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African American Female Engineering Students' Persistence in Stereotype-threatening Environments: A critical Race Theory Perspective

Stacie LeSure Gregory

AFRICAN AMERICAN FEMALE ENGINEERING STUDENTS' PERSISTENCE IN
STEREOTYPE-THREATENING ENVIRONMENTS:
A CRITICAL RACE THEORY PERSPECTIVE

by

Stacie LeSure Gregory

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Engineering Education

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2015

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ABSTRACT

African American Female Engineering Students' Persistence in
Stereotype-threatening Environments:
A Critical Race Theory Perspective

by

Stacie LeSure Gregory, Doctor of Philosophy

Utah State University, 2015

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Due to the social context of engineering classrooms, stereotype threat (STT) may play an essential role in the dearth of African American females in engineering. Empirical studies have confirmed the deleterious effects STT has on students' performance. However, acceptance of STT as more than a laboratory phenomenon necessitates an in-depth understanding of how stigmatized groups experience being socially devalued and negatively stereotyped. In this qualitative investigation, Intersectionality and the Critical Race Theory tenet of counter-storytelling were applied to capture the voices of 10 African American women to comprehend how they resisted or overcame STT and persisted in engineering degree programs. Data were triangulated from two different semi-structured interviews and reading reactions submitted by each participant. Findings reveal four characteristic themes shared by the participants: (a)

Proof Stereotype Threat Exists; (b) Primary Contributors of Stereotype Threat; (c) Secondary Factors; and (d) Tools for Persisting. Based on participants' narratives, 6 recommendations are offered to assist African American female students combat STT and persist in engineering.

(221 pages)

PUBLIC ABSTRACT

African American Female Engineering Students' Persistence in

Stereotype-threatening Environments:

A Critical Race Theory Perspective

Stacie LeSure Gregory

African American women are grossly underrepresented in engineering. Despite their low representation in engineering colleges, some are able to persist and earn their degrees. This qualitative study sought to better understand the strategies 10 African American women employed to help them remain resilient in engineering degree programs. For this investigation, there was an underlying assumption that African American women who persist in engineering must contend with stereotype threat. Stereotype threat is a psychosocial phenomenon in which people in stigmatized social categories fear confirming negative stereotypes about their group.

Ten African American female women who have persisted in engineering degree programs were interviewed twice over the course of one academic semester. They also wrote a brief response to an article they were asked to read. The interviews and reading reactions confirmed the assumption that they experienced stereotype threat. Data also disclosed six tools that contributed to their persistence. These tools include: (a) active involvement with the Black community on campus; (b) a strong desire to give back and inspire the next generation of engineers; (c) faith, family, and community; (d) a firm identity/strong sense of self; (e) being proud/passionate/committed to being an engineer; and (f) being advocates for themselves.

DEDICATION

God has truly blessed me with great people in my life. This dissertation is dedicated to the many individuals who have been instrumental in helping me accomplish this lofty goal. First, I dedicate this dissertation to the 10 women who made this study possible. To the participants who enthusiastically and candidly shared their stories, I am indebted. When completing this dissertation was daunting, I was encouraged by their words to press forward. To all 10 of these amazing women, I say, “May God continue to bless you.” I also dedicate this work to my husband, Dwight Gregory. Although it has not been an easy journey, he has always encouraged me to pursue my passion. We have traveled this country together and along the way he has always supported me in realizing my goals. I dedicate this dissertation to my son, Zyan Arie Gregory. My desire is to demonstrate to him what it looks like for one to live up to his/her fullest potential. This desire motivated me to return to graduate school and earn my doctorate. This dissertation is also dedicated to Dr. Tyrone Mitchell and his wife for over half a century, Mrs. Sandra Mitchell. For 25 years, these amazing individuals have provided me with mentorship, guidance, and most of all, love. I admire their love for each other. I applaud their commitment to inspiring and encouraging young scientists and engineers. Last, but certainly not least, I dedicate this dissertation to my mother, Roxie McDaniel. She is the example I look to when I need inspiration to combat obstacles. She models persistence. She is more than a role model, she is my hero. On her shoulders I stand. Without her many sacrifices and her demonstration of what it means to be resilient, I would have never learned to persevere. I reached towards the sky and believed I could earn the highest degree attainable because I hung around stars. To my shining star, my mom, I

say, “Thank you.” She was never able to realize her potential and earn a college degree. However, the time and effort she would have given to further her education, she unselfishly invested in me and my seven siblings. An investment that will continue to earn her more dividends than she could have ever imagined. To this amazing woman, I say, “Well done.”

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Stacie LeSure Gregory

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CHAPTER 1

INTRODUCTION

Females matriculate in greater numbers than males in both undergraduate and graduate institutions (US Executive Office of the President, & Office of Management and Budget, 2011). They also have higher graduation rates at all academic levels (US Executive Office of the President, & Office of Management and Budget, 2011). Between 1970 and 2009, the percentage of females with at least a high school diploma rose from 59% to 87% (US Executive Office of the President, & Office of Management and Budget, 2011). Across all racial groups, females account for the majority of undergraduate enrollment (US Executive Office of the President, & Office of Management and Budget, 2011). According to the most recent Department of Education figures, the gender gap is largest for African Americans. Sixty-four percent of all African American undergraduates are female (“Digest of Education Statistics,” 2012). By the year 2019, females are projected to account for 60% of the total undergraduate enrollment (US Executive Office of the President, & Office of Management and Budget, 2011).

Despite the progress females have made in postsecondary education, they continue to be underrepresented in *some* Science, Technology, Engineering, and Math (STEM) disciplines. In 2010, females earned 57% of degrees awarded in all fields (“National Survey of Recent College Graduates,” 2010). They earned 50% of *all* Science (i.e. chemistry, biology, psychology) degrees (“National Survey of Recent College Graduates,” 2010). However, in 2010 females were awarded only 18% of engineering

degrees (“National Survey of Recent College Graduates,” 2010). The percentage of Bachelor’s degrees earned by women and men in various disciplines in the year 2010 is presented in Table 1-1. Although men have a slight advantage in the percentage of chemistry degrees awarded, women outpace men in every other category except engineering. The percentage of degrees earned by African American women was significantly higher than those earned by African American men in every area with the exception of engineering (Table 1-1).

Table 1-1 *Percentage of Bachelor’s Degrees Awarded in 2010*

	All	Non- Science	Biology	Chemistry	Psychology	Engineering
All Women	57.2	60.4	59.0	49.9	77.1	18.4
All Men	42.8	39.6	41.0	50.1	22.9	81.6
African American Women	6.0	6.4	5.0	4.7	9.2	1.1
African American Men	3.1	3.2	2.2	2.5	2.1	3.1

www.nsf.gov/statistics

The proportion of women in engineering has grown a mere 5% over the last 20 years. This limited progress is not indicative of effort. Numerous scholarships, curriculum improvements and mentoring programs have been implemented to address the dearth of women in engineering (Knight et al., 2012). Various studies highlight the need to diversify engineering (Jackson, 2004; National Academy of Engineering, 2008; Watson & Froyd, 2007).

There are several arguments to support the importance of recruiting, retaining and advancing females in engineering (Cronin, 1999). Social justice (i.e. fairness and equity) is one argument (Moskal, 2000). The compensation for engineering degrees is often higher than that of other fields (Tate, 1997b; Terney, 1997). By not participating in engineering, women are excluded from the economic benefits afforded by this field (Moskal, 2000). There are also compelling advantages regarding how females can enhance the field of engineering (Moskal, 2000). Evidence supports positive outcomes in both educational and professional settings when females are adequately represented (Moskal, 2000). For example, there was an overall increase in the quality of students when Massachusetts Institute of Technology (MIT) implemented an affirmative action mandate to increase female enrollment (Johnson, 1993). Another example is how marketing and consumer product development businesses witnessed unanticipated benefits when the number of female employees was increased (Linn, 1998). Similar progress is expected to occur with an increased participation of females in engineering. Wulf (1998), former president of the National Academy of Engineering, speculated that increasing the presence of women in engineering would result in higher productivity. He maintained that creativity, which is central to engineering, is influenced by background. Since women in engineering bring a background that is different from that of their male counterparts, their participation offers a perspective that can potentially lead to more creative solutions to problems (Wulf, 1998).

According to Powell, Bagihole, and Dainty (2009), “Women are typically viewed as “honorary men” or “flawed women” for attempting to participate in fields traditionally dominated by men” (p. 2). Although women continue to face gendered related barriers

hindering their success in engineering, efforts addressing the obstacles confronting them must do so with an open mind towards diversity amongst this group. Lord et al. (2009) asserted, “Women in engineering do not necessarily share common experiences of marginality. For example, women of color may experience both sexism and racism, compounding their experiences of exclusion” (p. 170). Feminist scholars of color have insisted on a more distinct understanding of gender (Lord et al., 2009). They contend that gender experiences cannot be understood in isolation. Race is a necessary qualifier to consider when examining gender issues (Andersen & Collins, 2007; di Leonardo, 1991; hooks, 2000). To disregard race in gender analysis ignores the intersectionality of these separate sociocultural constructs. Intersectionality refers to the way in which gender operates together with race and produces multiple forms of discrimination and social inequality (Crenshaw, 1988). “This framework suggests the need to examine the conditions under which women of color persist in academia in spite of such obstacles” (Lord et al., 2009, p. 170). For African American women, resisting or overcoming the effects of the “double negative” (i.e., Black and female) may create a unique set of barriers impacting their persistence in engineering. According to Lord et al. (2009), “The culture of exclusion or feelings of isolation that White women experience in engineering are different than those experienced by women of color because racial stereotyping compounds the experience of gender stereotyping” (p.170).

The number of bachelor’s degrees awarded to women and men in 2010 is shown in Table 1-2. The degrees awarded in engineering by race and gender is also presented (Table 1-2). African American women represent the largest void in engineering degrees awarded; yet the relationship between their representation and persistence has received

Table 1-2 *Bachelor's Degrees Awarded in 2010 [National Survey of Recent College Graduates (2010)]*

Degrees Awarded Year 2010	All Degrees		Engineering		% Engineering	
	Female	Male	Female	Male	Female	Male
White	606,251	475,894	7,849	40,128	1.3%	8.4%
Asian	59,482	49,540	1,918	6,487	3.2%	13.1%
Hispanic/Latino	89,789	57,416	1,346	4,602	1.5%	8.0%
American Indian/Alaskan Native	6,968	4,517	77	289	1.0%	6.4%
African American	100,435	51,969	805	2,277	0.8%	4.4%

(<http://www.nsf.gov/statistics/wmpd/2013/resources.cfm>)

very little attention (Lord et al., 2009). Of all bachelor's degrees awarded in 2010, only 0.8% were awarded to African American women in engineering. The percentage of all engineering degrees awarded to African American women in 2005, 2007, 2008 and 2009 is highlighted in Table 1-3. There was a 16.5% drop in engineering degrees awarded to African American women from 2000 to 2009 (Table 1-4). However, all other populations experienced a rise in the percent of degrees awarded during the same time period.

Table 1-3 *Engineering Degrees Earned: Statistical Data [National Survey of Recent College Graduates (2010)]*

A CLOSER LOOK.....	2005	2007	2008	2009
% US Population	6.69	6.72	6.73	6.74
% of all Bachelor's degrees awarded to African American women	5.84	5.91	5.94	5.94
% of ALL Engineering Bachelor's degrees awarded to ALL women	19.6	18.53	18.48	18.06
% of ALL Engineering Degrees awarded to African American women	1.64	1.44	1.28	1.22

(<http://www.nsf.gov/statistics/wmpd/2013/resources.cfm>)

Table 1-4 *Engineering Degrees Earned in 2000 and 2009 [Male (M) and Female (F)]*

	USA Population 2009		% change in population from 2000 to 2009		% change in ALL degrees awarded from 2000 to 2009		% change in engineering degrees awarded from 2000 to 2009	
	F	M	F	M	F	M	F	M
White	80.5	81.5	6.4	7.8	18.7	22.0	3.9	21.0
Hispanic	15.3	16.8	36.3	38.0	54.8	49.3	28.4	41.4
Asian	4.7	4.5	32.6	32.0	39.8	38.0	6.1	21.3
American Indian	1.0	1.1	18.0	18.6	34.0	27.5	14.9	41.7
African American	13.5	12.7	10.5	11.0	36.5	36.3	-16.5	20.1

<http://www.nsf.gov/statistics/wmpd/2013/resources.cfm>

Theoretical Framework

This qualitative investigation adds to the literature by focusing specifically on African American women in engineering. This study presumed that African American female students face unique barriers in engineering education (Lord et al., 2009). This work was grounded in three different theoretical frameworks: (a) Stereotype Threat; (b) Critical Race Theory; and (c) Intersectionality. First, there was an underlying assumption that African American women who persist in engineering must contend with stereotype threat. Steele and Aronson (1995) defined stereotype threat as “the immediate situational threat that derives from the broad dissemination of negative stereotypes about one’s group; the threat of possibly being judged and treated stereotypically, or of possibly self-fulfilling such a stereotype” (p. 798).

Secondly, the study applied the Critical Race Theory tenet of counter-storytelling using narratives to better understand how these students resisted or overcame stereotype threat and persisted in engineering. Critical Race Theory was employed because it provided a critical analysis of race and racism. Narratives allowed those who have been ignored an opportunity to express their authentic experiences. Counter-stories challenged White supremacy and gave voice to those that have been silenced. The final framework employed in this investigation was intersectionality. Intersectionality recognized that multiple forms of oppression (i.e. being Black and female) are not suffered separately but rather as an amalgamated experience.

