example voice is used to draw power into a space where historically it has not existed.

The link between African American women and power is highlighted in both critical race and Black Feminist thought literature. Collins' (1998) explains that women were treated as property and producers of property, which later translated into citizenship. But the emancipation of African American women did not fully transfer over to the intangible benefits offered in American society (Collins, 1998; Delgado & Stefancic, 2012; Lynn & Parker, 2006). One clear example of this benefits transfer failure is in academia. The effects of which can be felt throughout institutions that support STEM majors. According to Malcom and Malcom (2011a), African American women are reflecting and defying tradition. While the presence of African American women in STEM fields has increased, this number has not increased in fields traditionally White and male. Through a critical race lens this instance can be viewed as situated within the argument of interest convergence. When viewed through this tenet it can be explained that the presence of African American women increased in the area of STEM because in some ways it supports the interest of Whites (Bell, 1979). Such an example would further explain Malcom and Malcom's (2011a) argument that African American women are reflecting tradition, providing support for why all areas of STEM fields did not see similar growth.

Seeking to understand law and society through its lens of oppression, a critical race analysis when applied with Black Feminist thought provides a salience to the historic double oppression experienced by African American women in STEM majors. Lynn (1999) suggests that CRT can be used in analyzing the ability of institutions, such as predominately White

institutions to produce desired outcomes for African Americans in American society. At the core of its vision are issues of race, gender and social class, all of which intersect providing the perfect marriage of CRT and Black Feminist thought. Crenshaw (1989; 1991) described the African American women's experience as an intersection because of the way it pushes beyond the boundaries of Black-male and White-female points of oppression. Arguing that the Black women's experience is multidimensional, Crenshaw (1989) uses several court cases where Black women's arguments are viewed and then tried as separate issues of gender and race. This dissection contributes to their marginalization, proving that intersectionality is a mainstay for African American women.

Malcom and Malcom (2011b) explain, "in order to understand the true nature of the obstacles faced by minority women in STEM, we need data disaggregated by race and by sex..." (p. 169). Such disaggregation is a movement away from the feminist thought of a common oppression shared by all women, and gives greater emphasis to the experiences of African American women. Crenshaw (1989) purports that the experiences of African American women are "greater than the sum of racism and sexism, [and] any analysis that does not take intersectionality into account cannot sufficiently address the particular manner in which Black women are subordinated" (p.140). Intersectionality is a significant frame through which to examine African American women in STEM fields. While a feminist approach focuses on concerns that speak to issues of gender, BFT shifts the focus to include experiences that are situated within a racial scope. Similarly applying a critical race lens provides the context of understanding what Collins (1986) calls the "outsider within" view, a view that places African American women as invisible workers alongside the dominant group. This new lens shifts African American women from a place of invisibility and places

them within a proper context, one that creates an understanding of the systems that created their invisibility.

CHAPTER II: LITERATURE REVIEW

As a leader in the production of top scientist and engineers, the United States growth over the past fifty years can directly be attributed to the growing science, technology, engineering and mathematics (STEM) fields (U.S. Department of Commerce, 2012). The industrialization of new products through new technology and inventions has generated the need for educated workers. These STEM fields place a higher demand on the need for workers trained in and ready for future innovation (U.S. Department of Commerce, 2012). The need for workers with STEM skills has become heightened in today's global economy. In order for the U.S. to remain competitive in this growing global economy, the diversity of the workforce too must continue to change. With growing proportions of this workforce being supplied from this diverse pool, it is critical that the number of women and minorities rapidly increase (Oakes, 1990; NSB, 2007).

While the number of women, minorities, and disabled individuals are underrepresented, this number is greatly disproportionate for Blacks. Comprising 12.2 % of the general population, Blacks account for only 5% of all employed scientist and engineers while Black women account for 2 of this 5% (NSF, 2013b). Increasing the number of Black women entering STEM fields can enhance the creativity and insight of research projects, while increasing the chance for true innovation. The purpose of this chapter is to present evidence supporting the importance and the increased need for Black women in STEM fields. In presenting this evidence, this chapter begins by examining the culture of science. In this examination, the history of women and minorities in STEM is framed from a historic perspective. This historic perspective frames the discussion of Black women in STEM and their transition from high school to college, higher education and later into their careers. In

support of this discussion, evidence of the academic and social impacts and the ways in which institutional characteristics, support systems, and peer relationships directly interrelate with Black women's level of success is presented. Finally, this chapter concludes with a discussion of the argument for a concentrated effort and increased expansion of the STEM pool by increasing the number of Black women in STEM fields.

Identifying the Problem

The Culture of STEM

Considered male-dominated fields, historically STEM has been portrayed as a masculine endeavor (Tang, 2006). This representation within the United States has served as the frame for how people determine who should pursue these fields. While women have had a substantial impact on the field of science, the recognition of this merit until most recently been reserved for males. For example, women receive little to no credit for their development of the science related fields of midwifery, nursing and home economics (Myers, 2002). Situated within the debate on intellectual ability and their role and responsibilities as wives and mothers, women historically have faced the challenge of gaining access to education (Wyer et al., 2001). One argument centers on the development of STEM as a male dominated field of study. The platform of this debate is that STEM has maintained its recognition as a male dominated field for so long because of the lack of talent when compared to women (Valian, 2007). This lack of talent can be directly linked to women having limited access to STEM majors, which results in limited proficiencies in STEM disciplines. Although the heart of the debate has been disproven, the absence of women serves to only perpetuate what Sindermann (1987) calls "total erroneous perceptions of females in science" (p.82). These

flawed perceptions are the result of the low number of women in positions to provide an alternate perspective to what information is being provided. Wyer et al. (2001) explains that it was believed that by educating women the balance of “white female fertility and education racial superiority” (pp. 1) would be thrown off balance.

Many women have been met with resistance to their participation in science regardless of how qualified they were (Charleston et al., 2014; Pinder & Blackwell, 2014; Russell & Russell, 2015; Warren, 2016; Wyer, 2001). Some women, those of high socio-economic status and those who came from a history of male scientists, were able to gain access; however as Myers’ (2002) notes, African American women were not afforded these same opportunities. But the absence of women and particularly women of color in STEM fields translate beyond low representation. This shift moves into the critical aspect of those who are in the field making the decisions about the direction the field and innovation will move.

In examining the shift that takes place in science, scholars (Wyer et al. 2001) explain, “at any given time a particular scientific community will have a prevailing paradigm that shapes and directs research in a field of science” (p. xxi). Therefore if African American women and women in general are absent from the community that is shaping and directing the field, decisions about the direction of these fields will be made that directly affect them, or worse no decisions will be made at all. The presence of these diverse voices adds perspective to the direction of the STEM community, particularly on issues affecting women, women of color and African American women. By adding these diverse voices to the community’s discussion, a broader range of solutions is presented on how strengthening the research and driving the community forward is needed (Espinosa, 2011). Diversity is not

only a benefit to society, but within STEM fields it is an asset, making organization and businesses more effective. Page (2007) argues that different people are equipped with diverse cognitive tools and that such diversity outweighs ability, providing a different lens to view problems through. These abilities bring a variety of perspectives, driving the economy because of the range of knowledge being brought to the table. These various perspectives are important because of their ability to shape and ultimately direct changes in STEM fields. Homogenous groups of people offer a linear and often one dimensional perspective.

There are conflicting views to the argument that diversity serves as an asset. While Page (2007) purports that diverse groups solve problems more effectively than homogenous ones, the Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce (2010) sites examples that refute this argument. They postulate that diversity is a source of conflict, creating barriers to economic growth rather than facilitating progress. One example of diversity creating a possible conflict is suggested by Bove and Elia (2017), who explain that conflict may arise over coordinating everything from cultural issues to language barriers. Bove and Elia (2017) explain that in some cases diversity facilitates language barriers, which in turn create mistrust because of inefficient means of communication. Countering the latter argument, Kochan et al. (2003) explain that racial diversity can have a positive effect on a company's overall performance. When diversity is found across an organization and is used as a resource for innovation it can have a positive effect. These same instances can be applied as further support for the need of additional African American women in STEM fields. Increasing the number of African American women can have an effect on both minorities and majority students in terms of their attitudes towards racial issues and learning how to work in a diverse setting. It is

maintained that students who were engaged in greater diversity in a classroom setting displayed greater cognitive skills, which translates to greater academic outcomes (Committee on the Underrepresentation, 2010).

Black Women in STEM

Women traveling on the road pursuing a STEM path have throughout history been met with challenges. Not until after the Civil War was it common practice in the United States for White women to be educated (Myers, 2002). Even with this paradigm shift, education maintained a position of exclusivity open to upper class Whites, generally isolated in the Northern and Northeastern parts of the United States. The educational opportunities afforded to White women historically were not afforded to most African Americans. Such inequalities directly translate into little to no opportunities afforded for African American women, particularly those situated in the south and rural areas. While these historic gaps in education attainment have been lessened and African American women have access, and are participating at various levels of education, the residue of these once limited opportunities can still be witnessed.

As discussions in science continue to evolve and grow, these discussions focus on women as a collective and fail to acknowledge the variation within this group (Hanson, 2004). As explained by Hanson (2004) shared discussions have left the field with little research on minority women in STEM, which in turn creates more questions with no answers. More than ever Black women find themselves at the intersection of their race and gender, facing a double oppression (Howard-Hamilton, 2003). As described, “Black women’s existence, experience...culture and the brutally complex systems of oppression,

[which are shaped by] the ‘real word’ of white and/or male consciousness” leaving African American women invisible and unknown beneath consideration (Smith, 1978, p. 20). Such failure to provide a voice for the perspectives that African American women give, only serves as a tool to further silence and push African American women off the pages of history. These perspectives are critical in understanding how to better serve girls and future women in STEM fields.

The Need to Disaggregate

The experiences of Black women historically have been pushed further to the margins in order to provide a greater perspective to the experiences of all women. Equally, when many of the experiences of Black women in STEM fields are discussed, they are debated under the window of their role as women of color (Carolone & Johnson, 2007; Espinosa, 2011; Johnson, 2012; Malcolm & Malcolm, 2011; Ong et al., 2011). This discussion situates all experiences under one voice, focused on the common oppression (hooks, 2000) that all women of color may experience because of the intersection of their race and gender (Crenshaw, 1995). Teranishi, Maramba and Ta (2013) assert that it is necessary to disaggregate all women of color in order to add proper perspective to their experiences. While these experiences may seem common because of their oppressive nature, a failure to disaggregate silences potential insight that may serve to assist with the development of interventions and other means of persistence not just for Black women, but for all women of color.

An example of this need to disaggregate the experiences of African American women from other women of color is supported by the work of Teranishi, Maramba and Ta (2013).

In their study they note that the experiences of Asian women gaining access to postsecondary institutions will vary among ethnic groups within the catch-all phrase of Asian women. This often perpetuates false information about degree attainment among Asian students. By providing distinct disaggregation, the barriers faced by African American and other women of color can be placed in their proper context. In a field that is overwhelmed by males, the barriers faced by men will be vastly different from those faced by women. Malcolm and Malcom (2011) assert, “in order to understand the true nature of the obstacles faced by minority women in STEM, we need data disaggregated by race and by sex as well by and institutional type” (p. 169). Such disaggregation has direct implications for often times data driven policy change.

Disaggregation provides an opportunity to clarify and make salient the ways in which STEM fields still need to grow. According the National Research Council (2006), Asian American women represent the largest group of women of color among STEM fields, at 14.47% of the total 43.2% of Asian Americans in STEM fields. Without disaggregation one might assume that out of the 43.2% that African American women may represent the majority, thus disaggregation provides a clear lens to view and understand areas for needed growth and development. While women of color, in particular African American women have grown in their representation within STEM fields, without proper context, the understanding of these numbers can be misleading and deceptive. The challenges for African American women in STEM fields deal less with opportunities to enter STEM fields, and more with the condition and support present once the field has been entered (Malcolm & Malcolm, 2011). Experiences as previously noted may differ from other women of color and present their own particular set of challenges. These experiences among African American

women consist of an array of barriers including both internal and external environments consisting of everything from the absence of STEM role models for African American women to the pedagogical structure of the courses. Proper disaggregation among the experiences of women of color would provide a salient understanding to the needs of women in particular African American women.

The need for disaggregation extends far beyond women of color, but also extends to African American men and women. Such generalization impacts the implementation of resources among men and women. In a study on the STEM experiences of African American boys and girls, girls were stirred away from STEM majors at a higher rate than African American boys (Hanson, 2004). This does not negate the need for additional research on African American males in STEM, but supports the importance understanding the different challenges facing both genders. Without such disaggregation the assumption is made that African American men and women share the same experiences, thus their needs can be met in the same ways.

Transition from High School to College

While disaggregation is a critical step to ensuring the experiences of all women are understood, particularly African American women, a lens needs to be placed on their transition from high school to college. Although a global leader, the number of adolescent females graduating high school and entering postsecondary schooling continues to rise (National Science Board, 2007). While some argue that although a global leader, when it comes to its K-12 STEM education, the U.S. is lagging behind in the quality and quantity of its production of prepared students, particularly Black men and women (U.S. Census Bureau,

2012). This lag translates into the number of women scientists being produced by undergraduate institutions. In order to remain competitive, the U.S. has to step up to the challenge to invest in “*all Americans*” (Ong et al. 2011) and build an infrastructure that academically supports more women of color in STEM fields (Griffith, 2010; Oakes, 1990; Ong et al., 2011). One false assumption is that the lack of Black women in STEM fields is due to a lack of interest in pursuing science majors. Research supports that Black women are just as interested as their White peers in science based majors (Espinosa, 2011; Goldman, 2012; Hanson, 2004, Oakes, 1990). While women of color continue to outperform their male counterparts in mathematics and science at an undergraduate level, the number of Black women obtaining bachelor degree’s still trail behind that of other underrepresented males (Grandy, 1998).

The transition for all women, especially Black women, from the secondary level to the university level is often described as a “leaky pipeline” when examining the participation of women in STEM majors (Blickenstaff, 2005). These leaks often occur in science and mathematics classrooms, long before women enter their collegiate experiences, and are further perpetuated with the lack of women and other Black mentors. Additional factors contributing to the leak of Black women from the STEM pipeline begin well before they enter their institutions of higher learning. These influences can be divided into several clear categories including teacher influence, pre-college summer programs, secondary curriculum and college choice selection. While this is not an exhaustive list of all the factors influencing STEM major selection in the transition from high school to college, it is an accurate depiction of factors affecting African American women major in STEM fields.

Teacher Influence. The student-teacher relationship is a well-known factor influencing the persistence and transition of African American students in their K-12 experiences and beyond (Baker, 1998; 2006; Conner et. al, 2014; Duchesne et. al, 2009; Silver et. al, 2005; 2010). Acting as a channel, students' relationships with teachers cut across social, cultural, financial and economic capital according to Freeman (1997). Teachers play a significant role, providing not only encouragement, academic rigor and support, but setting high expectations (Ladson-Billings, 1994). While researcher asserts that teachers play a significant role, Fordham (1993) offers a counter to this argument, suggesting that because of such channeling African American females when compared to their white counterparts may receive less attention and lower expectations from teachers. In such cases African American females do not benefit from the student-teacher relationship. However such disparities in experiences do not negate the impact that teachers can have on student achievement. In a study conducted by Freeman (1997) of African American students in the 10th, 11th and 12th grade, students noted that teachers played a significant role in their achievement level. Students noted that teachers impacted them not only academically, but in their cultural identify development.

Pre-College Summer Programs. Teacher influence transcends beyond the classroom and is connected to many of the summer enrichment programs in which students participate. Pre-college programs that focus on building science and mathematics skills have been proven to have a direct correlation to program participant's beliefs in their abilities. Stake and Mares (2001) concluded in their study of the impact of two science enrichment programs on science attitudes among gifted high school students that girls reported more gains, showing that the program had a positive impact on the girls who participated. Additionally it is noted that pre-

college programs can have an important impact by exposing girls to gender issues in science, therefore empowering them in their own abilities before entering the often male dominated STEM post-secondary classrooms (Stakes & Mares, 2001). Finally pre-college programs offer information about preparing for college while developing skills students can later utilize at their post-secondary institutions. Research has demonstrated that students who are exposed to early pre-college STEM programs have a greater chance of later majoring in a STEM related field (Markowitz, 2004; Stakes & Mares, 2001). In a longitudinal study on the impact of a university high school summer science program, students who indicated that the program influenced them to pursue a career in science were more likely to major in a science major (Markowitz, 2004). While the program may not be the sole reason for the students selection of a science major, it's contributions cannot be overlooked.

Notably these programs have a significant impact on college choice and preparedness. Tsui (2007) provides additional support in her research on effective strategies to increase diversity in STEM fields, suggesting that although the types of pre-college summer programs and transitional STEM programs may vary, overall they have been proven to significantly reduce the attrition rate from freshman year to sophomore year among students of color. These transitional programs generally provide rigor and preparation for academic experiences in STEM fields, narrowing gaps advanced placement (AP) courses create at the high school level (Tsui, 2007). Finally Swail (2002) reviewed major programs that sought to increase college access among economically disadvantaged and at-risk students and found that there were several common themes among these pre-college programs. An important common theme was each programs focus on college attendance and awareness. Additionally Swail (2002) noted that the success of many of these programs rest in, not just providing a

service, but providing a quality service. In her review of the effects of summer bridge programs and their effects on pre-college STEM majors, Raines (2012) reports that college bridge programs serve as tools of enhancement for academic success. In the case of pre-college programs, students are given the tools ahead of time that they will need to transition into majoring in their STEM majors. Raines (2012) additionally provides evidence for increased academic performance for students in both mathematics and science classes.

Secondary Curriculum. Academic programs are not the only major influence in student transitions. Curriculum at the secondary level, particularly in mathematics and science classes, play an essential role in the success of Black women at the undergraduate level. Women's interest in high-level mathematics has steadily grown (NRC, 2006), and these higher level and advanced courses serve as preparation tools for academic rigor and confidence. The completion of rigorous mathematics and science courses has a direct influence on postsecondary STEM entry (Huang, et al., 2000), as well as persistence beyond freshman year. Thus in order to prevent the leaky pipeline mentioned previously, African American females must not only be encouraged, but must be empowered to take academically rigor STEM courses at the secondary level. Many African Americans depend on counselors to direct their academic selection and have not been given the tools to advocate for themselves. Students who are the most likely to need the additional guidance are the least likely to have access to curricula and higher education information (Freeman, 1997). While those who are equipped with the necessary tools find themselves placed in the situations, as noted by Fordham (1993), of having to choose the image they will portray culturally, often having to play a character in order to fit in.

Curriculum selection is also directly influenced by student grade achievement. Used as a predictive factor, students are identified and tracked often according to their mathematics and science course grades. Participation on an academic track is generally an indicator of continued achievement and later aspiration for participation in higher education. In a national sample of African American women, it was shown that they outperformed their male counterparts in college level science courses (Grandy, 1998). This level of performance was attributed to their commitment and focus on mathematics and science. Examples of successful experiences among African American girls have further been witnessed in specialized pre-college programs whose focus is on strengthening student's confidence and ability. In one such example Buck et al. (2014) describe their study where they spend a year and half working with adolescent African American girls fostering their self-efficacy in science education. As a result they saw a significant increase in the self-efficacy of the participating girls. This not only provided the girls with a voice, but also additionally became a guide for the development of subsequent attitudes and skills. Additionally their intentionality exposed girls to science labs, that in turn resulted in an increase in the girls' abilities to explore their own questions about science through problem based learning. This example of a successful prior to college experience allows for congruence between home and school (Buck et al., 2014) that translates into later success in STEM based majors. Ellington and Frederick (2010) note in their study of eight Black high-achieving college junior and senior mathematics majors that elementary and secondary institutions played a significant role in students' success and persistence in mathematics. Students who were placed in accelerated, honors and other gifted programs by the end of their third grade school years had access to support systems which Ellington and Frederick (2010) note came in the form of

caring teachers and a quality learning experience not generally provided to Black students. This support, as described by participants helped them develop a “love” of mathematics. Such “love” is directly correlated with the later selection and persistence of African American females in STEM related majors.

College Choice. While Black women have, and continue to make advances in selecting STEM majors, they still remain underrepresented in the number of degrees conferred. Black women are less likely than their male and non-minority counterparts to persist in the STEM field majors (National Science Foundation, 2013a). If college students are the essential link to new innovation and furthering the scientific community, in order for the U.S. to remain competitive in the global market, the issue of the leaky pipeline of Black women must be directly addressed. The decision for an African American woman to major in a STEM field begins well before she enters her institution of higher learning. For example the opportunities for girls and minorities are far less than their white male counterparts, therefore effecting interest and participation (Oakes 1990). Supporting this assertion are Goldman’s (2012) findings that attempt to explain the gender gaps in STEM fields. Broken into three categories, biological explanations, social and structural explanations, and psychological explanations, Goldman (2012) uses these categories to debunk earlier myths about why women are not selecting STEM fields. Such myths included that women were not intelligent enough to maintain success in STEM fields, and therefore should pursue majors more suitable for women. Additional factors addressed included the lack of role models for women, the lack of adequate academic preparation and discouraging environmental factors. Myths will continue to be perpetuated if additional research is not conducted and the experiences of Black women shared.

According to the National Science Board (2010), addressing the pipeline leaks has greater implications. They share how in recent years, the US has become dependent on STEM talent internationally, rather than fixing and expanding its own domestic talent. Such neglect of domestic talent serves to further marginalize African American women in STEM fields. By not addressing the needs of African American women the issues directly affecting them will continue to be perpetuated. A seminal attempt to address the invisibility of African American women in STEM fields, Malcolm, Hall, and Brown's (1976) *The Double Bind* discusses the intersection of racial and gender discrimination experiences faced by women of color in scientific fields. This early discussion sheds light not only on the absence of women in scientific careers, but points to issues of bias. Their discussion points out the overlapping relationship of race and gender, framing the need to study both (hooks, 2000).

In an attempt to address the leak prior to African American women's collegiate experience reviewing what is influencing their college choice may serve as an important factor. Academic tracking as noted previously not only influences their college choice selection, but parents additionally play a significant role. While literature does not serve to answer all of the questions about parent influence, it does serve to delineate the ways in which parents shape college choice (Smith and Fleming, 2006). Smith and Fleming (2006) explain that parental involvement influences the kind of post-high school trajectories students select, with mothers having a significant influence among African American students. While Smith and Fleming (2006) argue that there is not a model that accurately charts parental involvement on the influence of college choice, the seminal work of Hossler et. al (1989) provide characteristics to assist in understanding the influence of parent involvement on college choice. In an attempt to further this discussion of college of choice among Black

female students, Smith (2008) provides a definition of parental involvement in college choice as a collection of interconnected activities both school based and at home based through which parents work with their child to create an educational trajectory. Thus parent involvement is a series of interconnected activities that contribute to their child's success.

African American females continue to persist from high school to college; however institutional characteristics can act as barriers to their selection and completion of STEM related majors. The previous section addressed the influence of teachers, curriculum, summer enrichment programs and parental involvement on the selection of STEM based majors; however following the selection of these majors, institutional characteristics plays just as equal of a role in students persistence within these majors. Thus, the attempt to address the leaky pipeline cannot be addressed without looking at the influence of institutional characteristics.

Institutional Characteristics

Following their transition from high school to institutions of high learning, often overlooked are the institutions structural and social environmental factors and the roles these characteristics play in shaping the overall experiences of African American women in STEM majors. Such structural and social aspects contribute to attrition rates for African American women from STEM majors creating leaky pipelines based on practices associated with institutional characteristics (Espinosa, 2011; Goldman, 2012). Institutional characteristics additionally will diverge based on the institution type, with experiences varying among these institution types. These contributions coupled with encounters of racism and sexism, influence African American women's identity and personal agency, shaping their career

pursuits. One clear divergence worth noting is that among the STEM experiences of African American woman at historically Black colleges and universities (HBCUs) and predominately White institutions (PWIs).

HBCU Characteristics

Bolstering that 17 of the 20 top producers of African American women holding STEM bachelor's degrees come from HBCUs (Borden & Brown, 2004), Gasman and Nguyen (2014) expressed in their research that there were four themes that contributed to such success in their HBCU experience. These four characteristics are situated under two broad constructs, *Environment* and *Support* and include the following: *Celebrating Success in STEM, Peer Mentoring Peers, Undergraduate Research, and Same Gender and Race Faculty Role Models*. Gasman and Nguyen (2014) assert that these themes not only encompass sound policies and practices but motivate and enhance the overall learning environment. The following section uses the construct of environment and support to discuss the foundation for the types of characteristics found at HBCUs that support persistence among African American women in STEM majors.

Environments. Campus environments are important factors in Black student success, whether attending HBCUs or PWIs. Researchers note that HBCUs play a particularly unique role in their ability to foster campus environments that support persistence among African American women in STEM majors (Allen, 1992; Gasman & Nguyen, 2014; Jackson, 2013). The National Science Foundation (2013) reported that in 2010 HBCUs produced 15.8% of all science and engineering bachelor's degrees awarded to African American women. In her exploration of the experiences of African American women transferring from a community

college to the HBCU environment Jackson (2013) notes that HBCUs are pivotal in their ability to help students gain what she called STEM and career capital. It is through this capital that students were able to gain and apply their new-found knowledge on pursuing future STEM based careers. Jackson (2013) showed that participants in her study gained their capital through socialization, which in turn is correlated to the campus environment. Gasman and Nguyen (2014) assert that by celebrating success in STEM, HBCUs promote a level of retention through a cultivation of student belief in their ability. While it is noted throughout literature that African American students may enter their undergraduate experiences with deficiencies in skills necessary to compete in their mathematics and science courses, research also notes that faculty and staff have worked to provide additional resources and support to bridge gaps in performance (Gasman & Nguyen, 2014; Perna et al., 2009).

Support. Peer and mentoring support was additionally found to be another essential factor to STEM success at HBCUs. This is not to say that other university types do not foster peer or mentor support; however it was found that HBCU environment promoted a collective support system rather than an environment where students were competing against each other (Gasman & Nguyen, 2014, Perna et al., 2009). This was found to be particularly beneficial for African American women, although some argue that this benefit is consistent at HBCU institutions that cater specifically to women (Lundy-Wagner & Gasman, 2011). While this may in some cases prove true, what cannot be eclipsed is the role peer and mentoring support plays in student success. While mentorship can come in the form of a peer relationship, often mentors are played by faculty who are critical not only inside the classroom, but outside the classroom, providing advice and knowledge to students on ways to navigate towards success in STEM. Mentors act as experts in their fields, and in many cases can provide a firsthand

account of the challenges students may face in STEM and beyond (Gasman et al., 2016; Gasman & Nguyen, 2014). Students additionally through these mentorship opportunities were encouraged and influenced to pursue additional opportunities that would provide them with a well-rounded academic experience. Undergraduate research opportunities in STEM fields at any institution provide students with invaluable skills and networking opportunities. As such, students were encouraged to pursue research opportunities, providing them with a consistent means of experiential learning (Gasman & Nguyen, 2014).

One characteristic consistent at HBCUs is the diversity among STEM faculty, and the number of Black professors in comparison to predominately White institutions. Often misleading is the notion that institutions that are historically Black will too often boast of a majority Black faculty. African Americans represent less than 5% of full-time faculty across both HBCUs and PWIs (NCES, 2010). This statistic is even further divided when looking at the number of Black females. Racial, ethnic and gender diversity are important to providing students with a counternarrative to the dominant discourse of the lack of diversity in STEM fields.

Identity Development at Predominately White Institutions

College brings both a time of excitement and potential challenges. While students entering a HBCU and PWI will have similar experiences and challenges common to the transition into higher education, students entering a HBCU may find themselves facing a different set of challenges at a PWI. Chavous et al. (2004) suggest that a college campuses racial make-up can have a significant impact on students' academic experiences. During these transitions to predominately White academic settings, students are faced with racial

stereotypes and discrimination. Black students are made aware of the White campus culture that they are now a part of, placing students in a position to examine their identity (Feagin & Sikes, 1995). For Black women this examination aligns with Black feminist literature's argument that the only way in which they can be successful at this academic level is to give up their Black identity. The message being perpetuated is that the only way for African American women to succeed in academia is to assimilate to the dominant White male environment.

The intersection of being an African American and a woman majoring in STEM is intricate enough, without the added complexities and challenges of campus climate and culture at predominately White institutions. For African American students at PWIs, race and ethnicity has been shown to be associated with one's sense of belonging, especially within the context of the institutional or campus climate (Johnson et al., 2007). Grappling with their sense of belonging African American women are often challenged with the intricacies of defining who they are amidst their campus culture. Historically an "outsider within", Collins, (1990) posits that African American women are invisible workers and because of this placement outside dominant society, it is difficult to develop a sense of belonging. Howard-Hamilton (2003) explains, "there is no place, space or stance provided for this cohort" (p. 21). A complex part of human development Leve (2011) says:

Identity is a powerful organizing presence in social life today—a social fact, or so it would, at least, seem. Whether measured by the amount of energy individuals expend claiming, cultivating, expressing, or bemoaning the lack of it or by the amount of attention devoted to it by institutions that profess to address or are said to reflect popular interests and issues, it is clear that being, in the sense of belonging—to

ethnic, national, religious, racial, indigenous, sexual, or any of a range of otherwise affectively charged, socially recognizable corporate groups—is among the most compelling of contemporary concerns (p. 513).

When studying African Americans it has been noted repeatedly by scholars (Arbuthnot, 2012; Harvey, Blue & Tennial, 2012; Parham, Ajamu & White, 2011) that the construct of racial identity is critical in understanding African American experiences. A complex part of human development is the fundamental question of “Who am I”? Defined in multiple ways from simple to complex, beginning to answer this question is not a simple feat. In an effort to define identity, it has taken many shapes, including one rooted in and defined by society (Appiah, 2005). However it is Leve’s (2011) definition that captures how identity can shift from an individualistic identity and transform into a group centered definition:

Identity is a powerful organizing presence in social life today—a social fact, or so it would, at least, seem. Whether measured by the amount of energy individuals expend claiming, cultivating, expressing, or bemoaning the lack of it or by the amount of attention devoted to it by institutions that profess to address or are said to reflect popular interests and issues, it is clear that being, in the sense of belonging—to ethnic, national, religious, racial, indigenous, sexual, or any of a range of otherwise affectively charged, socially recognizable corporate groups—is among the most compelling of contemporary concerns (p. 513).

Erickson (1986) notes that identity formation begins at birth, peaks during adolescence and continues throughout adulthood; as such multiple theories have emerged over time specifically studying African American racial identity. At the forefront of these theories, scholars (Cokley & Chapman, 2009; Parham, 2008; Parham et al., 2011; Sellers et

al., 1998) contend there is a double consciousness. A term first appearing in DuBois's (1903), *Souls of Black Folk*, a double consciousness is the term used to refer to the dualism of being both of African descent and American, while balancing the complexities of being Black in a White America.

Predominately White institutions face the challenge of providing African American women with environments that support healthy racial identity development. Failure to do so can leave students feeling isolated, acting as a catalyst for early departures from STEM fields. Blickenstaff (2005) notes nine major reasons why women leave STEM fields:

1. Biological differences between men and women.
2. Girls' lack of academic preparation for a science major/career.
3. Girls' poor attitude toward science and lack of positive experiences with science in childhood.
4. The absence of female scientists/engineers as role models.
5. Science curricula are irrelevant to many girls.
6. The pedagogy of science classes favors male students.
7. A 'chilly climate' exists for girls/women in science classes.
8. Cultural pressure on girls/women to conform to traditional gender roles
9. An inherent masculine worldview in scientific epistemology (p.p. 371 - 372).

The Classroom Experience. While Blickenstaff's (2005) list is not an exhaustive one, and does not maintain that all reasons apply to all women, it does closely align with current literature on the experiences of African American women and their reported experiences. Missing from this list is the competitive nature of STEM classrooms. In a first year study of

underrepresented minority students, Hurtado et al. (2007) found that a highly competitive environment made it difficult for students of color to transition into their first year of study. Some argue that this environment is necessary and often is used as a “weed out” process for students in difficult STEM courses. This competition can prove to be a tense and intimidating environment for women who often respond to environments where cooperative, group settings are supported (Seymour & Hewitt, 1997).

Healy (1997) provides historic insight into the successful experiences of African American women in cooperative settings, explaining that Black women throughout history have been placed in group-oriented settings, re-appropriating what may have been meant as a means of divisive control towards the development of skills and support of one another. Through these settings Black women learned to network and build interpersonal bonds. However such historically developed cultural skills, such as providing emotional support, aid and companionship are not considered transferable assets in current academic settings. Many undergraduate classes are described as being held in large lecture halls, but the structure of the classes often do not support cooperative learning and student engagement beyond, memorization, facts and theory (Baldwin, 2009). Settings such as these do not offer an opportunity for women to utilize the historically once transferable skills of emotional support and companionship, all which previously served as tool of collective strength and survival (Healy, 1997). These learning communities are not supportive of culturally relevant pedagogy; a term coined by scholar Ladson-Billings (1995). Through culturally relevant pedagogy, the focus shifts towards the development of students using cultural competence to assist them in experiencing academic success. It is in taking a culturally relevant approach that Freeman et al. (2008) through their study of students in STEM majors, found students

who participated in learning communities at their institutions were more likely to persist in their STEM majors. This persistence was due in part to the student's level of engagement, which promoted the retention of African American students.

Critical to the classroom environment is the individual creating the classroom environment. A broad body of literature mentions evidence of stereotype threat as an example of something working against students of color in science (Hanson, 2009). Spencer, Steele and Quinn (1999) explain "that being in the same classes does not mean that boys and girls have the same environment" (pp. 24). Therefore as a Black woman, receiving negative messages about other Black women in STEM fields may dissuade them from continuing their pursuit. These messages may be propagated by faculty or even peers; however either way there is a clear effect. These beliefs extend beyond a single incident, becoming engrained in the beliefs that students themselves hold about the use of mathematics for men and women. Oakes (1990) provides evidence that students believed that males would have greater use for mathematics and science than females. These beliefs while false are not uncommon. According to Morse (1995), "Science has historically been the domain of men. Men have largely determined what gets studied, which technologies are developed, and how science dollars are spent" (pp.1).

Experiences in the classroom among African American women can create the belief that they need to cover up or conform to maintain appearance or acceptance in their environments. McGee and Martin (2011) provide several vignettes in their discussion of the ways in which African American students manage stereotypes in their STEM undergraduate majors. These examples include students' avoidance of certain outfits that may come across as threatening, to situating oneself to avoid being asked if they are in the correct room of a

higher level mathematics class, as well as carrying the class textbook on the outside of a book bag. These tactics were used as coping tools to circumvent racialized beliefs dominant in the majority White environment (McGee & Martin, 2011). Although these experiences can have a visible, lasting negative and emotional effect on student's sense of belonging, students used them as coping mechanism to assist them in persisting in spite of their experiences.

The Faculty and Peer Engagement. While the classroom and campus environments are only a small percentage of a student's undergraduate experience, significant for transition is the faculty and peer interactions. Feagin and Sikes (1995) explain that professors can be academic obstacles to success for Black students on White college and university campuses. Hanson (2009) explains that "teachers have a tremendous impact on the career choice of young people and thus can be seen as part of the problem and the solution" (pp. 49) in attempts to increase the number of African American women in STEM fields. Feagin and Sikes (1995) provide an example in their study of the experiences of African American students at White colleges and universities. In this example they illustrate how the failure of White professors to treat African American students as individuals, but rather as one collective group can have an isolating and negative effect on students. In this incident one Black student's performance became the measuring stick for all Black students' performance, creating an isolating and lasting negative effect.

Isolated treatment of African American students is not restricted to student performance, but also relates to personal interactions. In a similar example, to the previously noted, the type of questions and behavior towards a student effects the student's belief about how they need to conduct themselves when dealing with their White professors (Feagin &

Sikes, 1995). In this same study a White professor left a student feeling demeaned, belittled and believing that she had no other choice but to learn how to “play the game.” In each example African American students were made to feel inferior by those who were in positions to empower them. Feagin and Sikes (1995) explain that it is necessary to share these experiences regardless of their individual nature. They contend that regardless of the “more acute or dramatically stated [experiences of students], it nonetheless communicates well the embattled character of the Black student's experience at mostly White universities” (pp. 95).

Student Involvement

Belonging. A fundamental need, belonging is essential in building and maintaining attachments, friendships, intimacy, and building a sense of community (Schunk, Pintritch & Meece, 2008). Maslow’s hierarchy of needs asserts that once the primary need for food, shelter and safety have been met, the social need to belong, and the need to be accepted must then be met (Freitas, 2011; Schunk et al., 2008). Belonging is an innate need to develop and maintain a minimal number of interpersonal relationships (Baumeister & Leary, 1995). However, when influenced by inhibiting factors, developing a sense of belonging can be a challenge. Clegg (2006) believes that a sense of belonging is referencing an individual’s feelings of membership to a group or institution and is directly linked with fitting in and connectedness.

Social interactions are a vital part of the universal and local community. Johnson et al. (2007) assert that students’ sense of belonging is critical to their interactions with their institution and ultimately the foundation of their success. Divided into two categories, a sense

of belonging is influenced by the social aspect of an institutions environment. This includes both the campus and academic environments, such as the feelings and connectedness to the institution both socially and academically including the classroom, professors and curriculum influence. A sense of belonging for African American women directly aligns with what Schlossberg (1989) explains are the feelings students express towards their campus environment. This person-environment fit for many African Americans shapes and directs their collegiate experiences. Campus communities and their climates act as a means to developing their sense of belonging. In addition it has been shown that interactions and involvement significantly influence the sense of belonging for African Americans women in areas of STEM (Hurtado & Carter, 1997; Johnson et al., 2007; Tinto, 1993).

Student involvement particularly those from underrepresented groups, has proven to be beneficial for African American students in STEM (Astin, 1984; Berger & Milem 1999; Flowers 2004). For example, in his study of African American students in college and the impact of student involvement, Flowers (2004) found African American students reported greater gains in areas such as vocational preparedness, thinking and writing and understanding areas of science and technology. In related studies, Strayhorn (2008a, 2008b) found African American males who interacted with a diverse set of peers reported higher levels of a sense of belonging. Higher levels of belonging can lead to higher rates of retention among African American students.

Astin (1984) explains that if students are involved in their institutions, referring to the amount of physical and psychological energy a student puts forth, the results will translate into positive experiences at their institution. The successful matriculation of African American women at institutions and their sense of belonging are dependent on more than just

academic factors, and are interdependent on the contributions of their social experiences. Experiences outside of the classroom can have a positive effect on attrition rates of African American women at predominantly White institutions (Flowers, 2004). While African American student involvement does not automatically equal a student's sense of belonging, it does bare a direct relationship to the type of connection student's associate with their institutions. A salient example of these connections is student involvement in campus organizations.

Organizational Involvement and Identity. Important to the psychological development and overall success of African American women in STEM majors, particularly those at PWIs are the connections they form with others (Washington & Moxley, 2003). Challenging the assertion that students need to integrate into the dominant culture of their college campuses, Hurtado and Carter (1997) suggest that students of color, in order to establish a healthy sense of belonging, must maintain affiliations that create and generate a connection to the community and present a feeling of being at "home" (p. 338) on their college campuses. Oftentimes this sense of "home" can be found for African American women among other African Americans, women and in general people of color. Affiliations with individuals who may share common experiences supports the healthy development of self-concept, shifting from a male dominated discourse to one that values and considers the women's voice (Liu & Regehr, 2006). These values extend beyond the classroom and are aligned with goal-directed activities.