Purpose of the Study

The purpose of this study was to offer a disaggregated view of minority underrepresentation in STEM. Most studies in the literature use multiple minority groups when investigating factors influencing students' persistence patterns in STEM fields (Brown, Morning, & Watkins, 2005). This aggregated approach prompts generic conclusions and implies that all minority groups' educational experiences are equivalent in all STEM disciplines. Although there may be similarities as to why some groups are underrepresented in STEM, it is likely that there are unique differences. Also, engineering is distinct from science, technology and mathematics. On the one hand, engineering involves the practical application of science and mathematics, as in the design of structures and systems (Steinmetz & Braham, 1993). On the other hand, science entails the systematic knowledge of the physical or material world gained through

observation and experimentation (Steinmetz & Braham, 1993). The distinctiveness of the disciplines must be examined separately as each may possess idiosyncrasies which impact the persistence among various student groups in disparate ways.

Research Question

This study answered the central research question: How do African American female engineering students resist or overcome stereotype threat and persist in engineering?

Significance of Study

The social construction of African Americans as biologically, intellectually, and culturally inferior to Whites continues to persist (Blum, 2002; Omi & Winant, 2005). In discussions of racial achievement gaps, African American students are persecuted by stereotypical beliefs of their intellectual inferiority compared to other social groups (Herrnstein & Murray, 1994; Thernstrom & Thernstrom, 2003). Women continue to be viewed as incompetent engineers (Goodman et al., 2002; McIlwee & Robinson, 1992). These compounding stereotypes have led to African American women being “marked as outsiders” (Lord et al., 2009, p 170). African American women are often the most socially isolated groups of students, regardless of their academic achievement (Brown, 2005). This isolation fosters feelings of incompetence and cultivates fear of failure (Ellis, 2000; Jordan, 1998).

African American women comprise the largest number of students of color in college at both the graduate and undergraduate level (Evangelauf, 1992). However, only four published studies have been identified which included African American female engineering students as respondents (Bush, 2013; Frillman, 2011; E.O. McGee, 2009; E.O. McGee & D.B. Martin, 2011). While most research about women in engineering focus on reasons for their underrepresentation, this study is an investigation on how 10 African American women persisted in engineering despite being threatened by stereotypes about their intellectual ability as African Americans and their “sense of belonging” as women in engineering.

An understanding of how African American female engineering students are able to avoid performance detriments and succeed in engineering is needed. This understanding will lead to intervention strategies to help them resist or overcome STT and persist in engineering. While most research on STT has focused specifically on short-term academic performance, this work is unique in that it examined long-term persistence. This study focused on concrete actions rather than just performance. It addressed specifically how “double minority” (i.e. African American and female) status students persist in spite of STT.

Definition of Key Terms

Category: a topic of discussion that emerged during data analysis and helped ground the themes.

Code: the technique used to organize data in order to find common themes.

Critical Race Theory (CRT): a “framework that can be used to theorize, examine and challenge the ways race and racism implicitly and explicitly impact social structures, practices and discourses” (Yosso, 2005, p. 70).

HBCU: Historically Black College and University

Intersectionality: a framework that recognizes the intersection of various forms or systems of oppression, domination or discrimination.

NSBE: National Society of Black Engineers

Participant: one of the 10 African American women who participated in this study.

Persister: one who has been a student in an engineering degree program for at least eight semesters (or earned an engineering degree).

PWI: Predominantly White Institution

SES: Socioeconomic Status

STEM: Science, Technology, Engineering and Mathematics

Stereotype Threat: “anxiety caused by the expectation of being judged based on a negative group stereotype” (Beasley & Fischer, 2012, p. 427).

SWE: Society of Women Engineers

Theme: a major topic that emerged during data analysis because it was common among all or most participants.

Limitations of the Study

Only four schools and 10 participants were represented in this study. Three of the four schools are predominantly White engineering schools and one is a historically Black

liberal arts college. It cannot be assumed that all African American women in engineering degree programs experience stereotype threat.

CHAPTER 2

LITERATURE REVIEW

Stereotype Threat

Stereotype threat theory (STT) is a well-established framework that has received much attention from researchers for the past 20 years. The concept of STT was introduced by Claude Steele and Joshua Aronson in the mid-1990's (Steele & Aronson, 1995). It was initially described as a social psychological predicament rooted in the prevailing American image of African Americans as intellectually inferior (Steele & Aronson, 1995). According to Aronson, "By the age of 6, virtually everyone in our culture is aware of a variety of cultural stereotypes" (Aronson, 2004, p. 15). Smith (1990) conducted an opinion poll which revealed that nearly half of White Americans endorsed stereotypes about African Americans which portrayed them as unintelligent. Research reveals that African Americans are cognizant of the negative reputation regarding their group's perceived intellectual inferiority (Aronson, 2004). Some researchers suggest that they have an inclination to be hyperaware of the negative expectations about their group (Aronson, 2004).

In their landmark study, Steele and Aronson (1995) conducted several experiments with African American and White American students. According to the United States Census Bureau, African American refers to a person having origins in any of the Black racial groups of Africa. White people, as defined by the United States Census Bureau, are those "having origins in any of the original peoples of Europe, the

Middle East, or North Africa” (Humes, Jones & Ramirez, 2011, p. 3). Students in Steele and Aronson’s (1995) study completed the verbal portion of the Graduate Records Examination (GRE) which was administered by a White experimenter. In one experiment, the students were told that the exam was indicative of intelligence. African American students performed more poorly than the White students. In a different experiment, the students completed a brief demographic questionnaire prior to taking the exam. The questionnaire for half of the test takers included an item asking them to indicate their race. Race identification posed as a potential threat to the African American test takers because of the real or imagined possibility of the White experimenter evaluating them with race in mind (Steele & Aronson, 1995). This threatening situation alerted the African American students, consciously or subconsciously, of the stereotypes about their academic inferiority (Steele & Aronson, 1995). The researchers posit that the African American students became anxious due to the subtle reminder of the stereotype and the risk of being judged (Steele & Aronson, 1995). This anxiety, in turn, caused the race-identified African American test takers to perform significantly worse than all other test takers (Steele & Aronson, 1995). These students solved only half as many problems as those who were not asked to indicate their race. Findings from this pioneering study demonstrated that performance in academic contexts can be hindered by the awareness that one's actions might be viewed through the lens of racial stereotypes (Stroessner & Good, 2011).

Steele and Aronson’s (1995) seminal work has been replicated a myriad of times with varying demographics assessing different performance measures including (Table 2-1): White males and athleticism (Stone, Lynch, Sjomeling, & Darley, 1999); women and

mathematics ability (Brown & Josephs, 1999; Gresky, Ten Eyck, Lord, & McIntyre, 2005; Inzlicht & Ben-Zeev, 2000; Marx & Roman, 2002; McGlone & Aronson, 2006; Schmader, 2002; Spencer, Steele, & Quinn, 1999; Wraga, Helt, Jacobs, & Sullivan, 2007); women and engineering problem solving (Bell, Spencer, Iserman, & Logel, 2003; Logel et al., 2009); Latinos and intellectual ability (Gonzales, Blanton, & Williams, 2002); socioeconomic status (SES) and intellectual ability (Croizet & Claire, 1998); elderly and memory (Levy, 1996); Asian women and math performance when their gender is emphasized over their race (Shih, Pittinsky, & Ambady, 1999); and White males' underperformance on a math exam when being compared to Asians (Aronson et al. 1999). Based on findings from these studies, it appears that a stigmatized identity may not be required to suffer the effects of STT. Crocker and Steele (1997) avowed:

Stereotype threat arises when performance motives are jeopardized by the awareness of an ability-impugning stereotype in a situation where that stereotype can be confirmed by low performance. Thus, because most people are motivated to feel and to appear competent, nearly anyone, we believe, can experience the pressure of stereotype threat in some situation and thus suffer the short-term consequence of impaired intellectual performance. (p. 71)

Since it has been shown to adversely impact diverse individuals in a variety of ways, STT has become more broadly defined as the “anxiety caused by the expectation of being judged based on a negative group stereotype” (Beasley & Fischer, 2012, p. 427).

Table 2-1 *Overview of Stereotype Threat Studies*

Demographics	Performance Measures	Researchers
African Americans	intellectual ability	Steele & Aronson, 1995
White males	athleticism math performance	Stone et al., 1999 Aronson et al., 1999
Women	mathematical ability engineering problem solving	Brown & Josephs, 1999; Spencer et al., 1999; Inzlicht & Ben-Zeev, 2000; Marx & Roman, 2002; Schmader, 2002; Gresky et al., 2005; Wraga et al., 2007; McGlone & Aronson, 2006; Logel et al., 2009; Bell et al., 2003
Latinos	intellectual ability	Gronzales et al., 2002
Low SES	intellectual ability	Croizet & Claire, 1998
Asian Women	math performance	Shih et al., 1999

The primary hypothesis of STT is known as “Performance interference.” It predicts that stereotyped individuals perform worse on evaluative tasks in stereotyped-threatening conditions than they would in non-threatening conditions (Steele, 1997; Steele, Spencer, & Aronson, 2002). For example, just as there are stereotypes regarding African Americans and intellectual inferiority, there are also widely known stereotypes concerning women’s mathematics incompetence (Eccles, Jacobs, & Harold, 1990; Fennema & Sherman, 1977; Jacobs & Eccles, 1985; Swim, 1994). According to Spencer et al. (1999), “In situations where math skills are exposed to judgment...women bear the extra burden of having a stereotype that alleges a sex-based inability...a predicament that others, not stereotyped in this way, do not bear” (p. 6). There is also a more “positive”

cultural stereotype that girls are more academically skilled in English and reading domains (Quinn & Spencer, 2001). Therefore, a female student is likely to suffer from the effects of stereotype threat in her math class, but not in her English Literature class (Bell et al., 2003).

Over 300 experiments on STT have been published in peer-reviewed journals (Block, Koch, Liberman, Merriweather, & Roberson, 2011). Empirical studies have produced a solid foundation of the deleterious effects STT has on students' performance outcomes. The reasons for STT emergence (i.e. mediators) have been thoroughly explored. Moderating factors (i.e., the degree stereotype threat will be experienced by different people) have been identified. In other words, evidence suggests that the strength of a threat varies with the situation.

Stereotype Threat and Mediating Factors

The processes underlying the reasons for performance decrements resulting from stereotype threat remained enigmatic for nearly a decade (Schmader et al., 2009). However, theory and research ultimately identified a host of factors that work individually or in concert to reduce the performance of stigmatized social groups (Schmader, Forbes, Zhang, & Mendes, 2009). A stigmatized social group is defined as belonging to a social category in which others hold negative attitudes, stereotypes, and beliefs (Crocker & Major, 1989).

Some researchers postulate that STT interferes with performance on mental tasks by increasing blood pressure (Blascovich, Spencer, Quinn, & Steele, 2001) and reducing working memory capacity (Croizet et al., 2004; Schmader & Johns, 2003). According to

Logel et al. (2009), performance suffers as concerns are activated when individuals perform an evaluative task for which there is a negative stereotype regarding the ability of their social group. For example when taking an exam, individuals under STT are motivated, either consciously or subconsciously, to suppress stereotype-relevant thoughts (Logel et al., 2009). This process, known as stereotype suppression, is an attempt to enhance concentration on the difficult test questions. In order to suppress a thought, stereotype-threatened individuals must consciously avoid thinking about the stereotype. Simultaneously, on a subconscious level, they are monitoring the environment for the presence of any cues which draw attention to the stereotype (Wegner & Zanakos, 1994; Wegner, Erber, & Zanakos, 1993; Wegner, Schneider, Carter, & White, 1987). The complex process of suppressing a stereotype leaves limited mental resources for solving difficult test problems and results in fewer correct test answers and lower test scores (Wegner & Zanakos, 1994; Wegner et al., 1987, 1993). Stereotype suppression is a resource-demanding task (Logel et al., 2009; Wenzlaff & Wegner, 2000) which leads to working-memory depletion (Schmader & Johns, 2003).

Over the years, researchers have identified additional mediating variables that affect performance. Some of the most cited include heightened physiological arousal (Blascovich et al., 2001; Osborne, 2006, 2007); anxiety (Ben-Zeev, Fein, & Inzlicht, 2005; O'Brien & Crandall, 2003; Spencer et al., 1999); impaired self-regulation (Cadinu, Maass, Rosabianca, & Kiesner, 2005; Inzlicht, McKay, & Aronson, 2006); lowered performance expectations (Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Stangor, Carr, & Kiang, 1998); and prevention focus (Seibt & Förster, 2004). See Table 2-2 for an overview of stereotype threat mediating factors.