As African American women in STEM majors participate in goal-directed activities, bonds form. Baumeister and Leary (1995) postulate that such social bonds form easily and

are usually associated with personal interactions. Bowlby (1969) explains that as a result of time spent with individuals, attachments will be developed. These relationships are natural and require no additional effort to be maintained. Social bonds as described serve as buffers against cold and isolating STEM experiences among African American women at PWIs. When the needs of African American women in STEM majors are insufficiently met, feelings of loneliness emerge (Baumeister & Leary, 1995). Failure to meet such needs will add to the leaky pipeline of African American women out of STEM majors (Blickenstaff, 2005). Strayhorn (2012) found that when African American students, especially those who had experiences with marginalization in STEM majors were socially excluded from a group, anxiety would ensue (Pederson, Anderson & Curtis, 2012). These feelings of exclusion can additionally lead to attrition with STEM majors and ultimately institutions (Strayhorn, 2012).

Just as an individual's self-identity development is based on both internal and external factors, the same holds true for organization identities (Hatch & Schultz, 2002). Many organizations attempt to create identities that have a positive rather than a self-enhancing image. Although not always successful, those mechanisms focused on self-enhancement are generally viewed as most salient (Hsu & Elsback, 2013). Organizations play an essential role in student persistence often serving as markers for social integration on college campuses. Guiffriids (2003) notes organizational involvement is important among students of color at PWIs, organizational affiliations serve as increased opportunities to engage in the campus community and break down barriers to persistence.

Well noted in the literature (Astin, 1984, 1997; Berger & Milem 1999; Harper & Quaye, 2007; Kuh et al. 2008; Tinto, 1975, 1993) are the effects of student involvement on student success in higher education. Whetten (2006) argues, "Organizations are more than

social collectives...[they] highlight important functional and structural parallels between” (p. 221) the individual’s identity and the organization. One example of this parallel relationship is witnessed in the work of Harper and Quaye (2007) who in their research of African American males examined the ways student organizations provided space for Black identity development. They found students increased their commitment to the community and developed skills for both academic and social success. Their findings additionally indicated that organization membership served as a means of enhancing students’ Black identity. These enhancements serve as bridges among African American women for greater levels of success.

One example of organizational affiliation that has proven to enhance Black women’s identity is membership in Black Greek letter organizations (BGLOs or BGOs). Historically many African American students have participated in BGLOs. McClure (2006) explains that BGLOs have enhanced African American college student’s experiences and served as a means of dealing with social and political issues facing the Black community both on and off college campuses (McClure, 2006). Often described as being cold, isolated and unwelcoming, BGLOs and other organizations that promote positive self-identity and socialization serve to fill in the gaps of negative campus and academic experiences. Ensuring that these gaps are filled is critical in the adjustment of African American women on predominately White campuses. Membership acts as a preventative method to the attrition of women out of STEM majors. Scholars (Blickenstaff, 2005; Fries-Britt, 1998; Fries-Britt & Griffin, 2007; Johnson, 2007; Strayhorn et al., 2010) argue that organizations that provide students opportunities to connect to their culture rather than assimilating to the dominant White and oftentimes male culture, have been proven to increase chances of African

American women persisting through their STEM field. While Fritt-Britt (1998) posits that all race-specific organizational affiliation may not be accepted by all African Americans, they do serve as venues of safety for many African American women and often offer mentorship. When examining the participation of African American women in STEM majors and the factors contributing to their leak out of the pipeline, academic and social experiences both play a critical role. Central to these experiences are student's abilities to negotiate and grapple with their sense of belonging.

CHAPTER III: RESEARCH DESIGN AND METHODOLOGY

Purpose and Research Questions

The purpose of this study was to explore the K-12 experiences of African American women majoring in an undergraduate STEM field. By exploring the experiences and messages, a counternarrative was created to add to and in some cases reject the dominant discourse of African American women in STEM majors. Through these counternarratives, insight was gained on the experiences that contributed to the collective selection and in many cases the persistence of African American women in STEM majors. This study addressed the following broad question:

How do the K-12 experiences of Black women contribute to their selection and persistence in an undergraduate STEM major?

I sought to address this overarching question through the following sub-questions:

1. What K-12 messages about STEM did you receive and how did these messages and experiences contribute to the selection of a STEM major?
2. What K-12 messages about gender and race did you receive and how did these experiences contribute to the selection of your STEM major?
3. How have your K-12 experiences contributed to your persistence and navigation within your STEM major?

Research Design

Qualitative research is a particular way of thinking about a problem and asking questions to get answers (Hesse-Biber & Leavy, 2011). This research approach looks to find the meaning from collected data and use it as a means of building knowledge. The

methodology and methods for this qualitative study were selected because of their ability to provide descriptions of personal experiences (Johnson & Onwuegbuzie, 2004). This research method is appropriate in seeking to describe what messages African American women received during their K-12 years. Using a qualitative method allowed me see how these experiences and messages impacted their selection of a STEM major and further how it contributed to and helped shape their current undergraduate experiences (Gray, 2004).

Method

Qualitative research allows researchers to explore the meaning individuals ascribe to a social problem, providing participants with a voice (Creswell, 2007). Merriam (2002) extends this notion by explaining that meaning is socially constructed by individuals and qualitative research uncovers meaning that participants have constructed about a particular phenomenon. This qualitative study is grounded in Critical Race Theory (CRT) and Black Feminist Thought (BFT). CRT and BFT provide a lens to understand the K-12 experiences of African American women prior to selecting their undergraduate STEM major. While each framework posits that issues of race and gender are endemic and woven throughout our social and institutional structures, collectively these frames provide a counternarrative to the historically silenced experiences of African American women. Stories are a powerful tool to convey one's experience. Using a narrative approach provides a unique insight on the perspectives of African American women illuminating a new perspective to the dominant discourse.

Narratives are defined as the “intention of the human actor” (Richardson, 1990, p. 119) and it is through this intention that individuals comprehend and understand the world in

which they live. The narrative is the primary way in which an experience is organized and thus understood; therefore how individuals experience a particular event or situation will be based on their position and placement within the context of the experience. A mode of both reasoning and representation, narrative analysis provides an opportunity to understand the experience not just as an individual experienced it, but how they have comprehended their experience (Richardson, 1990). Storytelling and narratives serve to delineate the personal experiences of African American women in education and society. The use of narratives as the primary data collection method for this research is informed by Black Feminist thought, which is a theoretical framework situated in telling the story of African American women as they maneuver through struggles related to race, gender and class (Collins, 2000; hooks, 1981; 1989; Crenshaw, 1993). Through narratives, the lived experiences of African American women are captured and the layers of these experiences are given a voice, creating dialogue to improve the experiences of these women. Further, the use of narratives and storytelling give rise to what scholars Solorzano and Yosso (2002) explain are ways in which the master narrative on race and racism can be countered. In the attempt to understand the lived experience of African American women and their educational experiences using narrative inquiry provides for insight into their experiences. As noted by Connelly and Clandinin (1990) :

The main claim for the use of narrative in educational research is that humans are storytelling organisms who, individually and socially, lead storied lives. The study of narrative, therefore, is the study of the ways humans experience the world. This general notion translates into the view that education is the construction and

reconstruction of personal and social stories; teachers and learners are storytellers and characters in their own and other's stories (p. 2).

I selected narrative as an attempt to understand not just the participants' past experiences, but as an attempt to understand how these experiences shaped and contributed to their persistence into their current major. The use of narrative enables a way of understanding the intersection of not just the past and present, but is a way in which people continue to transition through their past, present and even future (Clandinin et al. 2007).

Participants

This study explored the K-12 STEM messages and experiences of African American women currently enrolled in an undergraduate STEM program. Study participants were selected based on meeting the following criteria: self-identified as African American or Black; a woman; majoring in a STEM field at an undergraduate institution. Defined broadly, STEM fields include not only the common fields under its acronym of science, technology, engineering and mathematics, but also the categories of natural sciences, computer and information sciences, as well as design (Breiner et al., 2012). Participants falling within these categories were selected from institutions in the Southeastern part of the United States.

Purposeful sampling was used in conducting this study. This type of sampling allowed me to meet the pre-selected criteria. Additional snowball sampling was used as a means of achieving additional appropriate participants at underrepresented institutions. Through this method I was able to obtain participants who fell within the criteria for my research study. Ten women were selected spanning across both predominately White institutions (PWI) and Historically Black Colleges and Universities (HBCUs). Each

participant was given a pseudonym to ensure her anonymity (see Table 2 for a list of participants).

Table 2: Overview of the Participants

Name	Institution	Racial Identification	State Raised In	Age	Current Major	Classification
Brianna	PWI	American Gambian	NC	19	Electrical Engineering and Computer Science	Junior
Ashley	PWI	African American	NC		Materials Science Engineering	Second Semester Sophomore
Whitney	HBCU	African American & White	NV	20	Architectural Engineering	Second Semester Junior
Ericka	PWI	African American	NC	18	Electrical Engineering	Freshman
Tyra	PWI	African American	NC	21	Chemical Engineering	Junior
Dianna	HBCU	African	MD	18	Biology	Sophomore
Tamera	HBCU	Black	MD	19	Mathematics Education	Sophomore
Danielle	HBCU	Black	AL	20	Pure Mathematics	Junior
Donyela	PWI	Black, African American	NC	20	Mechanical Engineering Minoring in Arts and Design	Junior
Jada	HBCU	African American	FL/IL/NC	21	Computer Science	Junior

I used several methods to recruit the ten participants. Initial contact was made via email, contacting varying institution's diversity and other STEM program coordinators. To generate additional study participant interest I partnered with a Black Greek letter organization, Delta Sigma Theta Sorority, Inc. to host a workshop (*Appendix A*) discussing my research topic. Following the workshop an electronic sign-up sheet was provided to collect the name and contact information of interested participants. Each workshop participants that signed up was individually emailed a solicitation letter (*Appendix B*). Following the response each responding participant was contacted and an interview was scheduled.

Participants Institutions

Two universities were used in data collection, both located in a southeastern state, a historically Black University and predominately White institution. These two institution types were used to provide a salient understanding of the homogenous experiences of African American women during their K-12 years. By using two different institution types, a central understanding is gained, moving the discussion toward the alignment of experiences, rather than the differences in each institution providing post-secondary selection and persistence in a STEM major.

The predominately White institution that participants attended was assigned the pseudonym, Mainstay University. Mainstay University (MU/Mainstay) is the largest university in this southeastern state with a little over 34,000 undergraduate students. Of the 34,000 undergraduates, about 55% are males and 45% are females. While there are several race and ethnic groups represented at Mainstay University, the majority of the undergraduate

student population is White, at 73%, with African American students representing 6%. The HBCU that participants attended was assigned the pseudonym Historic University (HU/Historic). Historic University is the largest predominately African American university in this southeastern state. Historic has a little over 9,000 undergraduate students with 87% African American and 13% non-African American. Of the 9,000 undergraduates about 54% are women and 46% are males. Participants from Mainstay and Historic University were selected because of their focus on STEM undergraduate majors.

Data Collection

A semi-structured interview was conducted to allow study participants to retell their narratives as students within their K-12 experience and later within their STEM majors at their institutions. A semi-structured approach was used to ensure that the interview data provided is necessary to facilitate an understanding of the lived experiences (Creswell, 2007). The interview questions focused on the K-12 academic and social messages participants received prior to selecting their STEM majors, and how these messages prior to their undergraduate experience contributed to their selection and persistence in their STEM related field of study (see *Appendix C*).

The semi-structured approach additionally was an opportunity to build a conversation through an examination of questions that emerged, providing a deeper understanding of each woman's experience. An interview guide was used to ensure that all relevant topics were covered (Creswell, 2007), while probes were based on the response to the questions and not pre-planned. Interviews were conducted in a secure space located on or near each woman's

college campus. With permission from each woman, all interviews were recorded using a digital audio recorder. No compensation was provided for any participants.

Following the confirmation that each woman met the study criteria, each woman was contacted by telephone or email and provided with a confirmation letter with all significant study related information. During this initial contact an interview was subsequently set up with each participant. Each interview was held in the selected institutions library reserved study area or a privately arranged similar conference space, and or at a local church conference room. Prior to the participant's arrival the room was arranged to make each woman comfortable in the atmosphere, therefore helping them to relax and feel at ease in sharing.

Prior to the start of each interview each woman was informed that the interview could take anywhere from 60 to 120 minutes. Each woman was emailed a pdf of their consent form to ensure that if they had any questions or concerns, they could be addressed. This form was emailed 2-3 days prior to each woman's interview. Once each woman arrived for the interview, she was provided with a participant consent form and given time to read and sign the form (see *Appendix D*). I assured participants that all identifying marks will be removed from the results of the study and encouraged each woman to speak without limitation. Prior to the formal interview I engaged each woman in small talk asking noninvasive questions to break the ice, while establishing trust between the interviewer and each woman. Following this informal conversation, I used an interview protocol, which consists of scripted questions.

Prior to their recording, I asked each woman "do I have permission to record this interview," pausing for a response that signals that is okay for me to proceed, a scripted set of questions was used during the interview. Each participant was asked to elaborate and

expound on her responses within each interview. I concluded each interview by giving each participant an opportunity to provide additional information not asked during the interview.

By using a set of semi-structured scripted questions, I had a context in which to ask participants' questions related to social, academic, cultural, gender and racial identity experiences in the context of their STEM K-12 experiences. I additionally asked probing questions based on each participant's response. This semi-structured method was used in order to collect thick, rich details from each participant. Voice inflation, laughter and long pauses were noted throughout the typed transcript and field notes. Each interview was digitally-audio recorded, I additionally took field notes immediately following the interview to capture other non-verbal information that might add to the understanding of the participant's experience. After each interview, I transferred the audio files from the recording device to a secure password protected back-up file. Each interview transcribed and analyzed for common themes.

Data Analysis

To provide a reliable narrative of the experiences, a narrative analytical approach was taken to analyze the data. A Black Feminist thought framework is used as a means to challenging the status quo, and provides a voice for Black women (Collins, 1986, 1989, 1990; Howard-Hamilton, 2003; King, 1988). Critical Race Theory provides the historic lens to understanding the effects of racism and social justice inequalities (Tate, 1997). These two theories offer supportive lenses to view and understand the experiences of women in STEM fields. These two theories framed my analysis by supporting the experiences of African

American women in STEM fields in three specific ways: through voice, the intersectionality of race and gender, and the history by which these experiences are framed.

By using narrative analysis, I was able to situate the experiences of the women within a larger framework, which gave me an opportunity to give collective meaning to the lives and circumstances of each woman (Polkinghorne, 2007). Data analysis is a cyclical process which required first the organization and reduction of data through a coding process (Creswell, 2007). To begin this data analysis process I sent the audio-recorded interviews to a professional transcription service; Rev.com. Following the return of the transcription of each interview, a printout was created of each transcript. Each transcript was then reviewed for consistency with the audio-recording. These interviews were the primary sources I used for analysis as I began to re-story each participant's narrative. Scholars (Ollerenshaw & Creswell, 2002) explained this process stating:

Re-storying is the process of gathering stories, analyzing them for key elements of the story (e.g.,time, place, plot, and scene), and then rewriting the story to place it within a chronological sequence. Often when individuals tell a story, this sequence may be missing or not logically developed, and by restorying, the researcher provides a causal link among ideas. In the restorying of the participant's story and the telling of the themes, the narrative researcher includes rich detail about the setting or context of the participant's experiences. This setting in narrative research may be friends, family, workplace, home, social organization, or school—the place in which a story physically occurs (p.332).

As I began the re-storying process, I took additional printed copies of each transcript and completed an initial read through of each interview. As I read, I initially labeled

statements throughout the interview with topics or themes within the context of the interview. An effort was made in this initial read through to keep information in context of the interview as an attempt to avoid decontextualizing themes. Riessman and Quinney (2005) explain that this should be avoided, noting that “a decontextualized excerpt from an interview, so common in qualitative studies, can be problematic because language, when stripped of context, can be misinterpreted” (p.400).

As noted by Riessman and Quinney, (2005) a common practice in a qualitative study is information taken out of context, thus as I pulled information from each interview, I attempted to keep this information in context by listing them based on themes they were connected to. I used the method of re-reading and pulling out information from each transcript as a means of editing and re-shaping what was shared to create a connected counterstory. While maintaining each participant’s voice because of the importance, it was also significant to see if the experiences shared were connected. In this approach I sought to empower each woman through a collective voice. Riessman and Quinney (2005) state that “participatory/critical research” is an example of empowerment by taking past “inequalities into account and creating research context where muted voices [can] be heard” (p.42). Using information pulled from each transcript I attempted to find the “grand narrative” as a means of gaining a full understanding (Clandinin & Connelly, 2000).

Following the continued reading and re-reading of each transcription, themes and patterns of words and statements were captured and organized into charts. The approach I used was a three-dimensional approach and a problem-solution approach. Both approaches were used in an effort to ensure that individual experiences were understood in the context of the problems that the women collectively faced. Ollerenshaw and Creswell (2002) explain:

In both approaches, the researcher reanalyzes the raw data to form a new story. This story is reorganized to highlight events that occurred. The use of graphic organizers helps the researcher identify important information into a table or map to code, sort, and group the data. Both approaches lead to the development of a story that can be told orally or written for readers. The story includes a rationale to explain the reason for the particular telling style. In the two approaches, the researcher proceeds through the overall steps of obtaining text data, transcribing the data from audiotapes (if this is needed), and reshaping the transcription into a story (p.343).

I found that in the three-dimensional approach, experiences were conceptualized as both personal and social, allowing for each individual voice to be heard (Ollerenshaw & Creswell, 2002). Yet in using this approach I would have to go back and forth to the participants and rather than negotiating the meaning, the women would provide their own meaning. Thus using a combination of both approaches proved effective. In using the problem-solving approach I was able to make interpretations of the themes conveyed, providing a broader perspective. Initial coding required a three-dimensional space approach, where individual experiences were reviewed.

In an attempt to identify emerging themes from the collected data, I analyzed each transcript by hand. Handwritten notes indicating potential themes and their connection to larger research questions were taken. As each interview produced a large amount of information, this information was systematically reviewed and analyzed. Each transcript was analyzed for trends and themes, while inductive coding was used as means to categorizing each participant's articulation and processing of STEM messages and experiences at a K-12 level (Creswell, 2003). Inductive coding enables the analysis of the narrative by directly

examining and identifying patterns to gain insight. In applying an inductive analysis method, each transcribed interview was first organized based on the research questions. Through open coding, I continuously reviewed the narratives, making notes as connected themes emerged.

This process was repeated until a set of themes emerged from the narratives. These themes were then grouped; reducing redundancy within the number of categories. Similar topics were combined and major headings created. All emerging themes were categorized based on their relevance to the initial research question and sub questions. Themes were identified as they related to data and thus interpretations were based on the meanings I attempted to apply to this data (Ryan & Bernard, 2003). A key word table was created to display the key words or statements and the themes that emerged for each participant.

Repetition was used as a means to identify themes. In reading each transcribed interview, I looked for reoccurring topics or statements. These were topics or statements that are heavily emphasized by each participant and/or statements that elicited nonverbal emotional displays captured in field notes.

Using the data collected, I identified recurring patterns in the narratives. I additionally took field notes immediately following each interview, capturing non-verbal, key words, descriptions of the setting and other visual aspects that the audio recording could not pick up. These were used in conjunction with my own reflection, allowing for an examination of my positionality during the reach process (Hesse-Bieber & Leary, 2011). I began each narrative by using the field notes and other observations by creating a participant profile, which I used as an opportunity to introduce each woman to the reader. This profile was used as a means to frame each woman's individual voice. This profile additionally

provided highlights on person characteristics, demographics and other K-12 STEM experiences.

Next, composite themes were taken and used to present patterns found commonly among most of the women. Examples of statements were pulled from each woman that fell within the context of each theme. This was used as a means of finding a common story that could be told expressing each woman's voice. These quotes were used to anchor each theme, but were additionally embedded and supported by literature. In presenting the composite themes, I was able to present the study participants' collective experiences. These patterns were interpreted to understand the K-12 STEM messages that were received which shape and directed their pursuit and persistence in their current majors.

Trustworthiness, Credibility and Bias

In order to ensure credibility and trustworthiness of this study, I utilized multiple sources of data: individual interviews, institutions demographics data and field notes. Field notes were generated immediately following each interview. Notes were taken on body language and other non-verbal attributes that the digital recorder could not capture. Establishing trustworthiness of the study required that I establish credibility, reliability, transferability and dependability (Lincoln and Guba, 1985). In an effort maintain reliability, an interview protocol (*See Appendix C*) with the same questions was used. This provided consistency among what each woman was being asked, yielding similar measures, because of the ability to use the same protocol. Transferability was established through my writing "thick descriptions" that extensively described the data I compiled. Dependability and credibility were further established after analyzing the data; it was witnessed that many of the

women had similar experiences across different points in time, enhancing the credibility, dependability and transferability of the interview protocol and the methods used to collect data (Decrop, 2004).

A reflexive journal and subjectivity statements were used to capture any assumptions or other issues of subjectivity that I may have had while conducting this study. Following each interview, I gave each woman an opportunity to expand on or clarify any information that she provided. In order to ensure dependability and an increased level of quality of each narrative, field notes and other inventory information was used. In an effort to construct a narrative that provides a different lens to view each woman's experience, it is inevitable that some selectivity took place and as noted by Clandinin and Connelly (1990) it is impossible to avoid all together. To ensure credibility, each woman was given the opportunity following her interview and the completion of each profile to review as her request her profile for accurate character depiction.

Researchers often carry with them their own personal experiences to their research study. My similar background experience as an undergraduate in a STEM field and the previous messages received in my own K-12 experiences can be considered bias and must be eliminated from the design. However, it is important to note that in qualitative research it is often the researchers own personal experiences that provide the context for understanding. While my own K-12 and later collegiate experiences in STEM serve as a bias, they additionally serve as a resource. Tillman (2002) notes that in order to create a pedagogical and paradigm shift, ones cultural experiences can in fact act as a tool to deal with culturally sensitive issues. Therefore by acknowledging my experiences as a Black female adolescent who was exposed and supported throughout my K-12 STEM experiences, I am more

sensitive in my articulation of the perspectives of each woman's experiences. Creating what Tillman (2002) expresses are opportunities to express the complex challenges facing African American women, I used critical subjectivity to ensure that trustworthiness and credibility were maintained.

CHAPTER IV: FINDINGS AND DISCUSSION

Findings in this chapter are discussed based on collective participant characteristics, demographic backgrounds, K-12 experiences, transition from high school to college, institutional experiences, and their collective contribution to the identity of each participants' development. Study participants' ages ranged from 18 – 21 years old, which is the standard college age of populations. Each woman was a full-time college student representing two types of institutions: a predominately White Institution (PWI) and a historically Black College or University (HBCU) within the southeastern region of the United States.

This chapter is organized into two parts. The first part briefly breaks down each individual participant's profile including descriptive characteristics, interest, family backgrounds, educational attainment, K-12 STEM experiences and current college involvement. Through each profile an individual narrative is presented for each woman, setting the frame for each woman's individual voice within the collective experiences. Each narrative speaks to the respective woman's STEM exposure prior to entering college and is a frame for understanding the development of her interest and eventual selection of her STEM major (See Tables 2 and 3).

The second part of this chapter focuses on the collective and emergent experiences of the women. These themes are organized to provide a counternarrative in relation to the tenets of Critical Race Theory (CRT) and Black Feminist Thought (BFT). The first counterstories are composed of experiences common to most of the women participating in this study. An experience was determined to be a collective experience if it was shared during the interview by 50% or more of the women within the study. Included within these themes were: *early exposure to the STEM, family support, belonging, early high school success, considered*

changing majors, and direct influence from father in selecting STEM majors. Using CRT tenets through counterstorytelling, I present the personal stories of each woman as evidence to the understanding their K-12 experiences and its contribution to their selection of their STEM major.

Table 3: Other Contributing Demographic/Background Information

Name	Home Life	Considered or Changed Majors	Stronger Paternal Influence Mentioned	Stronger Maternal Influence Mentioned	Type of High School Courses
Brianna	Both Parents	Yes	Yes	Yes	College Courses
Ashley	Both Parents	Yes	No	No	AP and Honors Courses
Whitney	Both Parents	Yes	No	Yes	AP and College Courses
Ericka	Mother & Step Dad	Yes	No	No	AP and Honors Courses
Tyra	Both Parents	Yes	No	No	AP and Honors Courses
Dianna	Mother (Father Present/Not in the Home)	No	No	Yes	AP and Honors Courses
Tamera	Both Parents	Yes	No	Yes	AP and Honors Courses
Jada	Both Parents	No	Yes	No	AP and Honors Courses
Danielle	Both Parents	Yes	No	No	AP and Honors Courses
Donyela	Both Parents	Yes	Yes	Yes	AP and Honors Courses

Participant Profiles

Narrative 1: Brianna

Brianna entered the room and began speaking and asking questions about the research I was conducting. She dropped her large book bag on the floor beside her. Speaking with a noticeable, but not thick accent, she pronounced her words very clearly and thoughtfully. She recalled her interest in STEM began when she came to the United States. It was in late elementary school that she had the opportunity go to aerospace camp and became fascinated with stars, the solar system, exploring new planets and new constellations. This early exposure to STEM fields was very intentional as later explored in the collective narrative of the contributions of family. Brianna's father had a heavy influence on her interest in STEM as well. She explored medicine because of her father's career as a nurse. Family and being in the position in the future to support her family was an additional attractive feature of her STEM major.

Enjoying science and mathematics as early as fourth grade, Brianna's interest in STEM was fueled by her attendance to schools with a specific science focus. Early College High School is a school reform model that enables students to graduate with a high school diploma and an associate degree or college credit hours toward a baccalaureate degree. Brianna attended an "Early College" where the focus was health and sciences. This experience made her realize that she was no longer interested in pursuing medicine. While teachers had a heavy influence on Brianna, she explains that her dad was the influential factor of her decision.

Brianna selected Mainstay University because it was closer to home; this selection and the selection of her major was further guided by her father. Consistent with her original

interest, Brianna entered as a biological sciences major later changing to double major in electrical engineering and computer science. Raised in a predominately White neighborhood, Brianna had a full understanding of the lack of diversity that existed within the field of her interest; however, her parents provided her with what she termed as a “disclaimer” that “Even though this is what you're seeing there, they do exist.”

Taking full advantage of her early college high school experience, Brianna entered Mainstay University with her Associate’s degree. As a junior, Brianna was very intentional in choosing to double major, viewing her future career in engineering as an opportunity to one day help her family. At Mainstay University Brianna consistently expressed that she had built a network of support, viewing these individuals as tools and resources to her success within her major. Most of these individuals in her network were not directly associated with her major, such as an advisor or a professor; however this network was made up of individuals who were connected to her through organizations such as the multicultural student support program and the National Society of Black Engineers (NSBE).

At Mainstay University Brianna expressed that she had only taken classes with one African American STEM professor, an individual whom she expressed was approachable. While she continued to remain safe in her responses regarding race, it became very clear that the individuals she spoke of as approachable were females and or African Americans. This affinity towards females as approachable is connected to her K-12 experiences, where Brianna expressed that the majority of her K-12 teachers were female. Further, she shared that her close friends were mostly Asian, noting that there was a large percentage of Asian student within her major.

Narrative 2: Ashley

Ashley was an African American woman who grew up in a predominately White middle class rural town in the Southeastern part of the United States. Ashley was very expressive and thoughtful in her responses. She would say things like “that’s a big topic,” when I asked her broad questions that she seemed to have several opinions regarding. She had a positive and pleasant demeanor and smiled often during the interview. She sat very relaxed and comfortably across from me with her legs crossed. During her interview there were a few times that I could tell that she was still grappling with several of the topics/question ideas that I asked her; one of which was an identity question and the other was about her selecting a major, but being told that she was not good enough. It was obvious that she did not want to speak negatively about her department nor the individuals that made her feel as if she was not good enough for that major, but you could also sense that she was not happy about what had occurred.

Ashley recalled always having an interest in STEM, just not realizing it. She recalled being in the mathematics club and the science Olympiad in middle school. These activities encouraged her; building her confidence and provided an opportunity for her to be inquisitive. She additionally noted that receiving the mathematics award for excellence in 8th grade and later in high school made her pause and think “Oh wow, I can do this. I am good at it.” Ashley was heavily influenced by her family, particularly her God-mom to major in engineering. Unlike many of the other women, Ashley did not believe that she received a good foundation prior to entering her undergraduate institution. Ashley believes that although she was in honors classes, there was not an emphasis placed on critical thinking and problem-solving skills, but more of an emphasis on memorizing the content.

A critical part of Ashley's transition from high school to college was the minority-engineering program. The program and the staff provided a familial feel that assisted her with transition. As mentioned several times by the women who attended Mainstay University, Ashley encountered feelings of isolation and defeat. These feelings were associated in most cases with STEM courses where she was often the only African American female and many times the only African American. Being the only African American woman caused Ashley to question her ability and added pressure to her regarding her academic performance. Explaining that education at Mainstay University is great, however she notes that without the minority engineering program and the national Society of Black engineers, she would have transferred institutions her first semester.

It was necessary for Ashley to have family support during her experience. Critical to Ashley's support was the community she built with other Black students. However, Ashley notes that her relationship with her non-Black peers was one of just shared academic experiences and not a social relationship. These feelings of disconnection multiply and undergird many of the experiences Ashley shares. One experience that stands out is when Ashley applied for her specific engineering major. In sharing her experience it is obvious that she felt discouraged and deterred from applying, which as a result caused her to settle for a major that she was unhappy in. Mainstay allows students within the School of Engineering to declare a major after completing a set of courses typically after the first year. They must apply to the school of Engineering to declare this major. It was in this process that Ashley encountered what she perceived as pushback and a re-directing towards an easier major. She attributes this to being an African American woman. This experience affected her motivation because it was not something she could see herself doing for the rest of her life. In this

experience it was her peer support system, which served as a pseudo-familial support system that helped encourage her to not settle.

Growing up in a predominately White neighborhood, Ashley recalled that she did not associate often with the Black community; however since attending Mainstay University she began to embrace Black culture like never before, becoming proud of being an African American. She attributed this to the intentional exposure she received through programs and organizations she became a member of. In this setting Ashley was surrounded by African American students, unlike her former experience where she described often times being the only African American female and even African American in her honors and AP courses. During her K-12 experience she was painted as an angry Black woman, a coping mechanism she believes she developed from being placed in certain situations. These situations caused Ashley to isolate herself from her Black peer because of the fear of being stereotyped and perceived as a snob.

Narrative 3: Whitney

Born and raised in Nevada, twenty-year-old Whitney had a very bright and enthusiastic personality. Growing up in what she considered a very diverse suburban neighborhood, prior to attending a college tour geared at recruiting more students from the west coast to the east coast. Whitney had never heard of Historic University, recalling that she always had a love for buildings; she entered as an architectural engineering major. The product of a two-parent home, Whitney grew up as an only child, although she had older siblings. Whitney identified as both African American and White, explaining that because

she grew up primarily around the African-American side of her family and identified closely with this side of her identity.

Becoming interested in STEM in the sixth grade after entering a magnet program, this interest would continue to be fueled throughout her high school career through advanced placement and honor classes. Whitney's mother played an influential role in many of her choices; encouraging her to do what she wanted, and assuring her that she would do whatever she had to get her there. Although Whitney had a significant level of STEM exposure at a young age, she attributed much of her foundation to her participation in girl scouting. Through this organization she had a lot of opportunity for discovery.

Although she was encouraged to pursue advanced courses in high school, Whitney received mixed messages about women in STEM. Her peers, often males, provided negative and critical feedback regarding what fields men and women should pursue. Similarly, Whitney recalled mixed messages from teachers, not really sure if they believed in her or not. While the messages from her peers and even teachers were at times mixed, these same messages worked to fuel her pursuits, driving her to work harder. Messages from home served to counter any negative and even critical messages that she may have encountered.

With the support of both her mother and father, after visiting several institutions her final visit solidified that she would pursue Historic University. Prior to her transition, Whitney attended a predominately White and Asian high school. While in high school, Whitney was actively involved with her schools Black student union. Having a rich K-12 experience, Whitney's attendance at a magnet middle school placed her on a path of STEM discovery. This path of discovery led her to a career and technical academy high school

where she majored in architectural drafting and design. This would be preparation for her later collegiate experience.

Receiving mixed messages throughout her high school experience, while identifying as both African American and White, Whitney described pushback among her peers within the African American community on the authenticity of her blackness. Nonetheless this challenge did not deter Whitney from being involved. With a strong understanding of who she was, she chose to move past and ignore pushback from her peers, explaining it away as jealousy. With support from both of her parents, Whitney's greatest messages came from her mother, who she describes as an alpha female who constantly kept involved and exposed to STEM opportunities from elementary school throughout high school. It is through this consistent exposure and experience that Whitney attributes learning the necessary problem solving and critical thinking skills that she would come to rely on in her collegiate experiences.

Drawn to Historic University because of its family feel, as an engineer, Whitney explains that she feels a lot of love and supported. Being an African-American woman at Historic University, Whitney admits that she is a bit sheltered as an engineering student, because at an HBCU there are already a lot of African-American engineers. However, being in the south she perceives there to be layers of what she termed traditionalists who do not believe women should be in engineering. Yet it is in being an engineer at an HBCU that Whitney finds strength and support from the diverse cultural backgrounds that other African-Americans offer.

College often provides an opportunity for students to explore and negotiate their identity. Whitney notes that because she is attending a HBCU her identity as a woman is

more prevalent. She explains that at Historic University, she is accepted as an African-American; therefore her gender is more noticeable. As with many engineering programs, the majority of Whitney's engineering classes are male. It is in these classes Whitney describes gendered experiences, often, which favor and highlight male achievement. These experiences similarly reflect Whitney's field. As an architectural engineering major, Whitney describes her internship experiences noting that she has experienced both racial and gender stereotyping. Whitney's experience and experiences similar to hers can be understood through a lens of intersectionality. Used as a tool to understand instances of social control, the intersection of her race and gender made her vulnerable to stereotyping. Yet these experiences only served to encourage her to press forward with in her field, providing the foundation that there is a need for more women of color within her major.

Narrative 4: Ericka

Ericka at eighteen years old is a freshman electrical engineering major is a first-generation college student. The youngest of three, Ericka grew up with both her mom and stepdad. Transitioning to college was very important to Ericka. She viewed college as an opportunity to help her family in the future. Moving around a lot, Ericka had to adjust to the changing environments. This constant change assisted in developing her easy-going personality. Very soft-spoken, Ericka had a shy presence about herself during her interview. Choosing Mainstay University because of its location close to home, and its engineering focus, Ericka's early K-12 experiences were similar to her institutions, a White environment. During her K-12 experience she was placed in the academically and intellectually gifted program (AIG) in the third grade. This opportunity exposed Ericka to accelerated classes and

set her on a path towards her interest in STEM. Ericka explains that her interest in science and mathematics grew in late elementary school when her English classes started getting harder.

Explaining that her greatest push toward science came in middle school, Ericka credits her middle school science teacher for much of her interest. She explains that her teacher pushed her to be better and it was at this time that mathematics just started to click for her. It would later be in high school that her interest in a career in this field would fully blossom. After taking a personality test, which ascribed her to be an engineer, Ericka, began to piece together her interest in mathematics and science; thus being an engineer just made sense for her. Similar to her middle school experience she describes her high school experience and exposure as driving forces in her selection of not only her college, but also her decision to major in engineering. Unlike many of the other women, Ericka's school experience was a critical influence on her pursuit of a STEM based major. It was her high school engineering teacher that Ericka credits with inspiring her through real world experiences.

Through the encouragement and the support of her engineering teacher and her church family, Ericka applied and entered Mainstay University. Prior to entering Mainstay University, although some teachers attempted to stay clear of racialized conversations of what she may expect, her engineering teacher, who was an alumni of the university, attempted to prepare her for what she would experience racially and socially. Yet, in spite these verbal warnings she describes feeling a small shock upon entering the campus.

Pushing beyond this shock, Ericka believes she has to succeed and that her success is a part of a larger picture. Ericka describes her foundational experiences in high school as

good; feeling prepared particularly for her college mathematics classes. Additionally Ericka explained, that although her school's student body population was diverse, she often was the only African American student in her AP course. As similarly shared by other women, she was one of a few African-American students and felt ostracized from the Black community as a result. Carrying these feelings into college, Ericka admits that she has got to get more involved on campus, however, she does credit the minority engineering program for helping her find a sense of family at school. Unlike her high school experience where she didn't feel connected to the Black community, at Mainstay she feels a sense of pride. Attributing this to the common interest and goals of the Black students that she has met, she explains that she can just be herself.

Narrative 5: Tyra

Growing up in North Carolina, Tyra selected Mainstay University because she was attracted to the opportunities it presented. A junior, majoring in chemical engineering, Tyra is the oldest of her parent's three children. With a mother as a nurse and a father who works for a major computer science company, Tyra was exposed to the field of STEM at an early age. Placed in academically gifted classes in elementary school, Tyra built strong relationships with her teachers, which she attributes to having an impact on her at an early age. It was during middle school that Tyra describes first noticing a race. She explains that there were very few people that looked like her in her honors classes. As her transition into high school took place, she describes a very obvious socioeconomic divide. A divide that additionally was a racial divide.

In her transition to high school Tyra was placed in honors and advanced placement courses. Although exposed to STEM at an early age through her parents' careers, she describes her interest in STEM as one that was developed on her own. Although cultivated and pursued in her own right, a foundation was provided by her parents and other family members. Receiving a lot of encouragement from teachers in high school, particularly women, it would not be until later that Tyra would be exposed to the gender divide within the sciences. Even though she was in advanced placement courses Tyra describes high school as being a time where she was teased and experienced struggles with her identity. Among the comments she heard were individuals telling her that she was not really Black. These experiences provided a framework for how she viewed other African-Americans. However, entering Mainstay University, Tyra describes for the first time being drawn towards other African-Americans because of their common experiences.

When Tyra first entered Mainstay University, she struggled to find her place. Not wanting to enforce stereotypes and being the only African-American student in most of her classes, Tyra would not ask for help for fear that she would enforce the stereotype that perhaps Blacks were lazy and did not want to work. It was by becoming actively involved in organizations such as the National Society of Black Engineers and other minority student organizations that Tyra began to feel a part of a community on campus. Describing a feeling of belonging, this feeling of being a part of a family community helped her cope with what she would experience and her courses at Mainstay University. Around her sophomore year, Tyra notes that she noticed that she would be one of only two or three other African-American females in her classes. Describing times where she was the only African-American

and even female, in most if not all of her classes, over time she has grown comfortable with this information.