Table 2-2 *Stereotype Threat and Mediating Factors*

Mediating Factor	Researchers
increased blood pressure & reduced working memory capacity	Blascovich et al., 2001; Croizet et al., 2004; Schmader & Johns, 2003
stereotype suppression & monitoring of environmental cues & working-memory depletion	Logel et al., 2009; Wegner & Zanakos, 1994; Wegner et al., 1987, 1993; Schmader & Johns, 2003
heightened physiological arousal	Blascovich et al., 2001; Osborne, 2006, 2007
anxiety	Ben-Zeev et al., 2005; O'Brien & Crandall, 2003; Spencer et al., 1999
impaired self-regulation	Cadinu et al., 2005; Inzlicht et al., 2006
lowered performance expectations	Cadinu et al., 2003; Stangor et al., 1998)
prevention focus	Seibt & Forster, 2004

Stereotype Threat and Moderating Variables

Some researchers have replicated and extended the STT effect on cognitive ability tests originally identified by Steele and Aronson (1995) and have failed to find support confirming the performance interference hypothesis (e.g., Oswald & Harvey, 2000-2001; Schneeberger & Williams, 2003; Stricker & Ward, 2004). These mixed findings suggest that not every stigmatized person will experience stereotype threatening conditions in the same way. Researchers have identified a range of situational factors that moderate STT. There is evidence to suggest that the detrimental effects of STT can be more or less extreme or even in-existent depending on the situation or context. The most studied moderators are highlighted in Table 2-3 and presented below.

Threat is Salient. Stereotype threat elicitation does not require either directly presenting people with the stereotype (Spencer et al., 1999) or reminding them of their membership in a stereotyped group (Steele & Aronson, 1995). Instead STT is aroused by

any factor that increases the saliency of familiar stereotypes (Inzlicht & Ben-Zeev, 2000). STT can surface from the mere salience of situational cues that activate social identity, such as the race and gender of other people in the room. According to the interactive model of gender-related behavior (Deaux & Major, 1987), the environment can serve as a causal factor in determining whether gender stereotypes will be elicited. Inzlicht and Ben-Zeev (2000) found that by simply placing high-achieving females in an environment in which they were outnumbered by males caused them to experience performance deficits in the stereotyped domain of mathematics.

Table 2-3 *Stereotype Threat and Moderating Variables*

Moderating Variable	Researchers
salient	Inzlicht et al., 2000
personal identification	Steele et al., 2002; Aronson et al., 1999; Nosek et al., 2002; Schmader, 2002; Alter et al., 2010; Cadinu et al., 2003
stereotype relevance	Steele, 1997; Nguyen & Ryan, 2008
task difficulty	Steele et al., 2002; Mello, 2014

Personal Identification. “Stereotype threat theory proposes that only those who strongly identify themselves with a domain with which there is a negative group stereotype are susceptible to the threat of confirming the group-based stigma” (Steele et al., 2002, p. 390). In other words, a negative stereotype is threatening only when it is applicable to a domain (e.g., Aronson et al., 1999; Nosek, Banaji, & Greenwald, 2002) and a group (e.g., Schmader, 2002) that are personally relevant. Negative stereotypes are not threatening to individuals who are apathetic about performing well in a particular area

(Alter, Aronson, Darley, Rodriguez, & Ruble 2010). This apathy exists because success in that domain does not play a significant role in their identity. For example, only women who identify with math would experience STT while taking a math test (Cadinu et al., 2003, Study 1).

Relevance of Stereotypes. Steele (1997) posited that the intensity of STT effects varies depending on the relevance of a stereotype in a particular context. According to Nguyen and Ryan (2008), the adverse effects of STT can be reduced by refuting or removing the relevance between a negative stereotype and a test, either implicitly (e.g., by framing a test as a non-diagnostic task) or explicitly (e.g., by disputing said group differences in test performance). For example, Shih et al. (1999) revealed that when Asian American women encountered a stereotype threat-loaded situation (i.e., taking a math test), they solved more correct problems when the situational cues about their “Asian” identity was more salient than their gender.

Davies, Spencer, Quinn, & Gerhardstein (2002) conducted an investigation with three different studies in which they used television commercials with women to activate gender stereotypes about women in quantitative domains such as engineering. In the first study, it was revealed that only women for whom the activated stereotype was self-relevant underperformed on a subsequent math test. In the second study, exposure to the stereotypic commercials led women taking an aptitude test to avoid math items in favor of verbal items. In the final study, women who viewed the stereotypic commercials indicated less interest in educational or career options in which they were susceptible to stereotype threat (i.e., quantitative domains). They expressed more interest in fields in which women are stereotypically more suited (i.e., verbal domains).

Task Difficulty. An important trigger for STT is experiencing frustration with a task accomplishment (Steele et al., 2002). Mello (2014) posited:

On a simple task there is little frustration—the person is doing well and knows it. But with a difficult task, progress is not so smooth. People who experience frustration with a task try to explain their difficulty to themselves: “Why is this so hard?”...“Am I not working hard enough?”...They also think about how others will explain their difficulty: “Will they think I’m not working hard enough?” But when the person is a member of a stereotyped group, the stereotype is also likely to come to mind as a potential explanation that others might use: “Will they think the stereotype is true?” (p. 75)

When an individual is performing a challenging task all of his/her cognitive/mental resources must be directed toward accomplishing it. Performance decrements occur when some of these cognitive resources are diverted towards worrying about things such as one’s skill level and how one will be viewed by others (Beilock & Carr, 2005; Verbeke & Bagozzi, 2000).

You can observe from the above discussions, STT is a real phenomenon. It has the potential to impact almost everyone to some extent. It is important to note that STT is more than an internalized belief in the stereotype or a fear that it may be true (Bell et al., 2003). It is more than a belief that others will be prejudiced against you (Bell et al., 2003). According to Steele, it is a threat that is “in the air” (Steele, 1997). People with high self-confidence can also succumb to STT. Therefore, STT is more than low self-confidence. Whereas low self-confidence is intrinsic to the person and is felt in all situations (Bell et al., 2003), STT occurs only in very specific situations (Alter et al.,

2010). Research has suggested that the effects of STT are most profound among the best students who are most identified with a particular academic domain (Spencer et al., 1999; Aronson et al., 1999).

Stereotype Threat Interventions

There are many suggestions in the literature on how stereotype threat can be offset. They are highlighted in Table 2-4 and a few are presented in this section.

Role Models. There is an extensive inventory of studies highlighting the benefits of exposing stigmatized groups to positive role models as a means to offset STT (Aronson, Jannone, McGlone, & Johnson-Campbell, 2009; Cohen, Steele, & Ross, 1999; Cole & Barber, 2003; Marx & Roman, 2002; Marx, Ko, & Friedman, 2009; McIntyre et al., 2003; Stout, Dasgupta, Hunsinger, & McManus, 2011). Stout, Dasgupta, Hunsinger, and McManus (2011) conducted a study with female college students majoring in STEM fields. The female participants were randomly assigned to complete a difficult math exam. The exam was administered by either a female or male researcher who was perceived to be an expert in math (Stout et al., 2011). The study's findings suggested that participants who were administered the math exam by a female researcher increased their effort on the exam (Stout et al., 2011). They also displayed an increased identification with math compared to participants who were administered the math exam by a male researcher (Stout et al., 2011). The researchers concluded that in spite of being negatively stereotyped in STEM fields, exposure to an in-group role model protected the female participants' identification with STEM domains (Stout et al., 2011).

Table 2-4 *Stereotype Threat Interventions*

Intervention	Researchers
role models	Stout et al., 2011; Marx et al., 2009; Aronson et al., 2009; Cole & Barber, 2003; McIntyre et al., 2003; Marx & Roman, 2002; Cohen et al., 1999
reframe tests as challenges	Alter et al., 2010
shaping theories of intelligence	Aronson et al., 2002
self-affirmations	Cohen et al., 2006; Cohen et al., 2009
thinking about individual attributes	Ambady, Paik, Steele, Owen-Smith, & Mitchell, 2004
educating students about stereotype threat	Johns et al., 2005; McGlone & Aronson, 2007
providing an alternative positive identity	McGlone & Aronson, 2007; Blanchard-Fields & Horhota, 2006
challenging beliefs about the control one has over one's ability to perform well	Blanchard-Fields & Horhota, 2006
conducting exams in same-sex environments	Inzlicht & Ben-Zeev, 2000
reducing self-relevance of the threat	Marx & Stapel, 2006
making very explicit the link between group membership and performance	Kray et al., 2001
lessening the importance of the task or redefining a situation as less threatening	Croizet & Claire, 1998; Steele & Aronson, 1995

Reframing Tests as Challenges. Alter et al. (2010) investigated if African American students would perform better on a math test if it was framed as a challenge. They grouped students (African American and White) into either a threat or challenge condition. The groups completed the same test but were given instructions which were subtly different. The instructions for the threat condition emphasized the diagnostic

nature of the test (i.e. the test would measure their ability to solve math problems). While the instructions for the challenge condition explained the role of the test in improving their general mathematical ability (i.e. learning to do math well could help them in their studies) (Alter et al., 2010). The African American students in the challenge condition performed just as well as their White peers; whereas as those in the threat condition did not (Alter et al., 2010). As a surprise to the researchers, the White students in the challenge condition also performed better (Alter et al., 2010).

Shaping Theories of Intelligence. Aronson, Fried, and Good (2002) performed an experiment with African American and White Stanford undergraduates in which they encouraged students to see intelligence as a malleable rather than fixed capacity. Students in the study were assigned to one of three groups. Those in group 1 wrote a letter to a “fictional” pen pal. The pen pal was encouraged to work hard in spite of difficulties. Group 1 participants were also asked to impress upon their pen pals that intelligence is not finite. Instead it is expandable and increases with mental effort (Aronson et al., 2002). Group 2 also wrote letters to “fictional” pen pals but without the message about the nature of intelligence as being expandable (Aronson et al., 2002). The third group of students did not write a letter (Aronson et al., 2002). African American students encouraged to view intelligence as malleable reported greater enjoyment of the academic process, greater academic engagement, and obtained higher grade point averages than their counterparts in the two control groups (Aronson et al., 2002).

The literature presents additional interventions including: self-affirmations (Cohen, Garcia, Apfel, & Master, 2006; Cohen, Steele, & Ross, 2009); having students think about their individual attributes (Ambady et al., 2004); educating students about

stereotype threat (Johns, Schmader, & Martens, 2005; McGlone & Aronson, 2007); providing an alternative positive identity (McGlone & Aronson, 2007; Blanchard-Fields & Horhota, 2006); challenging beliefs about the control one has over one's ability to perform well (Blanchard-Fields & Horhota, 2006); conducting exams in same-sex environments (Inzlicht & Ben-Zeev, 2000); reducing self-relevance of the threat (Marx & Stapel, 2006); making very explicit the link between group membership and performance (Kray, Thompson, & Galinsky, 2001); and lessening the importance of the task or redefining a situation as less threatening (Croizet & Claire, 1998; Steele & Aronson, 1995).

Stereotype Threat Explored Outside a Controlled Experimental Environment

Investigations have produced a consistent picture of STT's deleterious effects on short-term performance outcomes in controlled experimental settings. However, how STT is experienced and conquered in real-world settings remain mysterious. There are only a couple of research groups who have published studies which investigated stereotype threat effects outside the laboratory over an extended period of time (Table 2-5). An investigation by Block et al. (2011) aimed to understand the long-term responses to STT in the workplace. McGee and Martin (2011) introduced the concept of stereotype management to explain how African American mathematics and engineering students excelled academically in spite of stereotype threat.

Block et al. (2011) proposed a model to explain how people respond to STT in the workplace. The authors posit a framework of STT response which is comprised of three different phases: (a) "fending off the stereotype"; (b) "discouraged by the stereotype";

Table 2-5 *Stereotype Threat Effects Outside the Laboratory*

Researchers	Response to STT
Block et al., 2011	3-Phase Model <ul style="list-style-type: none"> • fending off the stereotype • discouraged by the stereotype • resilient to stereotype
McGee & Martin, 2011	Stereotype Management <ul style="list-style-type: none"> • sense of agency and self-efficacy • supportive academic and social organizations • family socialization

and (c) “resilient to the stereotype.” Block et al. (2011) postulated that individuals in the “fending off the stereotype” phase work vigorously to prove that the stereotype does not apply to them. Individuals in this phase “may use work strategies, such as striving to perform at a high level, to appear perfect and demonstrate a ‘bullet-proof’ image” (Block et al., 2011, p. 575). Although they may experience high levels of production, they do so at a high “psychic cost” (Block et al., 2011, p.575). In the “discouraged by stereotype phase, individuals realize that no matter how productive they are, and how much they achieve, they will still be perceived in light of this stereotype” (Block et al., 2011, p. 579). According to Block et al. (2011), anger is a typical emotional response for those individuals in the “discouraged by stereotype” phase. Individuals in the “resilient to stereotype” phase accept that stereotypes exist and will affect how others judge them. These individuals redirect their energy toward the goal of changing the environment so that it is inclusive of members of their identity group (Block et al., 2011). They are more likely to employ group-focused coping strategies, such as trying to improve the treatment of their group (Block et al., 2011).

E.O. McGee and Martin (2011) described stereotype management as “a tactical response to the ongoing presence of stereotype threat” (p. 1354). Based on their research findings, they presented three primary differences between stereotype management and STT (E.O. McGee & Martin, 2011). First, there is a difference with how the racial stereotypes are manifested. With STT, the stereotype has to be primed; whereas, the stereotype is omnipresent with stereotype management. The students in McGee and Martin’s (2011) study expressed “that they felt more stereotyped in situations in which there were only a few or no other Blacks present, demonstrating how particular situations were more inclined to activate stereotypes” (p. 1355). However, these same students described feeling burdened to prove their intellectual abilities even while studying at home alone. The researchers concluded that “once the stereotype has been activated and perceived as a racialized threat, its longevity exists far past the situation or event in which the student was stereotyped” (E.O. McGee & Martin, 2011, p. 1355). The second difference between STT and stereotype management is related to the academic consequences of being stereotyped. While STT leads to academic disengagement, stereotype management arouses additional motivation for high achievement. The research methods used to explore stereotypes is the final difference between the two. STT has been explored in experimental settings mainly involving test-taking conditions. Stereotype management research has investigated the everyday microaggressions inside and outside the classroom (E.O. McGee & Martin, 2011).