As similarly mentioned, the minority-engineering program at Mainstay University has been essential in the transition for Tyra. As noted by all the women who attended Mainstay University, the African-American faculty and staff from the minority-engineering program are like mothers, providing for Tyra the support system she needed for continued success. Additionally these were the only African-American faculty or staff that Tyra had a relationship with. While the majority of Tyra's non-African-American faculty and staff have been white, these relationships serve as academic support rather than emotional or personal support. Not having had any exposure to African-American women in engineering at Mainstay University, Tyra describes her first real exposure to African-American women in chemical engineering came through her past summer internship. It was during her internship she was mentored by a PhD chemist in her late 20s. She describes a feeling of empowerment, and enjoyed the challenge that she presented her during that time. As an African-American woman in a major where there are very few African-American women, Tyra explains that this is a motivator to go out and recruit additional women to the field.

Narrative 6: Dianna

With a sweet presence, her full and natural hair flowed to her shoulders. She was excited about the opportunity to select her own name. Speaking softly, she inquired about the amount of information that she needed to give so that she would not get too much. Taking long thoughtful pauses, she used her hands to ensure the full magnitude of what she was

sharing was captured. Selecting Historic University as a result of her experiences growing up, Dianna was looking for an experience where she could be among other Black people.

Dianna grew up in Prince George County, Maryland and now at the age of eighteen years old, she was a sophomore at Historic University. Growing up with her brother in a primarily single-parent household, Dianna was still influenced heavily by her father. Inspired by her father, a nurse, Dianna selected biology because of her love for biology and medicine. Dianna explained that although her mother did not attend college, she always pushed she and her brother to attend. The product of a supportive home, Dianna attended public school until the third grade where she began a magnet program. It was at this time that she became exposed to a heavy load of mathematics and science classes. As she transitioned into middle school, although the focus was not on mathematics and science as it was in elementary school, the rigor was higher. These courses prepared her for high school where she would enter a science technology program that focused on biology. Similar to the experiences shared by the other women interviewed, Dianna too took advanced placement courses all throughout high school.

Sharing that her interest in STEM first developed in the seventh grade, and although she did not have many outside of school experiences, she explains that she participated in a lot of science career focused programs at an early age. In high school she recalled participating in hands-on labs that were practical and gave her an opportunity to view science through a unique lens. Dianna's love for science additionally was cultivated in middle school by her teacher. She describes her teacher as an open person that helped guide her towards the self-realization of her love for science. This love would continue into high school where Dianna would continue to embrace the challenges presented by her teacher. She explains that

for the first time she was in a class that although it was hard the teacher did not baby her, but still showed that she cared. Throughout high school Dianna recollects many of the messages that she received were positive towards females and science. Dianna credits her mother for many of the positive messages about women and work that she has embraced. Growing up in a predominately African-American community, Dianna explained that she didn't realize that there were not many African-Americans in science fields until she was about 15 or 16 years old. At this time she transitioned to North Carolina where she attended a predominantly White school. Her transition provided her something that she did not experience in PG County; being racially stereotyped. These experiences were from both her peers and teachers. In advanced placement courses, Dianna described experiences where she was questioned about being in the correct class by both her teachers and peers. As the only Black student in her class, Dianna began to reevaluate her move and decided to move back to Maryland to live with her dad and complete her senior year of high school.

Always wanting to attend a HBCU, Dianna additionally selected Historic University because of its geographic location down South. Describing the African-American community at Historic University as one that displays brotherly and sisterly love, she describes her major as being mostly African-American females. Although she describes feeling connected to the community at Historic University, she explains that she was expecting to see a lot of different faces. She recognizes that this is why she feels connected, because she is able to build community with other African-American students. Although she has developed a community among her African American peers, Dianna views her relationship with her instructors through a different lens. When describing her relationship with her non-African American instructors, she described these as impersonal and detached. However when describing her

relationships with her African American instructors, she described having experiences where they pushed and challenged her, rather than coddling she and her classmates. Finally, although Dianna considered changing her major, through these and a series of other similar experiences, she has developed a sense of belonging and believes that this is the best track for her in her future goals.

Narrative 7: Tamera

Smiling as she spoke, Tamera's personality and enthusiasm filled the room. She was very animated as she spoke; an excitement in her voice was obvious as she shared her experiences, particularly about her grandmother. As she smiled broadly the genuine nature of what she was sharing was overly obvious. Growing up in Prince George County, Maryland with her parents and sister, Tamera attended public school for elementary and middle school but later entered an all-girls private Catholic school for high school. Growing up in a predominantly Black community, Tamera recalls that in elementary and middle school she had great teachers. It was in middle school that she recalls that she began to do very well her mathematics classes, her love for mathematics fully blossomed. It was at this time that she was placed in the talented and gifted (TAG) program, a program for talented and gifted students. Students in this program are held to a higher standard, which was why in the eighth grade she recalls that her mother made the decision that she would attend a private school. Although it was a good mixture of Black students, Tamera attended a predominantly White high school including the staff and teachers.

Although she was in an accelerated and gifted program, she recalls that school was not interesting so she often would go to sleep in class. Even though she would complete all of

her assignment in her class and still get an “A” in the course, she was unable to relate her teachers. This disconnection she notes started when she entered high school. For much of Tamera’s middle school experiences she explains that mathematics was fun and her teachers provided challenges, particularly in the eighth grade. It was at this time that her teacher rekindled her fire for mathematics; explaining that she treated all of her students like they were her children, and wanting the best for them. It was this care that pushed her to want to be a better student.

Not wanting to stay in Maryland, Tamera wanted to attend an HBCU. After attending a few college fairs, she visited Historic University and fell in love. Her experiences in high school fueled her interest and desire to become a mathematics educator. Disinterested and disheartened with her experiences, she found herself sleeping in class one day, and being challenged by one of her teachers, she ended up teaching the class and realized she enjoyed the experience. From this day forward she began to consider majoring in mathematics. Influenced heavily by her grandmother, a mathematics teacher, she recalls that her grandmother always told her that mathematics was the gateway to everything. Although encouraged by her father to be an engineer because of her mathematics interest in the monetary opportunities, she ignored his anti-teacher sentiments and continued to pursue mathematics education with the full support of her mother.

Transitioning from high school to college Tamera felt prepared for her college level mathematics courses. Although she considered switching majors, this consideration was only after struggling with content. It’s after speaking with her advisor and getting proper guidance and direction she realized that with a little tutoring she would be successful in her class. The rigor of her high school coursework helped prepare her for the rigors of college. Tamera also

shared that whenever she shared with people that her major was mathematics, people were quick to question her choice of majors. Viewed as a male-dominated field, this message reminded her of her middle school experience where the majority of her teachers were men and where her peers looked down on their female teachers abilities compared to male teachers.

At Historic University, Tamera notes the demographics of mathematics educators are mostly foreign men and that in spite attending a historically Black institution, that there are only a few Black men and women in her department. Tamera's goal, however, is to be part of the change in how people see mathematics. With an advisor who is African-American and a woman she is inspired and encouraged that she can prove that women can succeed in mathematics.

Narrative 8: Jada

A junior computer science major, Jada, the youngest of two, was raised by her mother and her father. Growing up Jada attended both predominantly White and predominately African-American schools. Reflecting back over her experiences she shares that she was naturally good at mathematics, she just caught on. Additionally she shares a negative experience and science because of a student teacher she believes that these experiences lacked encouragement and creativity. Although she did not have a positive experience with her science teachers her interest in a science career never waned. She desired to become a doctor because of her love for animals in her general interest in science.

Actively involved in in and outside of school, Jada was in both advanced placement and honors classes throughout high school. Not only was Jada academically gifted, but also

she was athletically involved in high school playing rugby as well as cheering. Spring semester of her junior year in high school, computer science became an interest for Jada. This interest developed because of her enjoyment of mathematics. Academically Jada describes her foundation in preparation for her transition to college as lackluster, she felt like many of them just didn't care and would give out grades and did not bother to teach or engage she and her peers. She was objective about this however, noting that she did not attend tutorials and it was a "two-way street" meaning that she could have gone to tutoring to assist understanding the content. She felt unmotivated because she did not sense that her teacher cared.

Growing up the only images of scientists Jada recalls are those of Bill Nye the science Guy, a white male. Although this was the image that she recalls, the messages she remembers are those of her parents, which reinforced that, she could pursue anything that she wanted, and that STEM careers made lots of money. Encouraged by her father to pursue a STEM career, she notes that her father was very adamant about his children pursuing careers in science. Selecting Historic University because of its accredited engineering program, Jada received a lot of negative comments when she shared that she would attend Historic University. Some of these comments included a questioning of why she was attending this university rather than other similar universities. Additional comments were made about the major she selected, many people surprised that she selected a major such as computer science and said things like, "you must be really smart", and "but you're a girl".

Although entering a male-dominated field, she is hopeful that as the years go on more and more women continue to enter the field. As a student at Historic University, she feels like she is a part of a loving family, one with respect and support for one another. With both

parents having attended an HBCU, Jada expected to enter Historic University and have a great learning experience. This expectation was definitely met and exceeded Jada explains that she stepped out of her comfort zone and began to actively engage in programs with in her major and the local community of her institution. Additionally she is a member of the honors program that exposed her to leadership opportunities experiences and a family-like environment.

While Jada now feels connected to the African American community, she recalls a time during her high school experiences where she was not accepted. She has memories of being called an Oreo and being questioned about the way she spoke. This was consistent with the other women interviewed who also took honors and AP courses. Although these experiences were hard, college provided a new lens for Jada to view academic achievements. She explains that many of these experiences came directly from other African Americans rather than her White peers. Attending Historic University was an eye-opening experience for her, because it helped her to see other African Americans pursuing excellence. Although she attends a historically Black university, she still feels that there is a pressure to succeed. While in high school this pressure initially came from being the only African-American student in most of her classes, now there is a pressure to increase the number of African-Americans in her field. Jada realizes the challenge and welcomes the opportunity to increase the number of African-Americans females in her field.

Narrative 9: Danielle

Majoring in pure mathematics, Danielle, an enthusiastic junior who calls Alabama home, selected Historic University because she was looking to attend a school with people

who look like her. Danielle's love of mathematics started early in the second grade. The product of a two parent household, both she and her sister moved around a lot at an early age because of her father's career in the NFL. She attended diverse schools throughout her K-12 schooling experience. By the time she enrolled in high school she attended an Ivy preparatory school and later an international baccalaureate (IB) program where she would participate in a health Academy. Although Danielle describes her early schooling experiences as fairly mixed, she shared that the school she attended was predominantly White, Asian and Indian. It was at this time that she describes beginning to feel that she was the token Black person in her classes.

In her early experiences with mathematics she describes the impact her teachers had on her; illuminating that this teacher was a Black woman, and probably the first Black teacher she ever had that took the time to help her. This simple gesture encouraged her and set her on the path of realizing that she could do well in mathematics. However, when she entered public school from private school her experiences changed and she felt as if she were suppressed and treated as if she was dumb. It was at this time that she began doing things on her own at home in preparation to reach success and surpasses the expectations her teacher had for her. She recalled that her parents pushed mathematics and science hard, not in a forceful way, but in a way that helped her realize that she was smart and countered any negative messages she might have received at school.

By the time Danielle reached eighth grade, she realized that she wanted to pursue mathematics as a career. Initially seeing herself as a teacher, she attributes this realization to the earlier foundations set in motion by her first grade teacher. Her eighth grade teacher was what she called the icing on the cake by helping her to see herself as an actual mathematics

teacher. Transitioning from high school to college, Danielle believes that she had a solid foundation. Although in high school she encountered teachers who were not enthusiastic about teaching, the early foundations for learning had already been implanted, thus her interests continue in spite of these experiences.

Many of the early messages that she learned about girls in mathematics and sciences were broken as she encountered department of African-American women who mentored and guided her at Historic University. Determined to break the stereotype placed upon her in high school that Black people “don’t do math”, and that Black people are not smart, it was no longer just her parents encouraging her, but now a whole community as an example of success in mathematics and science.

As mathematics major at Historic University, Danielle feels empowered not only as an African-American, but also as a woman in her field. Although she notes her major is still small compared to other majors, attending conferences and meeting other from other underrepresented groups has empowered her and encouraged her that they are still Black women in mathematical sciences. These experiences are like night and day from her experiences in high school. As the only Black student in her AP courses, Danielle often felt as though her teachers and classmates viewed her as the spokesperson for all things Black. These experiences frustrated her to the point that her senior year she dropped one of her classes to avoid the experience of being the only Black student in a class.

Narrative 10: Donyela

Growing up in North Carolina, Mainstay University was not at the top of Donyela’s list of schools to attend. Throughout high school, Donyela always took honors and AP

courses. Her original desires were to attend another PWI further down south; however, she was waitlisted. Not understanding what it meant to be waitlisted, she selected Mainstay University as her second choice. She grew up in a two-parent household as the oldest of three children. Her mother is self-employed, and her father a safety engineer with a major engineering company.

Not initially interested in science and mathematics, Donyela attended majority white elementary, middle and high schools, where she recalls struggling early with mathematics. It wasn't until her mother intervened and ensured that she learned basic mathematics that Donyela began enjoying mathematics. In spite her continued disinterest in science, her love for mathematics and eventually for pursuing engineering fully blossomed between her junior and senior year in high school. It was during this time that she recognized that she was too good in mathematics to not pursue it as a future career option; this pursuit was additionally fueled by her desire to help society.

Her early experiences in her science classes gave her a glimpse of the disproportionate representation of not only African-Americans, but also additionally women and sciences. As she reflected on her class makeup, she recalls that there were never more than three women in her physics classes and only about 1-2 African-Americans at the time. Throughout high school she noted that there were always less African-American students in honors classes, and this number dropped even more significantly when she entered AP courses. She remembers counting the number of African-Americans in the room each time she entered. Adjusting to this reality because she had no other choice, she admits that it was intimidating not seen anyone that look like her in her classes.

Donyela's transition from high school to college was smoothed over by becoming actively engaged in the campus community. She took advantage of opportunities to join organizations that furthered her interest both academically and socially. One organization she joined was the National Society of Black Engineers (NSBE). Through her membership in NSBE she was able to find support and a family structure to keep her encouraged in her academic pursuits. Having two parents with Masters Degrees, Donyela notes that the messages she received from home were more positive. When faced with struggles, she is able to turn to both of her parents who she explains have experiences being the only person of color, taking classes, struggling, and taking finals. She even considered changing her major, but after a moment of reflection she realized that she had come too far to give up.

Although Donyela is a mechanical engineering major, she additionally is minoring in arts and design. This minor came at the suggestion of her mom who knew that Donyela has a passion for photography and that this was a better way to incorporate this love and find a realistic balance.

As a student at Mainstay University, Donyela's identity is still developing; however one part of her identity that she emphasized has become clear is that she is a Black female in engineering. The emphasis placed on being a Black female is a result of Mainstay's majority White male campus. As a junior she has only had one African-American female instructor in engineering, and majority of her instructors have been White a males. As stated by the other women, she also shared that her transition into college increased her circle of African-American friends. Many of the experiences at Mainstay University were a reflection of her experiences in high school. Although more overt in high school, these feelings left her feeling disconnected from the school community as a whole and wanting to tell her teachers

and peers that she was not the spokesperson for Black people. However now, these overt experiences have pushed her to excel within engineering so that she can increase the number of Black engineers.

Composite Themes - Counter Storytelling

In this section I present significant findings, organized using collective themes. In an effort to present a full narrative of each woman's story and its interrelatedness, direct quotes from each woman is used. Each quote was selected based on its direct connection to, and illumination of the emerging theme. Within the collective experiences, there were 14 themes (see Table 4). The themes discussed were a part of the collective experience; however, within each woman's story were experiences directly connected to the institution type each woman attended.

In an attempt to describe the wholeness of each woman's experience (Moustakas, 1994), textual descriptions and meaning were applied to the collective emergent themes. This study yielded rich narratives that illuminated the significant contribution and impact of the K-12 experience on the African-American woman's undergraduate selection of a STEM major. A narrative approach was ideally suited to reveal how these K-12 experiences impacted the lives of African-American women majoring in a STEM field. A narrative provided an opportunity for each woman's voice to be heard, and gave meaning through participant reflection on their individual experiences. Those meanings led to a greater understanding of the collective experience for African-American women.

Among the fourteen significant composite themes three themes resonated with all ten women. Those three themes were early interest in STEM, belonging – established a family institution, and K-12 success in mathematics and science. Additionally there were eight themes that resonated with nine of the ten women. Those eight themes were AP honors courses – college readiness, family support, positive view of the African-American community, considered changing major, a lack of African-American STEM instructors,

messages on who could pursue STEM, K-12 teacher support, token and an stereotyped – high school. The remaining three themes of father’s stressed STEM careers, extracurricular involvement, beyond academia – internship and conference experiences were attributed to five of the women. Although these themes were emergent among only five women, the weight of their impact was significant and worth including for analysis and discussion.

Using this data, I have taken each theme and created collective counterstories framed under two of the six CRT tenets: *Experiential Knowledge of People of Color* and *Rejecting Dominant Ideologies* (See Table 5), while the other tenets (eliminating racial oppression, the endemic nature of race and racism, the historical analysis of the law and CRT as interdisciplinary) are naturally interwoven within the narrative presented. Embedded within each of these counterstories is their connection to BFT. These themes explicitly and implicitly are connected within the counterstories. One such theme is BFT’s recognition of the commonalities among Black women and their experiences. These commonalities thus are revealed in multiple contexts and as such are understood through their varying experiences (Collins, 1986, 1990; Howard-Hamilton, 2003; King, 1988).

This section is divided by the two tenets and the collective emergent themes that fall within its context for discussion. Using counternarratives, I provide examples of the connected nature of each woman’s voice and use CRT to provide a frame for understanding their experiences. As noted by Solorzano et al. (2000) CRT’s function in education research serves to not only place at the forefront issues of race and racism, but serves as a challenge to traditional paradigms by providing an understanding of the social impacts and its roots.

Table 4: Composite Themes Among All Women

<i>Significant Themes</i>	<i>Participants</i>
1) AP Honors Courses – College Readiness	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna
2) Early Interest in STEM	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna, Brianna
3) Family Support	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Dianna, Brianna
4) Belonging – Established a Family at Institution	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna, Brianna
5) Positive View of the African-American Community	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna
6) K-12 Success in Mathematics & Science	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna, Brianna
7) Considered Changing Major	Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna, Brianna
8) Father’s Stressed STEM Careers	Jada, Tamera, Donyela, Dianna, Brianna
9) Lack of African-American STEM Instructors	Jada, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna, Brianna
10) Messages of Who Could Pursue STEM	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ericka, Dianna, Brianna
11) K-12 Teacher Support	Jada, Danielle, Tamera, Tyra, Donyela, Ashley, Ericka, Dianna, Brianna
12) Extracurricular Involvement	Jada, Danielle, Whitney, Donyela, Ericka
13) Tokened & Stereotyped – High School	Jada, Danielle, Tamera, Tyra, Whitney, Donyela, Ashley, Ericka, Dianna
14) Beyond Academia – Internship & Conference Experiences	Jada, Danielle, Tyra, Whitney, Brianna

Table 5: Composite Themes Aligned With CRT Tenets

<i>Composite Themes</i>	<i>Relevant CRT Tenets</i>
1) AP Honors Courses – College Readiness	<i>Rejecting Dominant Ideology</i>
2) Early Interest in STEM	<i>Rejecting Dominant Ideology</i>
3) Family Support	<i>Experiential Knowledge of People of Color</i>
4) Belonging – Established a Family at Institution	<i>Experiential Knowledge of People of Color</i>
5) Positive View of the African-American Community	<i>Experiential Knowledge of People of Color</i>
6) K-12 Success in Mathematics & Science	<i>Rejecting Dominant Ideology</i>
7) Considered Changing Major	<i>A Contextual and Historical Analysis of the Law</i>
8) Father’s Stressed STEM Careers	<i>Rejecting Dominant Ideology</i>
9) Lack of African-American STEM Instructors	<i>Rejecting Dominant Ideology</i>
10) Messages of Who Could Pursue STEM	<i>A Contextual and Historical Analysis of the Law</i>
11) K-12 Teacher Support	<i>Rejecting Dominant Ideology</i>
12) Extracurricular Involvement	<i>Rejecting Dominant Ideology</i>
13) Tokened & Stereotyped – High School	<i>A Contextual and Historical Analysis of the Law</i>
14) Beyond Academia – Internship & Conference Experiences	<i>A Contextual and Historical Analysis of the Law</i>

Counterstory - Rejecting Dominant Ideologies

Early Interest and K-12 Success in Mathematics & Science

Threaded throughout the narrative of each woman's individual and collective experiences are issues of race and gender. Themes situated under the construct of rejecting the dominant ideology shed light to educational issues surrounding White privilege and reject notions of neutrality. Recounting numerous stories beginning as early as elementary school, each woman shared overwhelmingly positive and consistent exposure and experiences with both mathematics and science. These early experiences served as tools of empowerment and provided a new narrative, displaying the elimination of barriers created through racism, sexism and poverty (Solorzano & Yosso, 2002). Statements such as the one made by Ericka, "I started noticing that I paid more attention in my science class than the rest of my classes. I enjoyed ... I felt like when I walked into science I felt like yeah this is going to be fun", were consistent among the narratives provided by each woman. One such experience shared by Danielle is consistent with research conducted by Ellington and Frederick (2010):

My first experience was first grade. We were learning how to do graphs at my private school in [a city in], Georgia, and for some reason I just couldn't get the graph down. My teacher, Ms. Davis, she was a Black woman. That's probably the first Black teacher I ever had, she would sit down with me and help me with it. She was like, "Well you can do it. You're fine. I don't know why you're in here," because I wasn't allowed to go out to recess until I finished my graph. She was like, "Well you can do it. You're fine. We'll work on it next time," so that's when I was like, "Okay, well maybe I can do this."