E.O. McGee and Martin (2011) interviewed high-achieving African American mathematics and engineering college students. From an early age, the students were aware of the negative stereotypes regarding their abilities to perform mathematics at a

high level (McGee & Martin, 2011). The students constructed a variety of strategies to lessen the threat brought on by the negative ways their mathematical abilities were perceived (McGee & Martin, 2011). The researchers confessed to being unable to uncover definitive answers to exactly how these students persisted. However, their analysis suggested that “the range of risk and protective factors that support or constrain resilience among these students are multifaceted, contextual, and grew out of each student’s life and academic experiences” (McGee & Martin, 2011, p. 1379). The researchers asserted, “Some of the resilience developed from the students’ own growing sense of agency and self-efficacy, where they realized they were able to change their individual circumstances and determine the direction of their lives in the face of stereotypes” (McGee & Martin, 2011, p. 1379). They also inferred that some students developed their resilience from numerous protective factors, including supportive academic and social organizations (i.e., National Society of Black Engineers) (McGee & Martin, 2011). In these organizations, students witnessed authentic examples of Black success in STEM disciplines. The support and encouragement of family was also cited by some students as contributing to their persistence (McGee & Martin, 2011). The researchers avowed that stereotype management “helped students to maintain strong senses not only of their racial identities but also of their disciplinary identities. That is, the students continued to see themselves as doers of mathematics and engineering despite the racial microaggressions and racial stereotypes” (McGee & Martin, 2011, p. 1379). E.O. McGee & Martin (2011) argued that stereotype management was a strategic tool that allowed stigmatized students to assert their academic excellence in the face of being stereotyped.

Critical Race Theory

Grounded in the work of legal scholars Derrick Bell, Alan Freeman, and Richard Delgado, Critical Race Theory (CRT) is a framework that takes into consideration the legacy of historic discrimination. It deliberately identifies racism as an endemic element of life in the United States (Delgado & Stefancic, 2001; Parker & Stovall, 2004). CRT developed during the 1970s as a “response to the failure of Critical Legal Studies (CLS) to adequately address the effects of race and racism in U.S. jurisprudence” (DeCuir & Dixon, 2004, p. 26). According to Ladson-Billings (1998), “CLS scholars critiqued mainstream legal ideology for its meritocracy but failed to include racism in its critique. Thus, CRT became a logical outgrowth of the discontent of legal scholars of color” (p. 11). CRT goes beyond challenging the meritocracy of the United States. It emphasizes the explicit effects of race and racism while simultaneously addressing the impact White supremacy has on the meritocratic system (Cook, 1995; Crenshaw, 1995; Dalton, 1995; Matsuda, 1995). Ladson-Billings (1998) asserted, “Because racism is so enmeshed in the fabric of our social order, it appears both normal and natural to people in this country” (p. 11). Some have argued that racism is a permanent fixture in American life (Bell, 1992). Thus, the goal of critical race theorists is to unmask and expose racism in its various permutations (Ladson-Billings, 1998).

There are five essential themes of CRT (Table 2-6): (a) centrality of racism (Bell, 1992, 1995; Lawrence, 1995); (b) White supremacy (Harris, 1995); (c) interest convergence (Bell, 1980); (d) critique of liberalism (Crenshaw, 1988); and (e) voices of people of color (Matsuda, 1995). The first theme (centrality of racism) is the idea that

racism is a normal part of American society. Delgado and Stefancic (2000) argued that racism is so deeply ingrained in the cultural landscape of America that it looks ordinary and natural. White supremacy, the second theme, was described by Ansley (1997) as “a political, economic, and cultural system in which Whites overwhelmingly control power and material resources...” (p. 592). The third CRT theme, interest convergence, signifies that “the interest of Blacks in achieving racial equality will be accommodated only when it converges with the interests of Whites” (Bell, 1980, p. 523).

The fourth CRT theme, the critique of liberalism, denounces three fundamental philosophies embraced by liberal legal ideology: (a) the color-blind mentality; (b) the neutrality of the law; and (c) incremental change (DeCuir & Dixon, 2004). DeCuir and Dixon (2004) argued:

In the abstract, colorblindness and neutrality allow for equal opportunity for all. However, given the history of racism in the U.S. whereby rights and opportunities were both conferred and withheld based almost exclusively on race, the idea that the law is indeed colorblind and neutral is insufficient (and many would argue disingenuous) to redress its deleterious effects. (p. 28)

CRT scholars have asserted that change will not come with the “color-blind” mentality (Bonilla-Silva, 2003; Delgado & Stefancic, 2001; Ladson-Billings & Tate, 1995; Lewis, 2003; Lopez, 2003; Lynn, Yosso, Solorzano, & Parker, 2002; Parker, 1998; Solorzano, 1997; Solorzano & Yosso, 2001, 2002a, 2002b; Tate, 1997a, 1997b). Scholars proclaim that the notion of “color-blindness” upholds White supremacy in terms of sweeping away racial classifications, while leaving political majorities intact. According to Yamamoto (1997), a “color-blind” perspective on race calls for assimilation; whereas, CRT

advocates for an awareness of how social action can be used to bring groups together to tackle shared concerns of racial and class inequality. Williams (1997) asserted that it is nearly impossible to effectively probe into the ways that White privilege is deployed while simultaneously normalizing the effects of whiteness. Williams (1997) further affirmed that “being different” in the colorblind discourse typically refers to people of color because being White is considered “normal.”

The final critique of liberalism argued by critical race theorists is the notion of incremental change. This ideology maintains that “gains for marginalized groups must come at a slow pace that is palatable for those in power. With the incremental change discourse, equality, rather than equity, is sought” (DeCuir & Dixon, 2004, p. 29). When equality is pursued, the ideologies that justify inequity are not adequately addressed and dismantled (DeCuir & Dixon, 2004). Solutions grounded in equality assume that citizens have the same opportunities and experiences. Race, along with experiences based on race, are not only different, they are not equal (DeCuir & Dixon, 2004). Therefore, the different experiences that people of color have with respect to race and racism inherently create inequality (DeCuir & Dixon, 2004). Unlike those solutions framed around equality, those grounded in equity takes into consideration the different racial experiences of people of color (DeCuir & Dixon, 2004). Remedies aimed at achieving equity acknowledge that the playing field is unequal and strive to address the inequality (DeCuir & Dixon, 2004). Incremental change is problematic because it “benefits those who are not directly adversely affected by social, economic, and educational inequity that come as a result of racism and racist practices” (Decuir & Dixon, 2004, p. 29).

Table 2-6 *Essential Themes of Critical Race Theory*

Theme	Explanation of Theme	Researchers
Centrality of Racism	Racism is a normal part of American society.	Bell, 1992, 1995; Lawrence, 1995
White Supremacy	Whites overwhelmingly control power & material resources.	Ansley, 1997; Harris, 1995
Interest Convergence	The interest of blacks in achieving racial equality will be accommodated only when it converges with the interests of White.	Bell, 1980
Critique of Liberalism	Critique of 3 liberal ideologies: a) the notion of colorblindness; b) the neutrality of the law; and c) incremental change	Crenshaw, 1988

The final theme of CRT is “voices of people of color” (Matsuda, 1995). Rollock and Gillborn (2011) reported, “CRT places particular importance on the voices and experiences of people of color; their insights into the operation of racism and their understanding of being racially minoritised” (p. 2). Such insights are presented in the form of storytelling (including counter storytelling) and counter-narratives (Rollock & Gillborn, 2011). According to Tate (1997a), storytelling is a powerful approach that enables racial minorities to “speak back” about racism and facilitate “psychic preservation” (p. 220). Tate (1997a) described “psychic preservation” as a means for

psychological and spiritual empowerment in response to the depleting effects of racism (p. 220). CRT scholars assert that although there is a tradition of storytelling within the African American culture, the stories of African Americans have not been properly told or are absent in the literature (Delgado & Stefancic, 2001; Lawrence, 1995). Delgado and Stefancic (2001) characterized counter-storytelling as an approach to telling a story that “aims to cast doubt on the validity of accepted premises or myths, especially ones held by the majority” (p. 144). They also elucidated that counter-storytelling “help[s] us understand what life is like for others, and invite[s] the reader into a new and unfamiliar world” (p. 41). Solórzano and Yosso (2002a,b) suggested that counter-stories can be found in a variety of forms, including personal stories/narratives, other people’s stories/narratives, and composite stories/narratives.

Although it emerged as a movement in the field of law, CRT has spread into other disciplines (Table 2-7). Scholars in the field of education have applied CRT to educational issues, including IQ and achievement testing (Ladson-Billings & Tate, 1995; Parker & Stovall, 2004; Solorzano, 1997; Solorzano & Yosso, 2002b; Tate, 1997b). CRT has been used as a framework for examining “persistent racial inequities in education, qualitative research methods, pedagogy and practice, the schooling experiences of marginalized students of color, and the efficacy of race-conscious education policy” (Lynn & Parker, 2006, p. 257). Political scientists have explored the voting strategies conveyed by critical race theorists (Delgado & Stefancic, 2012). Other scholastic fields which have embraced CRT include Ethnic Studies and American Studies (Delgado & Stefancic, 2012).

Table 2-7 *Disciplines in Which CRT Has Been Applied*

Disciplines in which CRT has been applied
Law
Educational Issues: <ul style="list-style-type: none"> • IQ and achievement testing • racial inequities in education • qualitative research methods • pedagogy and practice • race-conscious education policy
Political Science & Voting Strategies
Ethnic Studies
American Studies

Rarely has CRT been applied in STEM education studies. McGee investigated the practices of White mathematics teachers who embraced racial indifference and colorblindness (McGee, 2005). Her study revealed how White mathematics teachers rejected examinations of White privilege and anti-racist pedagogy (McGee & Martin, 2011; McGee & Pearman, 2014). DeCuir-Gunby, Long-Mitchell, & Grant (2009) used a CRT and a Critical Race Feminism (CRF) framework to explore the emotions associated with being underrepresented female professors of color in engineering. However, the literature is void of studies utilizing CRT to uncover specific challenges facing African American female engineering students.

CRT is distinct from other frameworks because it encompasses an activist dimension. According to Delgado and Stefancic (2012), scholars of CRT strive to do more than understand the racialized social environment in this country. They aim to transform it. They also strive to move beyond determining how society organizes itself along racial lines and hierarchies (Delgado & Stefancic, 2012). The overarching intention

of CRT scholars is to transform society for the betterment of all; particularly focusing on people of color (Delgado & Stefancic, 2012).

Intersectionality

A derivative of CRT is intersectionality. Originally coined by the prominent critical race theorist and professor of law, Kimberlé Crenshaw (1988), intersectionality is a theoretical framework that examines how race intersects with gender, ability, sexual orientation, and other biological, social, or cultural categories. This framework recognizes that the intersection of any of these categories contributes to systematic injustice and social inequality (Crenshaw, 1988).

Crenshaw (1989) maintained that it is impossible to understand the challenges of women of color without examining the intersection of race and gender identities. She explained intersectionality as follows:

With Black women as the starting point, it becomes more apparent how dominant conceptions of discrimination condition us to think about subordination as disadvantage occurring along a single categorical axis. I want to suggest further that this single-axis framework erases Black women in the conceptualization, identification, and remediation of race and sex discrimination by limiting inquiry to the experiences of otherwise-privileged members of the group. (Crenshaw, 1989, p. 140)

In the 1990s, intersectionality gained prominence when sociologist Patricia Hill Collins reintroduced the idea as part of her discussion on Black feminism (Mann & Huffman,

2005). Collins (1990) replaced her previously coined expression “Black feminist thought” with intersectionality. Like Crenshaw, Collins argued that cultural patterns of oppression are not only interrelated, but are bound together and influenced by the intersectional systems of society, such as race, gender, class, and ethnicity (Collins, 2002, p. 42). Black feminists argued that the experience of being a Black woman cannot be understood independently in terms of being Black, and of being female. The interactions of the two often reinforce each other and must be considered when analyzing social injustices (Collins, 1990; Crenshaw, 1989).

Study Applies CRT and Intersectionality to Extend the STT Literature

Grant argues, “Despite the significance of Black Women’s distinct perspectives, there is a paucity of research that accurately expresses the unique, yet common experiences of Black women; and even less research originates from the perspective of the Black woman herself” (Grant, 2012, p. 105). Johnson-Bailey (2001) affirmed:

The educational experiences of Black females are notably different than the experiences of other groups. From primary school through higher education, their lives are touched whether overtly or covertly by racism and sexism. (p. 15)

As a result of this constant awareness of their different experiences, African American feminists posit that “Black women conceptualize their existence as unique and their place as tenuous and uncertain” (Johnson-Bailey, 2001, p. 12). According to Keetley and Pettegrew (2005), “And she [Black woman] had nothing to fall back on; not maleness, not whiteness, not lady-hood, not anything. And out of the profound desolation of her

reality she may well have invented herself” (p. 74). This study aimed to understand how African American females, who are unable to fall back on maleness or whiteness, invent themselves so that they can persist in the White, male dominated field of engineering,

Collins (2002) encouraged Black female intellectuals to “produce facts and theories about the Black female experience that will clarify a Black woman’s standpoint for Black women” (p. 469). This investigation coupled the CRT tenet, voices of people of color with intersectionality to produce facts and theories about the experience of Black females who have persisted in engineering degree programs.