Ellington and Frederick (2010) note that these early experiences create the framework for students of caring teachers and a quality learning experiences not generally provided to Black students. This support, as described by participants in Ellington and Frederick's (2010) study, helped them develop a "love" of mathematics. These statements were consistent among the ten women. The word love was consistently used to describe early exposure and interest in both mathematics and science. Multiple women used statements such as, "I just got it" when discussing their early mathematics experiences. When describing early science classes and programs, consistently women made note of the interactive and engaging nature of their experiences. These real-world hands-on experiences created a foundation for learning, thus supporting the scholarly call for early exposure to science and mathematics; a call that is often overlooked because of the staunch need for disaggregation (Espinosa, 2011; Goldman, 2012; Oakes, 1990).

Early exposure has proven to develop an increased interest for girls in science and mathematics. Through continued exposure, interest are further stimulated and maintained, developing girls who are confident in their abilities. Every woman mentioned having an early exposure and interest particularly to mathematics and science, and as a result continued later pursuit of this early interest. This early experience only serves as a tool to equip women with the confidence and the understanding to later shift and shape the paradigm of STEM fields (Wyer et al., 2001).

As noted earlier one tenet within the CRT frame is the concept of rejecting the dominant ideology. One ideology worth noting is the concept of meritocracy as a myth, the misconception that knowledge and skills within a subject alone is enough. As each woman expressed, she was good in mathematics; however it was her ability to "just get it," coupled

with a cultivation and support from teachers and family that contributed to each woman's academic achievement. Scholars McNamee and Miller (2009) identify that the ideology skills alone is a false one, and that in order for this to be a true ideology, there would first have to be a system of education equality. They note that the concept of meritocracy in fact is a myth, that meritocracy only becomes true when educational opportunities are equal. Imbroscio (2015) explains that the merits of meritocracy set forth to "propel the haves" while simultaneously reducing the "have-nots", inadvertently creating a system where fairness and justice are awarded to the deserving. Thus by accepting meritocracy as truth rather than a myth, each woman's early interest and success in mathematics and science alone would be enough to ensure her continued trajectory of success. Rather, considering that while merit is the initiator of academic achievement, there are many systemic barriers preventing Black women from even entering, let alone achieving academic success.

Messages on Who Could Pursue STEM

A false assumption is that African American women are not interested in pursuing STEM fields. Yet, the mixed messages each woman received did not serve to sway her pursuit, but only worked to provide greater insight to fuel her endeavors. Whitney explains:

A lot of it was that it's not a field for women for sure. A lot of that came more from classmates rather than the teachers and people, mentors, people I looked up to. A lot of times these classes, these engineering courses, the concentrations that I had in middle school and high school, they were mostly guys in those fields. The girls went more towards the medical field and wanted to be nurses and things like that. They

were like, "Why don't you go with the ..." sort of thing. It was more criticism from classmates rather than, I guess, the older people.

Consistently shared were gendered messages and even surprise reactions on many of the women's intended undergraduate major selections. Tamera reflected having experienced both gendered messages and surprise reactions from her peers that she was a mathematics major:

They didn't expect me to be good at math just because I'm a girl. I always get that look with Black people they always think I don't look smart. I always get that all the time. People always think that I'm in the lower [math]. I'm doing math in the computer lab one time, this boys looking down my shirt he's like, "Oh. What math are you in? 103?" I said "I'm in cal 2." He's like, "Oh. You're in cal 2?" I'm like, "Yeah. What?" He's like, "What's your major?" I said "Math ed." Every time I say math education everybody's just like, "Oh." It's a shock I guess because they don't see a lot of girls doing math. That's honestly what I think it is. I always get the same reacting every time I tell somebody my major.

Scholars (Astin, 1993; Harper, 2013; Pascarella & Terenzini, 2005;) note that peers have a great influence on student experiences. While these scholars speak directly to undergraduate influences, these influences begin long before women enter their undergraduate experiences. While women often experienced racial and gendered messages about who could pursue STEM, their peers additionally acted as sources to counter these messages. Harper (2013) explains that same-race peers often act as resources, teaching peers how to handle stereotyping and experiences of isolation.

While peers play a role in presenting gendered and racialized messages on who can pursue STEM, these messages of who could pursue STEM fields did not deter each woman

in her pursuits. Expressing consistent success in mathematics and science classes throughout their K-12 experiences, nine of the ten women expressed that as a result of this early success they went on to take honors, college and advanced placement courses, experiencing high levels of achievement. Tamera described her success in mathematics:

After freshman year I did good in math, I got an A, so they put me in honors math. At first I'm like, "Honors math. This is going to be hard." My teacher that year, she saw that I was really good in math and she was like, "Oh. Yeah, you're going to honors math." She had me in honors math. I'm doing good and I'm doing good in it. Then junior year comes and it was time to take pre-cal... Then I took honors pre-call and got an A in that and my AP class.

This success generated a belief and a confidence in their ability to pursue a STEM major at the collegiate level. Donyela explained that her experiences in mathematics inspired and encouraged her to pursue a major with a mathematics focus: "I think maybe the beginning of high school I was like, it's got to be something math related, because I love math and I'm too good at math not to do something math-related." Research supports that the rigor of advanced placement and honors courses provide greater preparedness and encouraged the selection of STEM majors (Tsui, 2007).

One challenge to messages that African American women receive about who can pursue STEM is connected to the dominant ideology of interest convergence. Bell (1979) argues that while Whites may agree that Blacks should have equal rights and should be protected by the constitution, this agreeability ends when the potential for an outcome that serves to advantage Blacks over Whites. Interest convergence is the premise that Blacks can obtain racial equality only when the adjustment or change supports the interest of whites

(Bell, 1979). For example, several women mentioned often times being one of a few, if not the only Black in their honors and advanced high school classes although they attended racial diverse high schools. These situations can be viewed as an example of interest convergence. It did not serve the interest of Whites to increase the number of Black students within these advance classes, yet the interest was served by ensuring that at least one or two students were represented in number. It would be preposterous to assume that out of an entire student body that only one African American student is qualified to take an honors or advanced course. Therefore interest convergence provides the foundation for the message that African American women can pursue a STEM major is only realized when it supports the interest of Whites.

K-12 Support and AP Honors Courses

Coupled with their academic experiences were the significant roles K-12 teachers played in exposing participants to science and mathematics. Nine of the ten women identified teachers that played a major role in their interest in science and mathematics. The role these educators played transcended beyond the classroom and in some case became interpersonal. The women used terms like “he pushed us”, “she was with me”, “my teacher was just really helpful”. The student-teacher relationship is a well-known factor influencing the persistence and transition of African American students in their K-12 experiences and beyond (Baker, 1998; 2006; Conner et. al, 2014; Duchesne et. al, 2009; Silver et. al, 2005; 2010). Tyra describes her relationship with her teacher as one that was more than academic:

She would always joke with me during class. She helped me write my college essays, for my applications. She would ask me to come in and help her grade papers, stuff

like that. She really supported me a lot, actually my senior year she was really supportive even though I had already left her class. I would still stop by and go talk to her during lunch, tell her about any issues I was having. If there was one morning where I just had to vent to somebody about something, she had a free period and I would just sit down and talk with her and she would listen and she'd give me a pass to go back to my class and say, "She was with me." That was really helpful I think during my senior year of high school.

Teachers such as those described served as channels, building relationship with students that moved across social, cultural, financial and economic lined, providing students with capital that could be applied towards future success (Freeman, 1997). Tamera stated:

I was taking an AP class and I was like, "I don't want to take AP and honors pre-cal." I dropped honors pre-cal because she was like, "Why did you drop honors pre-cal?" She was like, "You can do it. You can do both." She was pushing like, "You can do both. I know you can do both." I'm like, "No. I can't do both." I'm like, "I can't do both." Then I took honors pre-call and got an A in that and my AP class. She was basically telling me I always try to take the lazy route sometimes. She was like, "No. You need to stay in it." She went to my guidance counselor and made sure I was in the class because she wasn't having that. She wouldn't let me do it.

In this example Tamera discussed an experience where her teacher's high expectations and belief in her had an impact on her later selecting her undergraduate major.

Often a source of confidence and support for student achievement, the role teacher's play is a pivotal one. However while often a source of encouragement and support, they can perpetuate dominant ideologies of racial and gender stereotypes. Ideologies often embedded

within the fabric of our educational system. Fordham (1993) provides an example where teachers showed lower confidence in African American female's abilities and thus in return provided less assistance when compared to their White peers. Although expressing how their AP and other honors courses prepared them for their future academic rigors, women also had to learn how to navigate waters of endemic racial and gendered experiences. Taliaferro and DeCuir-Gunby (2008) explain that African American students are often "acutely aware of the opportunity gaps," (p.179) expressing concerns including racial isolation, thus advance placement and other higher level courses come with possible damaging effects, effects that could possibly deter African American women from their interest in pursuing STEM fields.

Consistent within the dominant ideology of education, often encouraged and perpetuated by teachers beyond the concept of meritocracy is the idea of colorblindness. Colorblindness asserts that in order to ensure all students are treated fairly, not "seeing" their color and factoring issues of race is the answer. Often within the construct of their honors and AP courses students consistently noted that they were the only Black students. By then not acknowledging a student's race in situations where women were often the only Black student in their high school classes, creates an atmosphere of isolation and gives way to opportunities for microaggressions against African American women to develop. When teachers embrace a colorblind ideology, they make a choice to ignore factors that students bring to the table that may impact their performance within a class setting. Danielle shared an experience that continued into college. In her experience she notes the impact the messages she heard about who can pursue mathematics had on her. Danielle explains:

Girls don't do math, girls don't do science, and if you are, you're really smart, and if you aren't, you're just a regular girl. What are some other things I heard? If you're

going in something that's math or science, you're going to be around a lot of boys.

You're going to be alone because there's not a lot of color, and I still hear that being in college. It is true. What else did I hear? I heard Black people can't do math. I heard that. Those type of things, they inspired me to do it. It does, at times still keeps me going. I'm like, "Uh, yeah. I can."

Although Danielle continued on in her pursuit of a STEM major in spite these sentiments expressed, the role teacher's play is one of utter importance. Teachers should help students navigate the rocky waters of race and gender issues, rather than playing a neutral role and expecting students to ignore the differences they see and feel.

Tokened and Stereotyped Experience in High School

One salient experience many women expressed experiencing were feelings of isolation and tokenism. The classroom environment is just as important as what individuals who facilitate those environments. Nine of the ten women spoke explicitly about feelings of isolation, expressing being often times one of a few, if not the only Black student throughout their high school experiences. Consistent among all the women were the shared experiences of being placed in classes where they were the only Black female, furthering their invisibility and the need to fight for a voice (Malcolm & Malcolm, 2011; Smith, 1978). The women shared that this experience made them feel like a spokesperson for Black people and any and all associated topics. Tyra said:

I was put in a class where I was the only Black person sitting in there. Other students noticed that too because I would have my other Black friends come up to me when I was out of class and say, 'Oh Tyra you're my role model. Someday I want to be like

you.' It made me feel good, but at the same time it was like, it doesn't have to be like this. The teasing would come every now and then like, "Oh you're not really black. You want to be like the white kids." No I didn't. I just wanted to get through school. I wanted to graduate.

This statement described by Tyra is an example of a colorblind view. Tyra was viewed as "not black" and as a result she felt disconnected and lonely. Although made by Tyra, this sentiment and similar statements were repeated among eight of the ten women. Often each woman described feelings of being isolated because of their association with majority White students. This association often was by nature of the classes they were taking.

Another aspect of their tokened experience was being selected as the spokeswomen for the African American community. Danielle provides a salient example of the assumption that because she was the only African American in her class, that she would be able to answer a question regarding African Americans. Her reflection on the situation is similar to what many of the other woman expressed. Danielle described her experience stating:

High school 11 and 12th grade, like I said, sometimes I was the only Black kid in the class, so they weren't, my classmates weren't as conscious of what they said or how loud they said it...[I] still heard things, so it was something stupid, something as stupid as, why when they would say something and they expect me to roll my eyes or roll my neck. I'm like, "Not all Black people act like that. Not all Black women act like that." I just say there's something wrong with women that do act like that, but we don't all act like that so don't expect me to react that way to whatever dumb joke you just made, I'm going to just going to tell you, "No. You're wrong."

Experiences of being stereotyped and often made to feel as the token are examples of the endemic nature of racism. Masked often by a color blind approach, experiences of stereotyping and tokenism only serves to further perpetuate the endemic system of racism. By not acknowledging the role history plays, and acknowledging and addressing the roots of such stereotypes, the doors are opened for further oppressive behavior to continue (Gontanda, 1991).

Beyond Academia – Internship, Conference and Extracurricular Involvement

While experiences of tokenism and being stereotyped during their K-12 experiences continued into their undergraduate experiences, its impact however served as a catalyst in most cases for women and their pursuits. These early experiences prepared women for later experiences such as those experienced during their internships and attendance at conferences. Several women mentioned attending internships and field related conferences and the value these experiences had on their understanding of the need in their fields. These unique experiences gave them an opportunity to understand what future opportunities were available and to fully see that the lack of diversity extended beyond their undergraduate experiences and into their corporate experiences.

Internship and conference experiences provided each woman with a level of confidence in her abilities to achieve levels of success within her field. However, within these experiences women were able to see the challenges first hand that they may later face and given the opportunity to begin grappling with emotions that may come with these experiences. These internships additionally provided women with salient examples of possible different gendered experiences they may face. Entering these environments, women

may face different challenges than those of their male colleagues (Spencer, Steele & Quinn, 1999). For example, Whitney shared her experience of being mistaken as the secretary while at construction site during her internship. She recounts how the men who were making the comments had to be corrected by her supervisor. Although internships are great opportunities for networking and to establish a foundation for a future career, these experiences are not absent from and often reflect the racialized and gendered encounters experienced at each woman's home institution. Not all of the opportunities were stereotypical, but some of them served as tools of empowerment. Danielle explained:

Right now within my major, it's empowering because like I said, a lot of my peers in my major in my class are African-American females, but I'd been afforded a couple of opportunities to go to conferences, to national conferences. I've been to Opportunity Conference, which is a conference for underrepresented women in STEM, and so even there, although it was a lot of women there, there was still not as many Black women. Then last month I got to go to a Greater Opportunity Conference in the Mathematical Sciences, and I was going to be the only Black people there...It was almost like a wakeup call to see what it's really going to be like when I get out in that I'm in the math world, but as far as in my department and in my major right now I'm feeling very comforted and loved and empowered and I know that it's going to make me a better mathematician or statistician when I go out, and I'm confident in myself and in my abilities when I'm the only Black person or the only Black woman in the room.

Even though Danielle was the only African American, this experience served to empower her to continue in her field in spite the lack of diversity.

Considered Changing Major

Being stereotyped can offer an unnecessary burden to women in their academic pursuits, additionally the added pressure to succeed was the cause of nine of the ten women considering a change in major. While their considerations ranged in the level of complexity, one reason that several of the women noted was a drop in their academic performance.

Donyela shared that although there were many reasons, none of the reasons equated enough of a reason for change. However one consistent reason was a questioning of their ability to be successful and even the need of their major to do what they really wanted to do as a career.

Dianna explained:

That's funny because I'll have to think about that today, after the test. No. I mean, I thought about some other things that I was interested in and also in speaking to medical school advisors, would be the technical term, and them saying that a biology major isn't needed to get into medical school and also they like seeing the diversity of different majors, I've thought about it, but in thinking personally what I think I need, I think my track is the best track for me because if I go into something like, I'm interested in psychology.

Often this questioning was the direct result of a lower than expected test grade. Studies have found that females have significantly higher rates of test anxiety, anxiety that in turn effect their grade outcomes (Chapell et al, 2005). These lower grades and the pressure associated with maintaining grades made many of the women reflect on their major selection. While most women described experiences directly connected to their academic performance, several women discussed significant institutional characteristics and the ways in which these characteristics contributed to their connection to the campus community. Such structural and

social aspects contribute to attrition rates for African American women from STEM majors. Students additionally consider changing their major when there was a failure to establish a sense of belonging at their institution.

Irrespective of their contemplation on changing their major each woman stayed in her STEM field. As the women discussed why they considered changing, most of them admitted that if they were to change their major that they were unsure of what they would change their major to, but that if they did change their major it would be to another STEM major, such as another type of engineering. As described by Ericka, “I considered changing from electrical, but I never considered changing from engineering.” Research often attributes attrition from STEM majors to structural and social aspects of the institutional experience. Scholars (Espinosa, 2011; Goldman, 2012) often contribute this attrition, particularly in STEM areas to classes sizes, which are usually large and lecture based, faculty that is unapproachable and feelings of being isolated in collective and group settings.

Through this section I attempted to deconstruct the numerous layered intricacies of race and racism and counter those dominant ideologies as they aligned with major composite themes. My goal was as scholars argue when dealing with multiple theoretical perspectives, not to cast my net wide and address every concern possible (Ladson-Billings & Tate IV, 2006), but instead the goal was to draw attention to the large scale structures of racism, drawing attention to its deeply ingrained presence while providing a counterstory to experiences in spite the endemic nature of race.

Counterstory - Experiential Knowledge of People of Color

Family Support and Fathers Who Stressed STEM Careers

Academic experiences are not the only factors that influence a student's selection of a STEM undergraduate major. Family support plays an important role in the successful matriculation of African-American women into their future STEM majors and fields. Family support provided nine women with a voice in what in many cases is often a white and male-dominated narrative. Several of the women when asked to describe what images they perceive when they think of a scientist, described white males, including even stating that the image they recall was that of "Bill Nye the Science Guy". Dianna expressed that when she was asked to reflect, "the first thing that comes to your head is the little Google image of a white man in a lab coat with a bunch of chemicals in front of him...that was pretty much it."