This study extends the literature on how stigmatized individuals can excel in stereotype-threatening environments. Specifically, it focused on the strategies 10 African American females employed to persist in engineering degree programs while contending with stereotype threat. African American female engineering students have two salient identities associated with negative stereotypes: (a) African Americans as intellectually inferior and (b) women as incompetent engineers.

African American females in engineering face the double bind of being women and Black (Brown, 2004). The double bind is the way in which race/ethnicity and gender function simultaneously to produce distinct experiences for women of color (Ong, Wright, Espinosa, & Orfield, 2011, p. 175). Shih et al. (1999) found that Asian-American women performed better on a mathematics test when their ethnic identity (i.e. a positive stereotype about Asians superior math performance) was activated. However, African American women in engineering do not have available to them an alternate positive social identity. Nonetheless, they enter -- and some are highly successful in -- engineering (Crisp, Bache, & Maitner, 2009).

CHAPTER 3

METHODS

Research Question

Researchers have become well versed in STT and its effect on the academic performance of African American students (Blascovich et al., 2001; Howard & Hammond, 1985; Moore, Madison-Colmore, & Smith, 2003; Steele, 1997; Steele & Aronson, 1995; Steele et al., 2002). However, little is known about how this stigmatized group of students managed the adverse effects of STT. The literature is nearly void of studies highlighting the resiliency of African American students. Resiliency is the ability to form a successful adaptation in the face of obstacles and adversity (Arroyo & Zigler, 1995). According to Block et al., “individuals who respond to stereotype threat with resilience strategies realize that stereotype threat will be present and will affect how others judge them” (Block et al., 2011, p. 583).

Although E.O. McGee (2005) investigated how African American mathematics and engineering college students maintained high achievement outcomes in spite of negative stereotypes, studies confirm that achievement and persistence are not always in parallel (Goodman et al., 2002). Many students who transfer out of engineering and enter into other majors are not necessarily suffering academically (Goodman et al., 2002). Also, those who persist are not necessarily the ones with the highest academic achievements. After conducting a review of the literature, Malicky (2003) concluded that

the persistence of women in engineering is considerably lower than men, despite equal or better academic performance.

This study aimed to unveil what “tools,” “resources,” or “characteristics” are empowering African American female engineering students to persist in an environment which has been described as “chilly” and “unwelcomed” (Hall & Sandler, 1982) to women and under-represented minorities. The overarching research question for this study was:

- How do African American female engineering students resist or overcome stereotype threat and persist in engineering?

Methodology: Counter-storytelling through Narratives

Albert Einstein once said, “Not everything that can be counted counts, and not everything that counts can be counted.” As illuminated in Einstein’s quote, quantitative research methods are not always the most effective measures to understand the root of a problem. Often, qualitative research methodologies, which focus on everyday life experiences and value participants’ perspectives (Marshall & Rossman, 1999), are more appropriate because they tackle the “Why?” and the “How?” Not just the “How many?”. The qualitative approach adopted for this study is the CRT tenet of counter-storytelling (Matsuda, 1995). Solórzano and Yosso (2002b) define counter-story as “a method of telling the stories of those people whose experiences are not often told” (p. 26). Counter-storytelling challenges the complacency of historically marginalized students to not accept the simple yet domineering narratives about the fate of their race (Landson-

Billings, 1998; Solórzano & Yosso, 2002a). It also gives them an opportunity to confront their own assumptions and notions about these narratives (Landson-Billings, 1998; Solórzano & Yosso, 2002a,b). Solórzano and Yosso (2002a) suggest that counter-stories can be found in various forms, including personal stories/narratives, other people's stories/narratives, and composite stories/narratives.

For this study, narratives were used to illuminate how African American female engineering students negotiate the complex intersectionality of their race and gender in engineering education. Narrative is defined as “meaning making through the shaping or ordering of experience, a way of understanding one's own or others' actions...of connecting and seeing the consequences of actions and events over time” (Chase, 2011, p. 421). The narratives of African American female engineering students provided a vivid description of their experiences beyond their academic performance. Chase (2011) asserted, “Some study how narratives make change happen, and some collect and present narratives to make change happen. In either case, there is a sense of urgency, of the need for personal and social change” (p. 427). According to Shields (2008) research adopting an intersectionality perspective includes an agenda for positive social change. Lyons, Bike, Johnson, & Bethea (2012) stressed the need for qualitative research methods that allows participants of African descent to have their voices heard.

The overall goal of this study was to understand how African American female students persist in engineering despite experiencing STT. The broader impact of this study is that it will serve as a model that can be applied to better understand the authentic needs of other underrepresented groups in engineering. It can also lead to the creation of impactful intervention strategies to enhance their persistence.

Participants

Participants were recruited from nine engineering schools across the United States. The nine schools were selected based on very precise inclusion criteria. A three-tiered model was established to rank universities. The primary category included engineering schools which graduate the most African Americans. Two sub-categories were then created: (a) engineering schools which graduate the most females; and (b) engineering schools which graduate the most number of students from all demographics. Those universities which ranked high in all three categories were selected. Ten participants were selected using purposeful sampling techniques according to the following criteria: (a) students (or recent graduates) are female; (b) students (or recent graduates) are African American; (c) students (or recent graduates) are majoring (or earned a BS) in engineering; and (d) students have been enrolled in college as an engineering major for at least eight semesters; or recent graduates are no more than two years past earning an undergraduate engineering degree. Criterion four was chosen because eight-semester persistence has been used in the literature as a metric for success in engineering (Astin & Astin 1992; Humphreys & Freeland, 1992; Lord et al., 2009; Ohland et al., 2008; Richardson & Dantzler, 2002; Seymour & Hewitt, 1997). Even though students may take longer than eight semesters to graduate, eight-semester persistence has been shown to be highly predictive of 6-year graduation rates (Ohland, Camacho, Layton, Lord, & Wasburn, 2009). Recent graduates were included because their persistence in engineering school is evident by their degrees. Also, their memory of events that occurred during their tenure as undergraduates was fresh.

Someone from the college of engineering at each of the nine selected universities was contacted. Those who were contacted include: (a) directors of Minority in Engineering and Women in Engineering Programs; (b) retention specialists; (c) diversity and inclusion directors; (d) faculty advisors for student organizations including National Society of Black Engineers (NSBE) and Society of Women Engineers (SWE); and (e) African American engineering faculty members. An introductory email provided information about the researcher and this qualitative investigation [Appendix A]. The study was described as an exploration to better understand how engineering colleges can better assist African American female students' persistence in engineering. The university contact was asked to forward the email to all African American female engineering students and alumni who were no more than two years past earning their Bachelor's degree in an engineering discipline.

Once potential participants were identified, it was confirmed that they met the four inclusion criteria. An email was sent to inform the students (and recent graduates) that the purpose of this research study was to hear their personal stories of how they have persisted in engineering [Appendix B]. It further explained that the aim of the study was to ascertain the 'tools' and 'techniques', as well as, characteristics that have supported their personal journey in engineering. The email also elucidated how their participation will provide meaningful data that could assist other African American female students persevere in engineering. The students (and recent graduates) were informed that their participation in this study was completely voluntary and a coding system was employed to ensure confidentiality. The email also explained their right to refuse to participate or withdraw at any time without consequence. Furthermore, students (and recent graduates)

were told that those who complete the study will be awarded a \$50 American Express gift card. Thirty students and five recent graduates enthusiastically responded to the email. Taking into account that situations may arise that could potentially prevent some from not completing the study, the first 20 respondents were invited to join the study. All 20 completed the first interview. Twelve of the 20 also submitted reading reactions. However, only 10 women finished the entire study. Three of the 10 participants earned their engineering degrees 5 months prior to the start of the study. One of the 10 earned her engineering degree 17 months prior to her first interview. The remaining six were either fourth or fifth year seniors.

Role of Researcher

Miles and Huberman (1994) outlined four key characteristics of a good qualitative researcher including: (a) familiarity with the phenomenon and the setting under study; (b) strong conceptual skills; (c) multidisciplinary approach (opposed to a narrow grounding or focus in a single discipline); and (d) good investigative skills, including the ability to get participants to feel unguarded. Banks (1998) categorized researchers into four domains:

- i. The indigenous-insider: this researcher endorses the values of his or her indigenous community and is perceived by members as a “legitimate community member” (p. 8);
- ii. The indigenous outsider: this researcher was socialized within the indigenous community but has experienced “high levels of cross cultural assimilation into

an outsider or oppositional culture” (p. 8) and is perceived by the community as an outsider;

- iii. The external-insider: this researcher was socialized in a culture outside that in which the research is being conducted but due to unique experiences rejects their beliefs and attitudes and is adopted as an insider within a community;
- iv. The external outsider: this researcher is socialized in another culture and has little knowledge or appreciation of the culture in which the research is being conducted and can misinterpret and misrepresent the behaviors of the community.

According to Mizock, Harkins, & Morant (2012), the race of the researcher can play a powerful role in the research process and in the findings. They affirm, “When done in a collaborative manner, the research process can allow for mutual empowerment and agency between the researcher and participant...” (Mizock et al., 2012, p. 21). As an African American female engineer, I am an indigenous-insider. As one who acknowledges experiencing STT, I understand the phenomenon being study and the impact of intersectionality.

Data Collection

This study was comprised of two semi-structured interviews conducted over the course of one semester. Participants had the option to have interviews conducted via Skype or telephone. Four out of 10 of the first interviews were conducted via Skype. Due to an abundance of technical difficulties using Skype, all 10 of the second interviews

were conducted over the phone. All interviews were audio recorded. The first interviews lasted approximately forty-five minutes to nearly two hours. The duration of the second interviews ranged from approximately fourteen minutes to a little more than one hour. The elapsed time between the first and second interviews for each participant varied from 8 to 32 days (Table 3-1).

During the first interview, students were introduced to the concept of STT. Questions were framed to comprehend how the participants have been impacted by STT and how they either resisted or overcame it. Questions for interview one were borrowed from those previously tested in a pilot study (Gregory, 2014) [Appendix C]. Questions from the pilot came from the literature and were re-framed to fit the needs of this study. The questions for the second interview were created based on interview one discussions [Appendix D].

Table 3-1 *Date and Length of Interviews*

Pseudonym	INTRVW 1 (Date)	INTRVW 1 Length (Time)	INTRVW 2 (Date)	INTRVW 2 Length (Time)	Elapsed Time Interviews 1 & 2 (Days)
Sara	10/09/2014	0:48:25	10/23/2014	1:03:00	14
Shirley	10/12/2014	1:15:44	11/14/2014	0:50:36	23
Ellen	10/20/2014	0:50:42	11/24/2014	0:22:36	31
Ursula	10/29/2014	1:04:04	11/06/2014	0:21:31	8
Rebecca	10/29/2014	1:17:07	11/30/2014	0:20:52	32
Miriam	10/30/2014	0:44:27	11/20/2014	0:14:37	21
Euphemia	10/30/2014	1:04:00	11/26/2014	0:17:39	27
Mary	10/31/2014	1:10:07	11/26/2014	0:34:26	26
Jewel	11/01/2014	1:55:33	11/15/2014	0:28:27	14
Bessie	11/02/2014	1:32:31	11/18/2014	0:13:26	16
Total Interview Time		11:69:00		4:75:00	16:44:00

After the first interview, students were asked to read a short, eight page journal article entitled *Snow Brown and the Seven Detergents: A Metanarrative on Science and the Scientific Method* (Subramanin, 2000). This article is a fable about a young lady who leaves her homeland to travel to a far-away place to pursue her lifelong dreams of becoming a scientist. Upon her arrival, she quickly discovers that she does not have the ‘right’ characteristics to become a scientist. She is advised by an all-knowing ‘White patriarch’ that to succeed in this new land as a scientist, she must change her name, accent, and physical appearance. After making all these alterations, the young lady is still not ‘accepted’ into the ‘scientific land of truth.’

Participants were asked to write a reaction describing how the article resonated with them regarding their personal experiences with stereotype threat in engineering. Each participant submitted a reading reaction prior to her second interview. The second interview focused on a detailed discussion of the submitted reading reaction, as well as, other pertinent topics that surfaced during the first interview. The number of words each participant wrote in her reading reaction is displayed in Table 3-2. The duration reading reactions were submitted relative to the completion of first interview and prior to the second are also presented (Table 3-1).

Data Analysis

Ongoing data analysis is critical in qualitative research (Kvale & Brinkmann, 2009). The most essential components of data analysis are organization and management

of the data (Miles & Huberman, 1994). In this investigation, data collection and data analysis occurred simultaneously. All interviews were transcribed following the protocol outlined by Brown and Gilligan (1993). They provided three suggestions on how researchers should approach transcribing interview data: (a) listening to get a sense of what is happening in order to hear the story and the details of the narrative; (b) listening to hear “self” or the voice of “I”; and (c) listening to pay attention to the way participants discuss relationships, especially cultural norms.

Table 3-2 *Interview Dates & Reading Reaction Submission Dates & Number of Words*

Pseudonym	INTRVW 1 (Date)	INTRVW 2 (Date)	Submission Date Reading Reaction	Reading Reaction: Number of Words
Sara	10/09/2014	10/23/2014	10/20/2014	282
Shirley	10/12/2014	11/14/2014	11/03/2014	1078
Ellen	10/20/2014	11/24/2014	11/12/2014	564
Ursula	10/29/2014	11/06/2014	11/04/2014	433
Rebecca	10/29/2014	11/30/2014	11/27/2014	1292
Miriam	10/30/2014	11/20/2014	11/15/2014	140
Euphemia	10/30/2014	11/26/2014	11/12/2014	133
Mary	10/31/2014	11/26/2014	11/07/2014	519
Jewel	11/01/2014	11/15/2014	11/14/2014	459
Bessie	11/02/2014	11/18/2014	11/17/2014	373

At various stages of data analysis, notes were made in the margins of transcripts as they were repeatedly reviewed. Detailed notes were also maintained in a research journal. During data analysis, emerging themes were sought. Did the participants express common concerns? Were there shared experiences among the participants? Were there

clear contrasts? To fully digest and appreciate the data, a coding scheme was implemented. All interviews and essays were coded.

Kvale and Brinkmann (2009) acknowledge that computer programs can be used to perform data analysis and are useful with coding data. However, ultimately, it is the responsibility of the researcher to perform manual analysis and interpret the data that lead to the findings. To ensure that the authentic voice of the participants was fully captured, computer programs were not used in this study. My desire was to become very familiar with the data so that participants' counter-stories were realized.

The coding scheme implemented in this study is the same one employed and proven to be successful in the pilot study that laid the foundation for this work (Gregory, 2014). The actual words of the students were written on color-coded index cards. Each color represented a specific theme. Every card contained only one statement relevant to the theme. After coding the data, there were nearly 500 unique color-coded index cards and 14 different themes. The data was continuously massaged to merge similar themes. Finally, four themes emerged. The themes, discussed in detail in the following chapter, are: (a) proof stereotype threat exists; (b) primary contributors to stereotype threat; (c) secondary factors; and (d) tools for persisting.

Skype interviews were audio recorded only. An Amolto call recorder was used to capture the recordings. Phone interviews were recorded using the cell phone application, "Voice Recorder." Once interviews were transcribed the recordings were permanently erased. Prior to being erased, recordings were stored on a laptop with a secured password and accessible only to the researcher. The transcribed interviews and essays do not contain the names of participants or any other identifiers. A numerical coding system was

established to identify participants. The coding sheet and transcribed data remained secured in a locked file accessible only to the researcher.

Reliability and Validity

Traditionally, reliability refers to replication of findings; however, in qualitative research the focus is “whether the results are consistent with the data collected” (Merriam, 2009, p. 221). Reliability in this study was maintained through triangulation of three different data sources: two interviews, reading reactions; and the literature review on stereotype threat theory. All 10 participants were emailed copies of transcribed interviews as a form of member checking (Appendix F). Member checking added to the credibility of the study and offered the researcher and the participants “mutual enlightenment” (Miles & Huberman, 1994, p. 276).

Validity implies that the researcher practiced integrity and honesty throughout the research process. According to Johnson (1997), “when qualitative researchers speak of validity they are usually referring to qualitative research that is plausible, credible, trustworthy, and therefore defensible” (p. 282). Merriam (2009) has argued that the goal of the qualitative researcher is to tell the story of participants with a rich description of their experiences so that readers can assess if similarities exist between these descriptions and the research findings. In this study, the stories of 10 African American women illuminated their experiences with STT and how they have persisted in spite of it. Each participant was invited to read her written story and provide any feedback. Participants’ approval of transcripts and stories enhanced both the reliability and validity of this study.

CHAPTER 4

PARTICIPANT INTRODUCTIONS

To better appreciate the context of the themes and categories that emerged from analyzing the interview transcripts and reading reactions, participants' life stories are provided. These stories feature the challenges participants encountered as well as tactics they employed to help them persist. They also include details of when and why these women made the decision to become engineers, along with who encouraged them to pursue engineering. The participants' experience with stereotype threat is also incorporated in the stories. Information such as socioeconomic status, educational attainment of their parents, and academic performance were purposefully excluded from interview questions. These types of questions have the potential to ignite stereotype threat and lead participants feeling guarded. It is the authentic voice and candid words of these women that give credence to the common themes and categories that emerged during data analysis.

Participants

Ten African American women who persisted in engineering degree programs were the participants of this study. They represented eight different engineering departments: Aerospace (AE), Biological (BE), Chemical (ChE), Computer Science (CSE), Computer Engineering (CompE), Materials Science (MSE), Mechanical (ME), and Nuclear (NE) (Table 4-1). They were enrolled in (or graduated from) four

universities located across the United States. Three participants were enrolled in the same dual degree program between a Predominantly White Institution (PWI) and an Historically Black College and University (HBCU). One of the persisters was a first year graduate student in medical physics at a large, reputable public university located in the Midwest. Three were employed fulltime as: (a) an AmeriCorps member at a health center; (b) a project manager at a software development company; and (c) a research assistant in the neuroscience department at a university located on the West Coast. Two of the participants have an uncle who is an engineer. One has a dad who is a physicist. The other seven participants do not have any family members who earned STEM degrees (Table 4-1).

The participants are originally from eight states covering every region of the United States: Southern, West Coast, East Coast and Midwest. The primary reasons they chose to pursue engineering include: (a) high math/science aptitude; (b) STEM outreach programs; and (c) overall interests and passion for STEM subjects (Table 4-2). The people most responsible for encouraging them to study engineering were parents, teachers and outreach program staff (Table 4-2).

The majority of the participants decided they wanted to be engineers either in elementary or high school (Table 4-2). Only one made the decision as a college student. To protect anonymity, each participant was given a pseudonym. The selected pseudonyms honor African American women who are either inventors or trailblazers in STEM fields (Table 4-3).

Table 4-1 *Overview of Participants*

Pseudonym	Status	School	Major	Family	Hometown
Sara	June 2014 Graduate	TII	CSE	Uncle	Chantilly, VA
Shirley	June 2014 Graduate	TII	NE/Physics	Dad	Los Angeles, CA
Ellen	4 th year	APU	MSE	No	Richmond, VA
Ursula	4 th year	APU	ME	No	Pittsburgh, PA
Rebecca	June 2014 Graduate	TII	BE	No	Boston, MA
Miriam	December 2014 Graduate	NU/CC	ChE/Chem	No	Long Beach, CA
Euphemia	4 th year	NU/CC	CompE/CS	Uncle	Ridgeway, SC
Mary	4 th year	NU/CC	NE/Physics	No	Jacksonville, FL
Jewel	June 2013 Graduate	TII	BE	No	Chicago, IL
Bessie	5 th year	NU	AE	No	Flint, MI

Table 4-2 *Overview of Participants*

Pseudonym	When	Why	Who
Sara	HS Jr.	Math Aptitude; Outreach; Program; Robotics	Outreach Prog.
Shirley	ES	STEM Interest/Hands-On Version of Science	Dad
Ellen	7th Grade	Science Aptitude; Outreach Program	Sci. Teacher Outreach Prog.
Ursula	HS Sr.	Math Aptitude; Shadowed Engineers	Mom
Rebecca	ES	STEM/Medicine Interests	Parents
Miriam	ES	Financial security	Mom
Euphemia	College	Goal: CS; ENGRG add-on (3-2 program).	Self/Outreach
Mary	HS Soph.	Outreach Program; Math/Science Aptitude	Physicist/ Outreach
Jewel	HS Soph.	Math/Science Aptitude; Outreach Program	Mom/ Grandmother
Bessie	ES	Airplane Curiosity; Outreach Program	Self/Mom

Table 4-3 *African American Women Whose Names Were Chosen as Pseudonyms*

Trailblazer	Accomplishment
Sara Goode	1 st African-American woman to receive a United States patent.
Shirley Jackson	1 st African American woman to earn a doctorate at MIT; 18th president of Rensselaer Polytechnic Institute. 1 st woman & 1st African American to hold this position.
Ellen Eglin	In 1880s invented and sold rights to a wringer washer for \$18.
Ursula Burns	1 st African American woman CEO to head a Fortune 500 company (Xerox); rated 22 nd most powerful woman in the world by Forbes (2014).
Rebecca Crumpler	1 st African American woman to become a physician in US.
Miriam Benjamin	Obtained patent for inventing Gong & Signal Chair for Hotels.
Euphemia Lofton	1st African American woman to earn a Ph.D. in Mathematics.
Mary Kenner	Received 1 st patent (Sanitary Belt, 1956); 4 more patents from 1959-1987.
Jewel Cobb	Educator & researcher; contributed to the field of chemotherapy with research on how drugs affected cancer cells; President of Cal. State. Fullerton (1981-1990).
Bessie Coleman	1 st African American female pilot & 1 st African American to hold an international pilot license.

In an effort to highlight the exceptional caliber of the participants, descriptions underscoring the prestige of the highly-ranked institutions they were enrolled in (or graduated from) are provided prior to presenting their very personal and inspiring stories. To protect anonymity, the engineering schools were also given pseudonyms.

Technical International Institute (TII). Technological International Institute (TII) is a private research university located in an urban setting in the Northeast region of the United States. It is commonly cited as one of the world's most eminent universities. According to a reputable ranking of best US colleges and universities, TII has repeatedly ranked in the top 10. It is also rated as the top university in more than five different engineering disciplines.

For the 2013-2014 academic year, the acceptance rate at TII was 8.2%. The TII freshman class of 2018 consists of over 1000 students comprised of 48% female, 51% Caucasian, and 9% international; spanning 48 states and 53 countries. The annual tuition is more than \$40,000. Though it is best known for its math, science and engineering education, TII also offers architecture, humanities, management and social science programs. There are over 40 major programs and nearly 50 minor programs at TII.

The following four participants are outstanding African American women who persisted at this prestigious university despite experiencing stereotype threat. Each of them have a unique path; however, they all credit the support and encouragement of their family and a nurturing Black community on campus for helping them to persist. Their desire to give back and serve as an example for the next generation of aspiring African American female engineers is undeniable. Their commitment to earning their engineering degree is profound.

Sara is a 2014 graduate of TII working for a reputable software development company as a project manager. Shirley is also a 2014 graduate. She is a first-semester graduate student at a highly-ranked public university in the Midwest. Rebecca, a 2014 graduate of TII, is currently an AmeriCorps member who plans to attend medical school. Jewel graduated in 2013 and is currently a research assistant at a pre-eminent university on the West Coast. She has aspirations of becoming a clinical psychologist. Thankfully for these participants, TII had programs in place to help them succeed, including an office of minority education. However, it was sheer determination that was instrumental in helping these women persist and earn their engineering degrees.

Sara: a culture maker who had a major breaking point. Originally from Chantilly, Virginia, Sara became interested in engineering when she was in high school. She described her initial interest in engineering:

I have always been good in math. In elementary school, I was placed on an accelerated math track. I always knew I was gifted in that area. But I could not perceive myself as being an engineer until high school.

As a high school student, Sara participated in an extra-curricular program that exposed girls to engineering. This program was instrumental in her decision to pursue an engineering career. She shared, “The Girls Exploring Engineering program revealed to me that not all engineers are introverts. Not all engineers are White men. That’s when I became really passionate about engineering and thought, “I can be an engineer.”” Her journey to become an engineer was not an easy one. She encountered several challenges; yet she remained resilient.

Sara suffered her first setback as a college freshman. She stated, “Originally, I thought I wanted to be a mechanical engineer. But I failed my introduction to mechanical engineering class my freshman year.” Sara refused to allow failing a class divert her from pursuing an engineering degree. Even though she changed her major, she ultimately earned an undergraduate degree in Computer Science and Engineering. She currently works at a reputable corporation that develops and manufactures computer software and personal computers.

I was pleasantly surprised on the day of our first interview when Sara revealed that she was very familiar with stereotype threat. She affirmed, “I am very interested in gender studies. Last semester, I took a class in which we read and discussed the Claude Steele paper. I am very passionate about this subject.” It was clear to Sara that she was a victim of stereotype threat while still in high school. She shared:

I participated in the Girls Exploring Engineering Program. That program was designed to challenge stereotype threat. That’s why it was for girls only. But in the robotics club, there were only a few girls. I was the only Black person. People didn’t expect me to be an engineer. I had to work twice as hard to prove myself.

This persister acknowledged that the need to prove herself started before she entered engineering school.

I asked Sara to describe the climate of her engineering classrooms. She responded, “I noticed people talking over me or interrupting and not allowing me to finish. I also realized that I had to give a lot more details to be perceived as someone who is knowledgeable.” She further alluded, “I was always very aware of how I presented myself. W.E.B. Dubois spoke about double-consciousness. I struggled with that all the

time. I constantly wondered how I was being perceived by my professors and classmates.” Sara referenced double-consciousness, a term coined by W.E.B. DuBois.

In *The Souls of Black Folk*, DuBois (1903) described double-consciousness as:

...this sense of always looking at one’s self through the eyes of others, of measuring one’s soul by the tape of a world that looks on in amused contempt and pity. One ever feels his two-ness,—an American, a Negro; two souls, two thoughts, two unreconciled strivings; two warring ideals in one dark body, whose dogged strength alone keeps it from being torn asunder. (p. 3)

Sara’s concern of being negatively perceived surfaced several times during our first interview. I asked her if she believed things were different for her as an African American woman in engineering compared to a White woman. She replied:

Yes, I definitely think there is a difference. I struggle with the media and how it characterizes Black women as angry and aggressive. I struggle with how to be a leader and remain affable. As a woman, people expect me to be less aggressive, less forward. And as a Black woman, if I am too forward in challenging the perception that women aren’t leaders, then I risk coming across as an angry Black woman. It is always that balance of feeling like I need to be aware of how I present myself. I think as a Black woman it is certainly more difficult.