Thus family plays a critical role in reshaping these images and shifting the view of each woman possibilities of beginning to see herself within the narrative of STEM. Therefore the knowledge gained from prior experiences with family can be used to craft a counterstory that helps them later navigate within their STEM major. One theme that arose among half the women was the way in which fathers influenced each of their STEM pursuits. While researchers (Smith & Fleming, 2006) note the important impact of parental involvement, often the voice of a mother is highlighted. However in this study the voice of the African American father was equally important. With several women expressing that their father currently worked in a STEM field, their ability to share first hand experiences and knowledge was something invaluable and described by many of the women.

A safety engineer, Donyela recalled messages about STEM from her father, these messages about STEM fields later directly influenced her major selection and pursuits. "He

always says any STEM field is going to be difficult, simply because they don't want just any old person doing the things that an engineer does, or mathematician does or anything like that.” Additionally Brianna’s father, a nurse, played a pivotal role in her initial interest and eventual selection of her engineering major. She described his influence:

He believed education is the ultimate envelope to uplift your situation and because I come from a collective culture, whoever I guess is higher up are most stable. It's a not an obligation, but it's like, usually our culture to help, those around you and the family, to up lift them....I had teachers that kind of pushed me but I guess the ultimate deciding point would be my dad. He... I guess, like looking at, I don't think that's initially his intention, but looking at college graduates and I guess the easiest to find jobs are usually STEM. So he would kind of try to push me, "Have you heard about this major? Have you heard about this thing?" So he kind of like guide me, and then I started looking into it.

Consistent with literature mothers tend to play a major role in African-American children academic pursuits, however half of the woman described the influence of their father and it was obvious that they were intentional in exposing and pushing them towards STEM careers, an influence often over looked in research.

While every woman mentioned the influence of their mothers, family support was not limited to mothers, but included fathers, grandmothers, god-mothers and even church family. This support came in the form of words and action that later influenced many of the women’s selection of a STEM major. Nine of the ten women discussed the direct influence and support of their family throughout their K-12 schooling experiences. Many women described that their strongest messages and influence came from members of their family. Whitney stated:

I think the strongest messages came from my family, more specifically my mom because she had been my teacher from day one. She was never actually literally my teacher in elementary school; however, she has always been that teacher behind me making sure that I was learning what I needed to learn. She always had pushed me to I guess, aim for better and go for more no matter what it was in.

This foundation of support would later assist each woman during her transition and matriculation at her institutions of higher learning. In many cases family support served as a counter to negative messages received from, teachers and peers. Breanna recalled that her parents gave her what she called a “disclaimer”. She explains that they said to her, "Even though this is what you're seeing there, they do exist". These words were a counter to what she often saw and would see during her undergraduate experience, which was major White and male. Consistently nine of the ten women attribute their K-12 success to their family support structure.

Often negated are the experiences that African American women have, which provide support and empower them, giving them a voice. History has served to silence people of color, but the narrative experience serves to give people of color back their voice. While Delgado (1989) explains that counterstories break down barriers and dare to provide a new lens to view the existing state of society, these counterstories are for more than just African American women and other people of color. By listening to the narratives of others, members of the majority and those often in power are provided with a view of experiences outside of their own. Our realities are not constructed by single instances, existing in isolation, but rather are complex layers from our connection to the world around us. Using a counterstory to challenge the stock story, adds to the layered experiences by which we understand the

world around us. The family structure offers African American women a window into realities that education may not provide. The often White and male dominated science and mathematics classroom lens is shifted and refocused by each woman's experience. The family provided a counter to the dominant messages women were hear, and thus this invaluable experiential knowledge from participant's fathers and in all but one case with their mothers created a different lens for women to view their own experiences.

A Sense of Belonging, Family and a Shift in the View of the African American Community

Critical to the success of African American women at their institutions and within their majors was their sense of belonging. Belonging which comes in many different forms, one of which is through an established sense of community; a community that often acts as a bridge for family and connectedness within and outside of a woman's field of study. Researchers Washington and Moxley (2003) note that important to the psychological development and overall success of African American women in STEM majors are the connections they form with others. Hurtado and Carter (1997) suggest that students of color must maintain affiliations that create and generate a connection to the community which essentially become their home away from home. These values extend beyond the classroom and are aligned with goal-directed activities. Nine of the ten women shared narratives of how their affiliations created or shifted their views of the African American community towards a positive light.

Common among all women was an established sense of family at their respective institutions. Although these experiences could be delineated by institution type, each woman explained the essential role that their institution played in making them feel like they

belonged to a family. Common among each woman's experiences were an established sense of belonging. Several women explained that they currently had more African-American relationships than they did in high school. Relationships which research describes as buffers against cold and isolating STEM experiences. These positive relationships not only act as buffers to isolating experiences, but act as tools of persistence with in their STEM major. Donyela described her institutions environment, explaining that the support she received was a major reason she did not transfer schools. "My African American, Black friends, it's through the experiences that I've had with them that has really kept me here." Many women described their experiences of being a part of a family as the reason they drew closer to their institution. Experiences which served to heighten their sense of belonging to their campus community, Jada described her experience, stating:

I wanted to go to HBCU because I like the feeling of family. I've gone to a few homecomings because both my parents went to HBCUs and I just loved, it's like you always have someone there. You always have someone by your side who's going to support you. The teachers are really supportive, things of that sort, and it was close to home and they gave me money.

While this family feeling was common among many of the women attending Historic University. For students attending Mainstay University this same family community was established through organization association. Ashley shared her experience explaining "Within the minority engineering program you still have organizations such as NSBE and SHIP and it's like I have this family where I can talk about these things...It's good to have a sort of family away from home." These organizations rather than the institution served as a buffer for students. Organizations such as the National Society of Black Engineers and the

minority engineering program served as bridges to connect students to a family and assisted them in establishing a sense of belonging. Important in this sense of belonging was the common shared experiences among other African-Americans.

Most women conveyed that they experienced a shift in their view of the African American community. In previous experiences women explained that their view of the African American community during their K-12 experiences were shaped by a lack of African Americans in their classes and extra-curricular activities. These shifts in belief were consistent among the relationships with both African-American peers and African-American instructors. Those attending a PWI were not the only women whose views of the African American community shifted; women at Historic University consistently mentioned a shift in their view of their African-American instructors. Those attending Mainstay University mentioned positive relationships with African-American instructors specifically associated with the institutions' minority engineering program. This positive view of the African-American community in many cases was a change from previous views within the K-12 experience. Ashley explained:

As far as like African-Americans on campus, every time I see them, no not anytime I see them, anytime I go somewhere I always see somebody I know, like no matter where I'm at I'm going to see someone. That speaks volumes to me because it's always a reminder that I'm here alone there's someone else, even if you're not in engineering, I'm still the Black community where we're pretty close...I don't want to be like, because you're not Black, but it was just, I guess like the shared experiences that a Black community has and it's like we can oftentimes relate. We can say

something and no one's offended because it's like, "okay, I know where you're coming from. I know what you're talking about."

Nine of the women described their closest associations as predominately African-American. This theme aligns directly with research on belonging and identity. For several of the women this was a shift from their K-12 experiences, explaining that the shared experiences create a necessary support system. Ericka explained, "Right now, mainly with African Americans I've been seeing them all as being family. That's really been my core thought. It's mainly been I need to find a family here, and that's what I've been thinking of them." Many women felt like they belonged within the African American community and believed that they and their African American friends had shared experiences and were moving towards similar academic goals. This was a shift from what several women believed about African American peers, particularly in high school.

Establishing a sense of belonging and a connection to a community is critical for African American women following selecting and entering their undergraduate STEM majors. African American women regardless of attending a PWI or a HBCU are faced with issues of race/ethnicity, gender and social class. CRT is interdisciplinary in nature and is a tool to explore and intersect these issues. Working toward eliminating oppression in the broader context, CRT in this case serves as a tool to help understand why each woman was drawn toward other African Americans. In spite of the Black/White binary still being present, CRT provides an introspective look that goes beyond the lines drawn by history and even contemporary boundaries in efforts to challenge the dominant ideology (Yosso, 2005). These ideologies include ideas of colorblindness and meritocracy, which often when entering into an undergraduate experience African American women are faced with. Yet in drawing from

Black Feminist Thought, each woman found a sense of belonging and established a sense of family with other African Americans as an acknowledgment that as individuals they possess multiple identities. These multiple identities range from race, gender and even class; identities that have begun to intersect and take shape, contributing to the range of their experiences and desires to feel connected (Carbado & Gulati, 2013; Crenshaw, 1989). Finding a sense of belonging with other African Americans was a way to draw from their collective experiences and gain strength and encouragement to continue in their STEM major.

The collective experiences of the women in my study can be framed by understanding a term forged by Crenshaw (1989) called intersectionality. As defined in her work intersectionality is a way to understand the “various way[s] in which race and gender intersect to shape the multiple dimensions of Black women’s employment experiences” (Crenshaw, 1989, p.139). In the case of my study, it serves as a means to understanding how race and gender shaped their academic and social experiences. By viewing their experiences through the lens of both race and gender, patterns that are explicit to Black women emerge. For example Riegle-Crumb et al. (2011) consider the intersection of gender and race on adolescent youth’s career aspirations. In their study they viewed the disaggregated data of African American, Hispanic and White adolescents’ attitudes towards science and mathematics careers. Their findings show that African American males displayed a similar trajectory as White males in terms of their early aspirations and science career aspirations. Without disaggregation it may appear that the experiences of all African Americans are the same. Thus through disaggregation and using an intersectional lens, an understanding of the complexities of collective and individual experience is witnessed.

In addition, used by each woman throughout this study was the word “family.” When discussing the role family plays in the intersection of gender and race Collins (1998) explains that by establishing a home, women find and establish security within the boundaries of race and gender. Collins (1998) states:

In the United States, the traditional family ideal’s idea about place, space, and territory suggest that families, racial groups, and nation-states require their own unique places or “homes.” Because “homes” provide spaces of privacy and security for families, races and nation-states, they serve as sanctuaries for group members. Surrounded by individuals who seemingly share similar objectives, these homes represent idealized, privatized spaces where members can feel at ease. (p. 67)

Thus explaining the high value each woman placed on their sub-groups of friends and support within their STEM majors. The concept of family is associated with membership requirements. In order to be considered a member, there first has to be an established connection through some common experience. Therefore it is understood that being both Black and a woman majoring in a STEM field, that their experiences intersect and thus connect them as family.

While research provides evidence that negative racial and gender experiences can impact gender, racial and even STEM identities (DeCuir-Gunby et al., 2009), intersectionality provides a lens to view the experiences of Black women majoring STEM fields. It reveals the complexity of the experiences in STEM that Black women face. These experiences when viewed through both race and gender reveal the ways in which Black women experiences move beyond the boundaries of the limiting lens of only race or only gender. Crenshaw (1991) frames the importance of intersectionality when studying women of

color through her example of the experiences of battered women of color. In her example she explains how a law enacted to protect against marriage fraud served to further marginalize these women. She explains that intersectional subordination, which is the failure to recognize the multiple and simultaneous factors of oppression at work, served to disempower these women, furthering their vulnerabilities (Crenshaw, 1991).

Finally, as noted in the literature review section, the historic nature of STEM fields constitutes a greater understanding of the experiences of African American women in STEM majors. The White male affinity should encourage a look beyond racial practices of STEM majors, looking to understand the ways in which race, gender and class work in conjunction contributing to the experiences of African American women.

Lack of African-American STEM Instructors

Consistently expressed was the lack of African American STEM instructors. While it was noted repeatedly there was a lack of African American STEM teachers at the K-12 level, it was made abundantly clear upon entering their collegiate experience. Women at both Historic (HBCU) and Mainstay (PWI) expressed a lack of African-American STEM instructors. While this factor historically is expected and often described as an experience at White institutions, Black students entering PWIs become hyper-aware of the White campus culture that they are now a part of, and often times begin to examine their identity (Feagin & Sikes, 1995). However, four of the five women attending Historic University, a HBCU, described a lack of African-American instructors within their departments as well. Dianna recalled trying to remember how many African American professors she had. As a sophomore biology student she explains, “I’m trying to think how many African-American teachers I’ve had. Right now I can only think of one, and that’s the one that I have right now”.

While research supports the lack of African American STEM instructors at predominantly White institutions, this theme was consistent for nine women. While there is a concern for the number of African American women entering STEM majors and fields, this concern is just as real for the pipeline of African American faculty. Smith et al. (2004) expressed that often this lack of diversity is directly linked to leaks in the number of African Americans obtaining PhDs. These leaks directly affect the number of STEM faculty regardless of the institution type.

Although those who attended PWI's were exposed to far fewer African American instructors, they found connections to African American women through the minority engineering and other similar organization based campus programs. Several women additionally recalled that outside of the minority engineering program instructor, that they had not had an African-American instructor. Donyela stated, "I've only had one African American professor, but she's the director of [minority engineering program], so I already had that relationship with her."

Consistent with research, many of the women described their STEM course instructors as predominantly White or foreign, repeatedly each woman expressing the lack of African American and even African American women within their majors. Whitney said, "With engineering, it's very diverse. There's a lot of [different professors], especially foreign faculty on campus." The lack of African-American instructors can serve as a tool of discouragement, however in several cases the women used it as a tool of encouragement. Statements such as the one made by Brianna provide a glance at the reality woman in STEM face: "Well, I've only had one Black engineering faculty..." Additionally this lack of seeing oneself reflected in the professors can cause a questioning of one's identity and serve to

silence women. African American woman attending HBCUs are increasingly facing similar opportunities to reflect on their identity.

The lack of African American instructors when viewed through a critical race lens can be discussed by using as a frame of reference interest convergence. Interest convergence can be viewed when a shift for Blacks serves to additional advantage Whites (Bell, 1979). In the case of higher education and particularly STEM fields, I would posit that it has not been favorable enough to Whites to generate enough support for a consistent and permanent change to the current status quo. Thus women at both HBCUs and PWIs reported consistently the lack of African American STEM faculty. Until there are both economic and political advantages that will be provided to those in power, no major shift or change to the state of STEM will be made. Thus it is important that those African American women majoring in STEM fields use their experiences and knowledge as tools to pass on to future generations. This knowledge that is passed on becomes an apparatus of empowerment, one that can challenge the majority stock story.

Summary

The purpose of this chapter was to identify and analyze findings related to African American woman's K-12 STEM experiences using 10 individual interviews. Through this examination common themes related to the theoretical framework emerged including: *An Early Interest in STEM, Belonging – An Established a Family Institution, K-12 Success in Mathematics and Science, College Readiness, Family Support, A Positive View of the African-American Community, Considered Changing Major, A Lack of African-American STEM Instructors, Messages on Who Could Pursue STEM, K-12 Teacher Support, Token*

and an Stereotyped – High School, Father’s Stressed STEM Careers, Extracurricular Involvement, and Beyond Academia – Internship and Conference Experiences.

Each theme was described using collective and individual experiences from each woman that I interviewed. Counterstories were created using a critical race lens to understand the lived experiences of each woman. I used two themes to explicitly provide a counter voice to the K-12 experiences of African American women; these themes included Experiential Knowledge of People of Color and Rejecting Dominant Ideologies.

CHAPTER V: SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Study Summary

The purpose of this study was to explore the K-12 STEM experiences of African-American women currently majoring in a STEM field. The following sub-questions helped guide the broad question of: *How do the K-12 experiences of Black women contribute to their selection and persistence in an undergraduate STEM major?*

- a) What K-12 messages about STEM did you receive and how did these messages and experiences contribute to the selection of a STEM major?
- b) What K-12 messages about gender and race did you receive and how did these experiences contribute to the selection of your STEM major?
- c) How have your K-12 experiences contributed to your persistence and navigation within your STEM major?

The study employed narrative inquiry to gain insight into participants K-12 STEM experiences. Several themes emerge from the participants' narratives, which were used in making meaning of their experiences.

Most participants expressed that their K-12 STEM experiences directly contributed to their selection of an undergraduate STEM major. The participants mentioned early science and mathematics exposure, family support and K-12 success in mathematics and science were helpful in selecting a STEM undergraduate major. However, despite these experiences, many participants revealed that their early race and gender experiences and exposure only served as a catalyst and preparation for their later undergraduate STEM experiences. In fact, several participants believed that these early experiences were a reason to persist and move forward in a STEM major, viewing it as a way to break down the doors of stereotypes,

forging a new path for African American women. Most participants viewed their K-12 experiences as a means to preparing them for their undergraduate STEM majors.

All of the participants believed that their K-12 mathematics and many their science experiences prepared them for the selection and eventual success of a STEM undergraduate major. Most participants expressed that during their K-12 experiences there were teachers who supported and encouraged their early science and mathematics interest. For example, participants mentioned several key instances during their early elementary and middle school years where they wanted to give up because they did not believe in their mathematics ability. However it was at these key instances that a teacher pushed them and helped build confidence in their academic abilities. Most of these key instances of encouragement and academic boost in confidence came during each woman's elementary and middle school years. This boost in confidence provided a foundation for what women noted later helped them remain confident in their high school mathematics and science classes. Overall, the participants felt supported and encouraged, building a buoyance that helped them persist through experiences of tokenism and being stereotyped.

The participants also provided insight into how race and gender impacted their high school experiences, particularly in their mathematics and science classes. Most women expressed being one of a few, if not the only African American women and many times the only African American in their mathematics and science classes. Though the participants recognized this as a disparity, they eventually grew to accept the nature of their situation. In a few examples participants explained that these experiences created a divide among them and other African American peers who were not in these same classes. As a result these divides caused the women in some cases to feel disconnected and to identify with the African

American community. However in every case where the participants felt disconnected because of experiences within the African American community in high school, she expressed that later this would be the community during her undergraduate experiences that she felt the most connected to.

Participants consistently discussed feelings of a disconnection to the African American community, often expressing feelings of isolation and only-ness. Yet, in spite these feelings women described experiences of being stereotyped and being the representative for Black culture and issues of race. Beyond these experiences most of the women expressed multiple times when they were stereotyped as a result of being one of a few both in race and in gender in their AP and honors classes. These experiences came in the form of both racial and gender stereotypes. Consistent in literature (Taliaferro & DeCuir-Gunby, 2008) most women pointed out that these stereotypes added a pressure that they later realized had formed after they entered their STEM undergraduate major. This pressure shifted initially how many women viewed their academic abilities.

Feeling an academic pressure, many participants described how this early pressure later translated into academic and social performance. Some participants explained that because of their high school experiences with being stereotyped, particularly in their mathematics and science classes, they developed an unspoken pressure to succeed. This pressure to always display success and excellence was often rooted in a desire to not perpetuate negative stereotypes. Many women expressed feeling like their voices were not valued because they were females, and by only displaying characteristics of success that they were somehow breaking these stereotypes. In this study, the occurrence of racial and gender

discrimination while women were in high school had a lasting effect on participants well after they graduated.

In addition to the aforementioned internal factors, there were also feelings that impacted the participants' external experiences. For instance, though the experiences of being stereotyped and made to feel as a token during their high school science and mathematics classes not dissuade each woman from pursuing a STEM major, it did make many women question their abilities to be academically successful in their undergraduate majors. Most participants shared that they considered changing their undergraduate major. Often this consideration was a result of insecurities developed about their abilities to be successful. Many women expressed feeling a pressure to be successful in their high school classes, therefore when experiencing any academic challenges, many participants expressed they began to question their own ability to be successful within their major. This questioning led to most of the women considering changing their major. However most expressed it was the support of their community that made them take a step back and reconsider remaining within their STEM undergraduate major.