Even though Sara believes engineering is more challenging for her as an African American woman, she remains committed to the profession.

A confirmation that Sara continues to be victimized by stereotype threat emerged during our conversation. She discussed the pressures of having to constantly prove that

she belongs in engineering and is qualified to perform her current job as a project manager.

It [pressure to prove herself] actually causes a lot of the stress and anxiety that I experience. I have been feeling extremely micromanaged on my job. I don't know if it's a perception about me. I am so used to being negatively perceived. People are constantly asking me about how I am spending my time at work. They are not even my manager. I can't understand why they are questioning me.

A desire to work extra hard to dispel a negative stereotype is symbolic of stereotype threat's presence. Sara knows that she is a hard worker and a competent engineer.

However, she attests:

I feel that I work so hard and nothing that I do is enough. I have to stop judging myself. I hate the idea that I internalize these things. I also feel that working above and beyond to prove myself is a protective mechanism. I don't want anyone to be able to say that I can't do my job.

Later in the conversation Sara admitted:

Sometimes I ask myself, "What's the point?" No matter how smart I am, no matter how successful I am, some people are going to think of me as nothing more than a Black woman. And that is really sad." I try to remember that the reason I am in this field is because I am passionate about it. I am a culture maker in that sense.

Sara is aware that others' perceptions of her as an engineer may be less than desirable; yet she described her overall experience as an African American woman in engineering as empowering. She asserted: "My career has become a point of empowerment for

me...I love when I can say to young kids 'I am an engineer.' I love that I am one more example for them."

In addition to being passionate about her chosen career, Sara also affirmed that being an engineer has become an important part of her identity.

Computer science became so cool. It became a proud part of my identity. Yes, there were times; I wish I was a better type of designer. There were times I thought, "Maybe, I should have gone to design school." However, once I changed from mechanical engineering to computer science and engineering, I was certain this is what I wanted to do. I never considered changing my major again.

Passion and pride are key components of Sara's success. However, it was overcoming the fear of looking "stupid" that catapulted her to the next level. Sara declared, "I don't care about looking stupid anymore. I don't allow people's thoughts about me prevent me from being who I am and doing what I need to do to be successful. She insisted, "Fear and others' opinions of me are the worst reasons in the world for me not to pursue my dreams." Sara also shared that learning about stereotype threat played an integral role in helping her persist. She avowed, "Learning about it [stereotype threat] incentivized me to develop coping mechanisms in order to lessen its negative impact in my life."

In addition to learning about stereotype threat, there was another event that occurred during her college years that transformed Sara for the better. Sara confessed:

My breaking point occurred during my sophomore year. My personal issues and anxiety were impacting my work ethic. I basically stopped trying. The attitude I had was if I try and still fail, I will feel worse than if I failed and I didn't try. At

one point, several other students and I were actually caught cheating. We basically copied the exact same solution to a problem and submitted it.

The fact that Sara was caught cheating was not as devastating as the words she heard from her professor. She explained how a comment from her professor was the wake-up call she needed:

When I met with my professor he asked me, “What would your parents think if their daughter, who was accepted to [this prestigious institution] was kicked out for cheating?” To me, that was the most devastating thing to consider. The fact that I disappointed not only my parents, but all of my ancestors was too much for me to process. After that experience, I realized that I could no longer allow my self-esteem to affect my work ethic.

She goes on to discuss how this event ignited an authentic desire for her to do better. She confessed: “I knew I was cheating myself because of my identity issues in engineering. I was so embarrassed and ashamed.” Despite the embarrassment, Sara recognized the blessing in this experience. She maintained, “If my peers and I did not have that wake-up call, we would have continued to cheat ourselves. For me, it was a big deal. I knew better. I knew I could do better.” Not only did Sara’s grades suffer, but her self-worth was shattered. However, like many people who are resilient, she understood that this momentary lack in judgment was a temporary setback; a setback that set her up to succeed. This event caused Sara to no longer allow her self-esteem to affect her work ethic.

Sara failed her introduction to mechanical engineering course. She also received a zero on the assignment she submitted when she was caught cheating. Nonetheless, Sara’s

passion for engineering helped her to persist despite the obstacles. I was inspired to hear her story of transformation. She progressed from a student who violated ethical academic polices into a woman who is now proud to say, “I am an engineer.” Just as Sara is proud to say she is an engineer, I am proud to say that I had a chance to hear how this amazing young lady remained steadfast and forged her own path, a path that those behind her can follow.

Shirley: a physicist just like her dad. Shirley is a first year graduate student attending a highly-ranked public university located in the Midwest. She is pursuing a doctorate in medical physics. As an undergraduate, she majored in nuclear engineering and physics. She is the only participant who has a parent with a STEM degree and credits her dad for developing her interest in engineering. She shared, “My dad is a physicist. That’s what piqued my interest initially. At one point in his life he worked at NASA. When I was growing up, he started his own internet service providing company.” Shirley’s early interest in computers exposed her to technology. She asserted, “For me, it was always better to see how things worked. In middle school, I decided I was most interested in the “hands-on” version of science. I figured out that was engineering.”

From the beginning of our interview, it was evident that Shirley’s parents played a major role in her persistence. She acknowledged, “My mom, she is my spiritual grounding. I talk to my dad about what’s going on socially. He is incredible with helping me deal with the issues of being an African American in science.” She further declared, “I had the perfect example of parents for where I am in life today. I had the spiritual backing and the technical backing. Without those two, I can’t imagine what my undergraduate experience would have been like.”

I asked Shirley if she had experienced stereotype threat in her engineering courses. She responded with a resounding, “Absolutely!” To help deal with stereotype threat, Shirley shared how it was important for her to have regular discussions with friends. She stated, “I really couldn’t stay sane if I didn’t have someone to talk to about the challenges I face on a daily basis as a Black woman in engineering. You have to be so thick-skinned for this stuff.” She also believes that it is important for other people to acknowledge the challenges African American women face. She argued, “People need to be upfront about it. I don’t know how people can shrug off the things that minorities and women experience.”

When asked about the climate of her undergraduate engineering classrooms, Shirley described a common experience shared by other participants. She discussed the agony felt when her classmates did not want to work with her on group projects. “In my classes, one of the main things that bothered me was when lab partners were being picked. If you were the only Black or one of few, you were probably going to be the last person picked.” Later during our conversation, Shirley re-iterated how being overlooked by her classmates and not chosen as a team member or lab partner caused a lot of angst:

I was really unhappy in undergrad because of the way I was being treated. I didn’t like going to class and no one sitting next to me; or not being picked for lab and having to be stuck in the default groups with the students who don’t go to class. I struggled academically in undergrad and I am completely upfront about that. It was just really, really, really tough.

She goes on to state: “As a Black student, you have to go out of your way to make White people feel comfortable with you.”

Shirley also touched on the subject of identity. She asserted, “Regardless of whether or not you identify as being Black, everyone else sees you as that and treats you accordingly. At some point you need to come to terms with your race.” Shirley has a strong sense of self and solid connection to the Black community. She confirmed, “I had never been to school with White people prior to going to undergrad. It was a culture shock. To cope, I became extremely active with the Black community on campus.”

Shirley believes that her experience as a Black woman in engineering is different than that of a White woman. She affirmed, “I am still the last person to get picked as a team member or lab partner. When I am studying with other people, they will always ask her [the White woman] to confirm answers and not me.” Shirley further alluded, “I feel people primarily identify with one trait and that is where most of the discrimination comes from. On top of being Black, I am also a woman. Therefore, there is an extra, extra hurdle, I have to overcome.”

Shirley is cognizant that her race is likely contributing to her “hyperawareness” or “hypersensitivity.” However, she recognizes that there are occurrences that warrant this level of awareness and sensitivity. She explained:

I just started graduate school last month. I am trying not to revert to how I was in undergrad; which is attributing all my negative experiences in my department to race. I am trying really hard not to do that. But in some situations, it is really difficult not to. It is hard when I am in a lab and my lab instructor is talking to a group of four, which includes me and three White guys, and he is talking to everybody, but me. The only person he is really focusing on, during that entire

time, is the White guy who comes to class in button-up shirts and slacks every day.

While on the discussion of “hypersensitivity”, I shared with Shirley how I have spoken to some people who believe that teaching students about stereotype threat may be harmful and that such knowledge may cause them to be overly sensitive. I asked Shirley how she felt about this comment. She responded, “I think that is a cop out, a tremendous cop out. The only way you can change something is to be more aware of it.” Shirley elaborated,

Interestingly enough, the people I am closest to at my current institution are doing work closely related to this study. We are having consistent conversations. One of the things we discuss is the fact that, yes, the civil rights movement was a really big thing for us. But it is becoming challenging for us to gain traction because of people not wanting to acknowledge that these things exist.

She went on to discuss why it is important for people to know about stereotype threat.

She maintained:

People who believe knowing about stereotype threat is harmful are trying to sweep it under the rug, but in a slightly more advanced way, or by justifying an excuse for it. I think hypersensitivity is necessary. Recognition is the first step in changing something. You have to know what needs to be changed in the first place. Ignoring race and thinking that everyone is equal is absolutely ridiculous. It is insane.

Two key elements to Shirley’s persistence is clearly her strong sense of self and the chip on the shoulder which causes her to work extra hard to prove herself. She shared:

One of the lines I live by is “you have to be twice as good to get half of what they have.” I always feel there is something to prove. Some people don’t like operating like there is a chip on their shoulder. But personally, it helps me to perform.

Her advice to other African American women is: “To put it colloquially, “Don’t believe the hype.” One of my mentors told me, “They think that affirmative action got you through the door. But you are the only one who can open it.””

Shirley knows that she is in control of her destiny. She is also very committed to being an engineer. I asked if she ever considered changing her major. She answered, “No! I know this is what I want. My end goal is to make a difference. Whether it is in making some breakthrough scientific discovery or by increasing the number of students in engineering who look like me.”

I was very impressed with Shirley’s commitment to not only finish her degree, but also her desire to increase the number of African American women in STEM fields. Although Shirley continues to be threatened by stereotypes, she remains driven. She is dedicated to accomplishing her goals. Shirley proudly affirmed, “I may doubt myself, but I never doubt what I am supposed to do. For that reason, there is no doubt about if I am finishing. It is only when I am finishing.” I revere her resilience. I respect her grit. I honor her commitment to increase the number of engineers who look like the two of us.

As I ended my second interview for this study, I was again in admiration of the strength and the courage of these young ladies. They gave me hope. They helped me see the light at the end of a very long and dark tunnel, a tunnel that many African American women in engineering have traveled. A tunnel that others have decided was too dark and

uncertain for them to continue. Shirley is a persister who is providing the light so that those behind her can find their way.

Rebecca: a future medical doctor with a servant's heart. Rebecca was born in Nigeria, West Africa. However, she was raised in Boston, MA. She graduated in June 2014 with a Bachelor's of Science in Biological Engineering. At the time of our interview, she was an AmeriCorps member serving at a community health center. It was obvious from the beginning of our conversation that Rebecca's family played a major role in her persistence. I asked Rebecca if there was anyone she credited for encouraging her to pursue engineering. She responded, "My parents. They noticed my interests in STEM when I was young. They pushed me in that direction." Rebecca has maintained her interest in STEM. She has plans to attend Medical School; a decision she made prior to beginning college. When I asked her if she ever considered changing her major from engineering, she responded, "Yes. I considered changing to another STEM discipline because I thought it would be more fulfilling for me and more in aligned with what I wanted to do later in life." However, Rebecca affirmed, "I am 100% satisfied with my major and I think I made the right choice from the beginning."

Even though Rebecca is confident that she made the right choice to study engineering, she believes that her experience as an African American woman is more challenging compared to White women. She stated, "In my graduating class, I was the only visibly Black female in my department. There was another girl who was mixed, but she passed as White." She argued, "It was definitely different for me. The other students really seemed to know each other. They formed close knit communities." Nonetheless, Rebecca believes she never had the opportunity to form bonds with other students. She

explained why she lacked this opportunity, “Mostly because I was Black and I couldn’t relate to people and people could not relate to me.” She further detailed, “When I was in settings where students were working problems, I always felt left out. I would not understand their inside jokes. They all hung out together outside of class. I was never a part of that group.”

Just as Sara and Shirley were aware of stereotype threat, Rebecca was also very familiar with the phenomenon. She shared, “At the health clinic, there is a lot of discussion around stereotype threat, bias and race in general.” She further asserted, “The clinic adopts a social justice approach and advocates for better healthcare for their patients.” She explained that the overall mission of the center is “to not only treat patients but to tackle the social determinants of their health.” She elaborated, “The health center’s slogan is, ‘We lead with race. We are race explicit, but we are not race exclusive.’ People don’t want to talk about race. So we have to lead with that.”

The fact that Rebecca was serving as an AmeriCorps member was only one indication of her desire to give back and make a difference. Her longing to serve was also evident when she discussed her involvement in extra-curricular activities during her time as an undergraduate.

I was involved in the Black Student Union. I served on the executive board two years in a row. I also served on several committees. I was involved in our Black Women’s Alliance. I was also a member of the executive board for two consecutive years and served on several committees.