A major goal of the study was to explore how participants' K-12 experiences contributed to their ability to navigate their undergraduate STEM major. This question is important to understanding the lasting impacts of K-12 experiences on African American women into their undergraduate STEM experiences. One such impact that began during participants' early K-12 experiences was the family support structure. The participants had guidance and a solid support system throughout their early elementary school years that continued into their later high school years. This example of family support from mothers, fathers, grandparents and even church family served as a reflection of the kind of positive

support units participants would later need to continue their persistence as STEM majors. Though important in their formative years, family support was particularly important as an undergraduate student majoring in a STEM field. Early positive experiences with support served as a blueprint for participants who found themselves during their undergraduate experiences seeking out similar relationships. These family units fostered a sense of belonging for women, when often their academic experiences made them feel as if they didn't belong.

Implications

The participants' experiences provide a layered understanding of the K-12 experiences of African American women majoring in an undergraduate STEM major. The insights and understandings that emerged as a result of this study have several significant implications for K-12 educators and future policy and practices. The results from this study can be a useful resource for K-12 teachers, administrators and policy makers aiming to increase and enhance the number of African American girls interested and prepared to pursue a STEM undergraduate major. K-12 teachers and administrators are often aware of the critical importance of early exposure to mathematics and science for students of color. However, this exposure was pivotal for African American women during their elementary and middle school years. These formative years provided the confidence and encouragement in the participants' own ability that later served as a device for persistence despite racial and gender segregated classes. In this study, every participant expressed having an affinity to mathematics and science, an affinity that was nourished not only at home, but at school, where teachers often were keys players in "make or break" moments for students confidence.

Second, the role the support system plays in African American women's K-12 experiences were invaluable to each woman's level of success. This support system is multidimensional, involving multiple stakeholders, including parents, teachers and administrators. Thus this becomes an important tool for teachers and administrators to use when exposing African American girls to STEM topics, and further a mean by which to engage parents. By partnering with parents, schools develop a system of empowerment and support that will further strengthen girls in their confidence and abilities. Additionally, parents are provided with a knowledge bank to pull from, balancing out means of support students receive. Research provides evidence that students with "high self-esteem, strong familial relationships, a high degree of parental monitoring, and a great deal of social support" (Bang, 2015, p.102) displayed greater levels of resilience. Such resilience is evidence of each woman's ability to persist in her STEM major beyond her negative and adverse experiences.

An additional implication of this study is that every participant discussed feelings of isolation, stereotyping and tokenism as a result of their advanced, honors and college level courses. While advance placement course are more diverse than ever, school counselors, administrators and teachers must collectively be more intentional in preparing and placing more students of color, particularly African American and girls in advanced placement, honors and college level courses. This trajectory often begins long before students enter high school, so it is worth noting that teachers are often the gatekeepers to building not only students skills, but their confidence in their ability to operate within their skills.

One theme expressed by all the participants was the lack of African American men and African American women in STEM during their high school and later undergraduate

experiences. While participants viewed this as a reason to keep pushing and in the future work to be the change in her field, administrators at a K-12 level can work to diversify their recruitment, by actively recruiting African American teachers. Participants expressed that seeing other African Americans, particularly when it was a woman in a field they were interested in, this alone was a point of encouragement and empowered them to pursue their STEM majors, despite the lack of diversity.

In addition, practices that encourage active and collaborative learning activities should be incorporated into all K-12 classes, particularly those that foster science and mathematics. Elementary teachers should be heavily encouraged to expose students to STEM practices and concepts through consistent hands-on activities. A major focus should be placed on exposing students to critical thinking through science and mathematics. This early exposure would begin a pattern of preparing students for later rigors of honors, and advanced placement courses. By building confidence in student's ability during their elementary and middle school years, students will be more likely to pursue and maintain an interest in STEM fields.

Last, Universities and Colleges play an important role in not only supporting African American women in their transitions, but in providing support and exposure to STEM based fields to students in their K-12 matriculation. While many institutions offer high school summer programs in a range of areas, institutions need to do a better job at recruiting African American girls to these programs. Several women mentioned participating in programs sponsored by institutions of higher learning, and explicitly described the lasting impact it had on their interest in majoring in a STEM field. Recruitment efforts should additionally be focused on hiring diverse faculty. Every participant mentioned a lack of African American

and women faculty in their STEM courses starting as early as their high school level and continuing into their collegiate courses. Although being intentional with recruitment is one aspect, the final aspect would be making sure that scholarships for summer programs are additionally made available to women who may have the desire, but lacks the financial means may greatly benefit from these intentional STEM experiences.

Research Study Limitations

While the study yielded important findings, I address the study limitations and ways to improve this study in the following section. One of the limitations of the research was the number of universities represented and the university locations. There were only two institutions represented, both of which were in the Southeastern part of the United States. Homogenous experiences are likely to result when individuals are from the same institution. Additionally the number of majors represented within the study may provide a narrow view of STEM experiences at the collegiate level. Majority of the women majored in engineering. This may provide a limited understanding of the experiences within other STEM majors.

In addition, to fully understand the K-12 experiences and messages of women majoring in STEM it might be effective to obtain additional data in order to help triangulate (Denzin, 1978; Patton, 1999). For instance, I could have conducted classroom observations and incorporated the voice of classroom teachers at both the K-12 and the collegiate level. By collecting this additional rich data, it serves as a means of checking for consistency in the experiences of the study participants. It further adds an additional lens to view aspects of the same phenomenon. Finally, triangulation would serve as a tool to not necessarily generate a

consensus of experiences, but would potentially provide additional perspectives to view and interpret the study's findings.

Further my own biases from the perspective of an African American woman who studied science and currently is a science educator served as a limitation. Throughout the study I acknowledged by prior experiences and biases that may have impacted this research study in order to reduce bias interpretation of the data.

Areas for Future Research

Through this narrative study, I set out to give voice to African American women who are persisting in STEM majors at their undergraduate institutions. The understanding and insight that emerged as a result of this study have the potential to inform school wide and classroom-based practices, policy and program development.

Elementary and middle schools have an opportunity to maximize upon African American adolescent interest in science and mathematics. Teachers are critical factors in this exposure often shaping how African American females view their abilities and the type of experiences they have, whether positive or contrary. Early exposure often sets the tone for later pursuits, thus the development of programs and curriculum that engages and encourages the natural abilities of girls provides initial exposure that is important in providing confidence in African American adolescent perusal of a STEM major.

Additionally an area of research worth exploring is the voice of the K-12 teacher. As examined through this study, teachers played an important role in the experiences of African American women and their selection of a STEM major. However missing from the narrative were the voices of teachers and the messages about STEM that they believe they needed to convey. As a science teacher, I am very aware and even intentional in the messages I convey

about STEM. This study has further provided a foundation for how important early exposure is for later STEM pursuits, thus surveying elementary and middle school teachers about how much time they spend on STEM topics may prove to provide further insight to why more African American women and people of color are not pursuing STEM majors. By exploring the K-12 teachers voice in addition to the voice of the African American woman a full context of the experiences shared can be presented.

One area of research that could have a significant impact directly on STEM program development would be a longitudinal study of students who entering middle school expressed interest in STEM fields. Following these students throughout their middle school journey, collecting data to see if after their first year of high school their interest has been maintained, can be powerful tools for not only teachers, but those who train and work with K-12 teachers. It has been stated repeatedly that elementary and middle school years are pivotal times in developing students' confidence in their own abilities. Thus capturing longitudinal data on their growing or waning interest in STEM would provide educators and specifically STEM based teachers with insight to build strategies for future student interest.

Conclusion

This study provided insight on the STEM K-12 messages and experiences of African American woman who were majoring in a STEM field. This study used narrative inquiry, which provided each woman with an opportunity to express her perspective on her K-12 STEM messages and experiences. It is important that we recognize the K-12 experiences of African American women majoring in STEM areas as a means of understanding the underrepresentation of African American women in STEM fields. Several themes arose from

the participants' experiences giving them an opportunity to provide a counterstory to the dominant narrative of African American women who select STEM undergraduate majors. Using Critical Race Theory and Black Feminist Thought, this study yielded counterstories that allowed each woman's individual and collective voice to be captured and her story authentically told. Through each woman's persistence and pursuing a STEM major African American woman continue to fill in the cracks in the leaky pipeline (Malcom & Malcom, 2011a).

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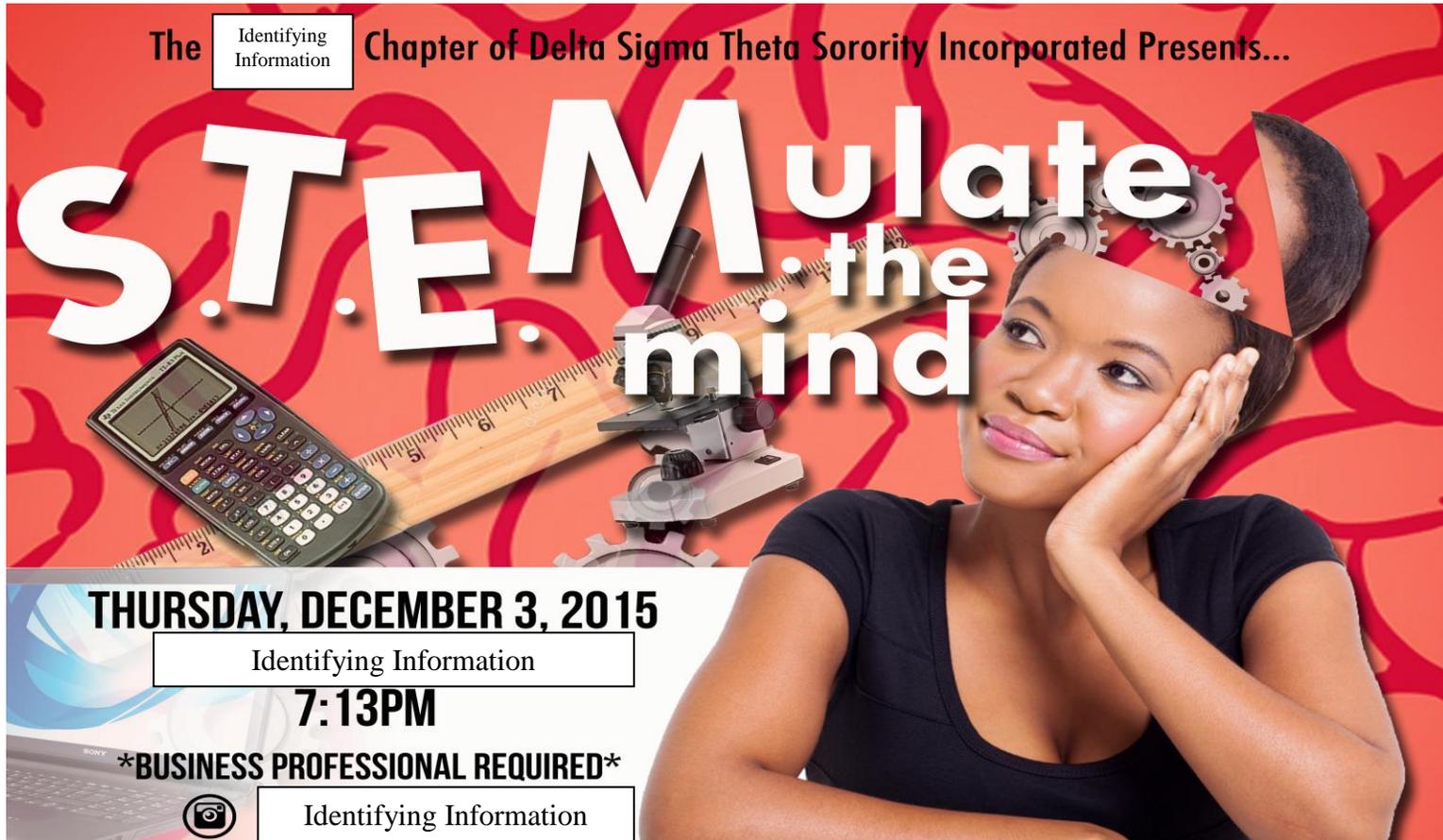
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APPENDICES

A flyer for a recruitment workshop titled "STEMulate the mind". The background is red with abstract white and blue patterns. The title "STEMulate the mind" is written in large, white, stylized letters. "STEM" is in a bold, blocky font, while "ulate" is in a more elegant, serif font. "the mind" is in a smaller, lowercase serif font. A woman with dark hair, wearing a black top, is shown from the chest up, resting her chin on her hand and looking thoughtfully to the right. Several gears are visible behind her head. In the foreground, there are images of a scientific calculator, a wooden ruler, and a microscope. At the top, it says "The Chapter of Delta Sigma Theta Sorority Incorporated Presents...". At the bottom, it says "THURSDAY, DECEMBER 3, 2015" and "7:13PM". There are also two boxes labeled "Identifying Information" and a note that says "*BUSINESS PROFESSIONAL REQUIRED*" with a camera icon.

Identifying Information

Chapter of Delta Sigma Theta Sorority Incorporated Presents...

STEMulate the mind

THURSDAY, DECEMBER 3, 2015

Identifying Information

7:13PM

BUSINESS PROFESSIONAL REQUIRED



Identifying Information

Appendix B: Solicitation Emails

Email to Potential Participants/Organization/Diversity Coordinator Office

Greetings!

I am emailing your organization/office because I am conducting a research study to explore the underrepresentation of African American women in STEM fields and entering STEM majors. The purpose of this study is to examine the STEM k-12 experiences of African American women. These STEM messages and experiences contribute significantly to the development and eventual undergraduate STEM major selection, and in some cases persistence.

Study participants will be asked to participate in an interview that may last anywhere from 1 – 2 hours. Additionally, participants may be asked to participate in a follow up interview. I would like to schedule a time to speak to the members of your organization about my research and their possible participation.

I will follow up with you in the next few days to schedule a convenient time to speak about my research.

Sincere Regards,
Sharonda R. Eggleton
PhD Candidate
Curriculum & Instruction – Educational Psychology
NC State University

Email to Selected African American Women Undergraduates

Greetings!

You have been chosen to participate in a study exploring the underrepresentation of African American women in STEM fields and entering STEM majors. You will be asked to participate in an interview that may last anywhere from 1 – 2 hours. Additionally, you may be asked to participate in a follow up interview.

If you think you are interested in moving forward as a participant and would like to be contacted to schedule your interview, please reply with your name and contact number to this email.

Sincere Regards,
Sharonda R. Eggleton
PhD Candidate
Curriculum & Instruction – Educational Psychology
NC State University

Appendix C: Interview Protocol

Pre-Questions

1. Where are you did you grow up?
2. Why did you select NC State?
3. What is your current major?
 - a. Why did you select this major?

Transition From High School to College

1. What type of K-12 schools did you attend? (ie. elementary, middle and high school)
2. As a child when did you recall first becoming interested in science, technology, engineering or mathematics?
 - a. What contributed to this interest?
3. Can you identify a specific moment or instance in your K-12 educational experience when you knew you wanted to pursue a career in a STEM field?
4. Was there a teacher or mentor who played an important role in developing your interest in science? If yes what did she/he do to inspire you?
5. Did you feel like you received a good educational foundation for the sciences? If so what was that foundation?
6. What types of messages did you receive/hear about females in science fields?
7. What types of messages did you receive/hear about African Americans in science fields?

Institutional Experiences

1. Describe what it is like to be an African American female student at NC State.
2. Describe the African American community on campus.
3. Describe your experience as an African American female within your major.
4. What cultural experiences were you expecting at NC State?
5. Tell me about your social affiliations at NC State.
6. Are you connected to this campus community? If so, how?
7. Describe your experiences on campus socially.
8. Describe your relationships with other African American
 - a. Non-Black students.
9. Describe your relationships with African American faculty/staff and non-Black faculty/staff.
10. Do you feel that you belong within your major?
11. What experiences have contributed to these feelings?
12. Have you had any experiences where you felt like you did not belong within your classes?
 - a. If so describe.
 - b. How did you handle these?
13. Have you considered changing your major?
 - a. If so what experiences contributed to this consideration?

- b. What has motivated you to remain in the sciences?

Identity

1. How do you identify racially?
2. How do you believe other that are non-African Americans perceive you in your major? In your social groups?
3. What experiences have contributed to the development of your identity?
4. Describe the racial/ethnic diversity of your program and how this has shaped your educational experiences.
5. Describe the racial/ethnic diversity of your closest group of peers and how this has shaped your educational experiences. (*this can be the group you study with or socialize with*).
6. How has being a woman affected your experiences within your major?
7. As a woman have you ever felt like you did not belong within your major and on campus?
8. In your experience as an African American woman are there times when have felt like one of the two identities are more prevalent than the other?

Appendix D: Participant Consent Form

North Carolina State University INFORMED CONSENT FORM for RESEARCH

Title of Study: Exploring the K-12 STEM Experiences of African American Women

Principal Investigator: Sharon R. Eggleton

Faculty Sponsor: Dr. Jessica T. DeCuir-Gunby

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purposes of research studies are to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?

The purpose of this study is to make sense of the underrepresentation of African American women in STEM fields and entering STEM majors. In order to make sense of this phenomenon it is important to first understand the STEM K-12 messages and experiences of African American adolescent females. These STEM messages and experiences contribute significantly to the development and eventual undergraduate STEM major selection, and in some cases persistence.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to examine and express your experiences academically, socially, emotionally and culturally at NC State and its additional contributions to your identity development. The first interview will be approximately 50 – 1.5 hour and will be audio-recorded. This recording will be transcribed after recording. Notes will be taken following the interview to describe the interview atmosphere and environmental interactions that cannot be captured by recording. Follow-up interviews may be used to answer additional research questions about issues that arise during initial interviews.

All recordings and transcriptions will be secured in a password-protected laptop in a locked office, and will be kept confidential to the full extent allowed by law.

Risks

There are minimal risks to participating in this research. You may also be concerned about whether your classmates, professors, or entitles will ‘find out’ what you reported during the interview process. I will mitigate these risks by changing the names of the participants from interviews, and we will delete or change any identifying information to ensure confidentiality. Audio recordings will be stored on the researchers’ password-protected personal computer, and will be destroyed after transcription.

Benefits

The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. However, information expressed during the interview process may help you as a participant reflect on the experiences within the context of the institution. This information can also help the research make recommendations to the institution on future intervention resources for participants.

Confidentiality

The information in the study records will be kept confidential to the full extent allowed by law. Data will be stored securely and safe measures will be taken to protect the security of data. No participant information will

be shared, however because of the researcher intends to study a underrepresented group, specific experiences shared could lead to the identification of participants. However, due to the specific population, the information will be confidential but I cannot insure anonymity. I will however try my best to protect the identity of participants by using pseudonyms and shielding any readily identifiable information.

Compensation

You will not receive anything for participating.

What if you are a NCSU student?

Participation in this study is not a course requirement and your participation or lack thereof, will not affect your class standing or grades at NC State.

What if you have questions about this study?

If you have questions at any time about the study or the procedures, you may contact the researcher, Sharonda R. Eggleton, sregglet@ncsu.edu, under the direction of Dr. Jessica DeCuir-Gunby (jtdecur@ncsu.edu).

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514).

Consent To Participate

“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.”

Subject's signature _____ **Date** _____
Investigator's signature _____ **Date** _____

Appendix E: Composite Themes by Institution

Table 6: Composite Themes by Institution

<i>Significant Themes</i>	<i>Participants</i>
1) PWI Theme: Fighting Isolation	Ashley, Tyra, Ericka, Donyela
2) PWI Theme: Viewed Role as a Change Agent	Tyra, Donyela, Brianna, Ericka
3) PWI Theme: Fear of Being Stereotyped	Ashley, Tyra, Ericka, Donyela, Brianna
4) PWI Theme: Exclusive African American Peer Relationships	Tyra, Ericka, Donyela
5) PWI Theme: Pressure to Succeed	Ashley, Ericka, Donyela, Brianna
6) HBCU Theme: Pride & Cultural Appreciation	Whitney, Danielle, Tamera, Jada
7) HBCU Theme: Viewed Non-African-American Instructors as Approachable	Whitney, Danielle, Tamera, Jada, Dianna