Rebecca confirmed, “My desire to encourage other African American women is the only reason I stuck with the Black Women’s Alliance. On the executive board, it was really

tough for us to get our act together. However, I literally could not quit.” Her passion to serve was further highlighted when she shared, “In my heart, I could not let that organization dissolve; even if I had to take on the bulk of the responsibilities myself. As Black women, being the minority of the minority, we need a strong support system.” Eventually, Rebecca was able to release the leadership of the organization. She declared, “I was able to step down when I believed there were other women joining the executive board that shared my same ideology.”

A common theme amongst the participants was their commitment to self-advocacy. Rebecca demonstrated this attribute when she stated the following: “The University is not going to provide adequate support for us. We must do it ourselves. I stuck with the Black Women’s Alliance because I knew it could be very impactful.” Rebecca was committed to helping other African American female students succeed. She knows first-hand how difficult it can be for these women to persist. She acknowledged, “The struggle is ridiculous.” Although it was challenging, Rebecca never questioned her belongingness in engineering. She shared:

I am blessed in a sense. Although it was hard, there was never a moment after my freshmen year (which was my hardest year) that I felt like quitting. I never felt as if I was not good enough or at least not to the extent as most other people of color on campus.

I asked Rebecca what helped her persist despite the challenges. She responded, “I have really strong faith. I am a really religious person.” She also credits the encouragement and support of her family. She shared:

I am the first person in my family to attend college in the United States. I had too many people in my ear saying, “You are the one that we sent to school. You are going to do great things.” I had too many people supporting me. I could not let them down. I could not let myself down.

Even though Rebecca was born in Africa, she clearly identified as an African American opposed to an African immigrant. This was evident when she shared how her family do not understand her social struggles as an African American woman in engineering. She stated, “They don’t understand everything that I am going through. Most of my family are immigrants and none of them are in engineering or science fields.” Rebecca appreciated the support of her family. She valued their encouragement. However, she was also aware that many African American women needed additional resources. She declared, “I saw too many girls who were disheartened. They were not being re-affirmed about their abilities.” Recognizing that other students needed support empowered Rebecca to provide the reassurance they needed. She asserted, “I felt I had to be part of something that could at least add some sort of cushion. I wanted these girls to know that they didn’t have to leave, go back home and not complete their education.” Rebecca also displayed her compassion and desire to serve others when she articulated:

People knew my door was always open. They knew they could come into my room even if I wasn’t there. There were times, I walked into my dorm room and found people lying on my futon or bed. They knew it was a safe place for them if they wanted to just sit and think or vent and cry. It was okay. It was something I tried to emphasize. I knew what I had to go through. So I made myself available to others, especially Black women.

I applaud Rebecca's loyalty to assist other African American women persist in engineering.

Although she was committed to helping African American women succeed, Rebecca encountered women who did not share her compassion. She shared a poignant story about one of her female professors.

I recall an experience I had with one of my female professors. As a woman, I felt I had to prove myself more in her class. She was more partial to men. She paid more attention to them. She called on them more frequently. It was if she was constantly affirming their answers.

Rebecca was not impressed by her female professor who seemed to affirm male students at the expense of discouraging females. She ended our discussion about this professor by stating, "It really saddens me when influential people in oppressed categories don't want to associate with others who are also oppressed. They have the power to affect positive change and chose not to. It is disappointing."

Rebecca admitted that she was accused of being overly sensitive about her race. Considering this allegation, I asked her if knowing about stereotype threat contributed to her "hypersensitivity." Her response was:

Having a term to describe the things I am feeling puts them in perspective. Knowing that stereotype threat is real helps me realize that I am not crazy. If someone says I am being too sensitive, I know that is not actually true. I am experiencing a real phenomenon.

She further asserted: “I think it is informing. When people are armed with information, we can alleviate ignorance. It allows for growth and for people to make a positive contribution. I wish more people knew about it.”

With women like Rebecca dedicated to serving and inspiring the next generation, I am hopeful that more Black women will persist in engineering. I am optimistic that these future engineers will follow the advice of First Lady Michelle Obama. During her 2011 commencement address at Spelman College, she proposed, “As you climb those career ladders, just remember to reach down and pull others up behind you.” Rebecca, the aspiring medical doctor, has already taken heed to these words.

Jewel: the outlier who had a change of heart. Jewel graduated in 2013 with a Bachelor’s of Science in Biological Engineering. Based solely on the date of degree attainment, she is the oldest participant. Originally from Chicago, Illinois, Jewel decided to pursue engineering when she was a sophomore in high school. She explained, “I had a strong background in math and science. Biology was my favorite subject. My math teacher told me, ‘If you are good in math and science, you should be an engineer.’” In addition to her math teacher, Jewel credits her mother and maternal grandmother for her decision to study engineering. She elaborated, “My mother pushed me towards a career in medicine, law or engineering. She told me these were the top professions.” Jewel goes on to say, “I don’t think my mother really knew what engineers did. However a close friend of the family was an engineer. We knew she was a Black woman in engineering and she was pretty successful.”

At the time of our interview, Jewel was working in northern California as a research assistant in the neuroscience department at one of the world's most

prestigious universities known for its high undergraduate selectivity. She was in the process of applying to graduate school. However, Jewel is not planning to attend graduate school in engineering. She aspires to earn a doctorate in clinical psychology. She shared why she made the decision to switch from engineering to psychology:

After all of my negative experiences in engineering school, I just wanted to graduate and get out of there. I was no longer excited about engineering. I thought, “Maybe I want to do something else.” So I sat down and thought about what I ultimately find interesting. I was naturally drawn to neuroscience and psychology.

Towards the beginning of our first interview, I asked Jewel, “Do you think you experienced stereotype threat in engineering? If so, how?” She responded:

Yes. Definitely. I was already nervous about taking exams. Then I had the added pressures of being a woman and being Black. Both of those things caused people to expect me not to do very well. I think overall being Black and being a woman added another level of stress when I was studying.

Jewel discussed how stereotype threat particularly manifested while working in study groups. She explained:

When I was in study groups, there was always this constant questioning from others about my knowledge. If I explained how to do something to the other students in my group, someone would say, “I am still going to ask the TA.” They didn’t trust what I had to say so that made me second guess myself. I often wondered, “Maybe, what I said was wrong.”

Jewel further confessed that stereotype threat negatively impacted her grades. She shared, “I had severe test anxiety. I spent too much time on one question. I often changed an answer that was already correct.” When I asked her to describe the overall climate of her engineering classrooms regarding their inclusion of African American women, she replied: “I definitely didn’t feel included. It was a different world that I was trying to operate in; but I didn’t really know how.” She also stated:

The climate was lukewarm. I had some level of support. It was a learning environment. I had some professors and teaching assistants who wanted me to learn. At the same time, I was never completely comfortable when it came to study groups, tests, and activities in class. I was in my comfort zone only when I was with friends and doing activities with the Black Student Union.

Jewel discussed why she believed she had a different experience as an African American female engineering student compared to her White female peers. She explained, “It seemed easier for them because they were more comfortable with one another. They were taking classes with their friends. I was always the outlier.”

I was curious whether Jewel thought it was harder being Black or a female in engineering. She clarified, “I see more White women or Asian women than I see Black faces. I would say being Black is harder. Ultimately being a Black woman.” Basically, Jewel was unable to separate her “blackness” from her gender. This is an example of the double bind African American women have to manage.

According to Jewel, an ideal engineering classroom is one with a Black professor and more Black students. She shared:

Having Black professors, I think psychologically that would have helped me. It would have been great to see someone who looks like me who has been through an engineering program and succeeded. To have that added support would have relieved at least some of the tension I was feeling in the classroom. I wish I had more Black classmates, especially when it came to group activities. I feel there would have been less questioning whether or not I knew my stuff.

Jewel discussed that students not only questioned her intelligence, but often refused to work with her on team projects. She asserted,

There was one time a professor asked the class to select a team member to work with on an assignment. I didn't know anyone else in the class. No one chose me. I had to send out an email to the entire class stating if there was anyone needing a team mate, I was available. Lo and behold, the only Black guy in the class contacted me.

She admitted that she was pleased to have a Black teammate:

Honestly, I was a bit relieved having a Black guy as my partner. At least I didn't have to deal with racism. I didn't have to deal with the added stress of proving my worth as a Black person. When it came to picking group members, it was not a positive feeling, having to deal with that feeling of, "Oh boy, here we go again. Who will want to partner with me?"

Jewel's discouragement from not being embraced by the majority of her peers was evident.

Other students were not Jewel's only issue. Her academic advisor, a White female, also perpetuated her feelings of not belonging in engineering. She revealed, "I

had an advisor for three years. She told me that she didn't think I would make it through graduate school." She continued:

My advisor told me that she went to Berkeley for her graduate degree. She told me how hard it was. She actually said, "It was even hard for me." I just didn't understand where she was coming from. She really didn't know anything about me. We only met once a year.

She further described how this experience impacted her:

First, I was appalled that she even had the audacity to say that to me. However, in the back of my mind, I was thinking, "What if I don't succeed? What if it is true?" I had not started applying to graduate school yet. But I began to question, "What if I don't get in?"

Jewel affirmed that she wished she knew about stereotype threat when she was in engineering school trying to find her way. She asserted:

Not knowing about it [stereotype threat] makes things even more stressful. You are constantly thinking, "This may only be happening to me? Why is this happening? Why aren't my grades better?" To have an explanation and an understanding of a phenomenon that has impacted a lot of people helps to calm the mind.

I was curious how this young lady, who openly admitted her struggles with stereotype threat, persisted and earned a degree from one of the country's most prestigious engineering programs. She offered:

I was very active in the Black community. I was very active with the Black Student Union and the Black Women's Alliance. Having these support groups and

being able to talk about things like impostor syndrome helped a lot. It helped being able to share our stories and realize that this was happening to all of us. Impostor syndrome is psychological phenomenon in which people are unable to internalize their accomplishments. Despite external evidence of their competence, those suffering from this syndrome remain convinced that they are frauds and do not deserve the success they have achieved. Proof of success is dismissed as luck or as a result of deceiving others into thinking they are more intelligent and competent than they believe themselves to be (Clance & Imes, 1978).

Based on the definition of persist used for this study, Jewel persisted. She graduated with a degree in engineering. However, because of the many negative experiences she had as an undergraduate, she made a conscious decision to leave the profession. Despite encouragement and support from her fellow African American classmates, family and friends, Jewel was unable to realize her potential as an engineer. Yes, Jewel earned her engineering degree. Nonetheless, we have lost the talents and creativity of another African American woman who had the potential to help solve some of the many problems engineers tackle on a daily basis.

American Polytechnic University (APU). American Polytechnic is a public land-grant university located in a rural area in the Southeast region of the United States. Based on the National Science Foundation ratings, APU is the number one research university in its state. Its research portfolio is over \$400 million. APU offers more than 200 undergraduate and graduate degree programs to nearly 31,000 students. The College of Engineering undergraduate program ranks in the top 20 amongst accredited engineering schools in the nation that offer doctorates. It ranks in the top 10

among engineering schools at U.S. public universities. Several of its undergraduate engineering specialties rank among the top 20 of their respective peer programs: including aerospace and ocean engineering; civil engineering; electrical and computer engineering; engineering science and mechanics; environmental engineering; industrial and systems engineering; mechanical engineering; biological systems engineering; and chemical engineering.

APU is among the top 50 colleges and 25 best public colleges in Money Magazine's best college rankings list. Money evaluates colleges on three measures: (a) educational quality; (b) affordability; and (c) outcomes. Educational quality encompasses among other things graduation rates and instructor quality; outcomes consider early and mid-career earnings of graduates. It also ranks among the top 25 public colleges by FORBES. Entering first-year students at APU have competitive academic records, with an average high school grade point average of 3.98 on a 4.0 scale. Undergraduate students received more than \$100 million in grant aid and scholarship support in Fiscal Year 2013. The approximate demographics of students at APU and in the college of engineering are shown in Table 4-4.

The two participants from APU are fourth year seniors on a five year track. Both are actively involved in student organizations. They are also committed to inspiring young girls to pursue STEM careers. Each has a firm sense of self and strongly identify with the Black community on campus. They are very determined young ladies and committed to earning their engineering degrees. Ellen is a student ambassador for the Materials Science and Engineering department. She takes pride in being able to represent Black women in her department. Ursula is the only African American female student in

the Mechanical Engineering department at APU. She is also the president of APU's chapter of the National Society of Black engineers.

Table 4-4 *Student Demographics at APU*

	University	College of Engineering
Male	14,000	6000
Female	10,000	1,300
Asian	2,000	700
Black or African American	800	200
Hispanics of any race	1,200	400
Native Hawaiian or Pacific Islander	30	5
White	17,000	5000

Ellen: an engineer with a big personality. Ellen is a senior studying Materials Science and Engineering. She decided she wanted to be an engineer while in the seventh grade. Although she originally dreamt of becoming a fashion designer, she had a teacher who recognized her aptitude in science. She explained:

In the seventh grade, I scored very high on a science test. I was in the regular science class; yet I scored higher than students taking honors science. So my science teacher recommended me for a program called Richmond Area Program for Minorities in Engineering. Participating in this program ignited my interest in engineering. I decided I wanted to be an engineer.

In order to assess whether or not Ellen believed she was a victim of stereotype threat. I directly asked her, "Do you feel you have experienced stereotype threat in your engineering classrooms?" Her response was: "Yes. Throughout my time here, there have

been ups and downs. I've questioned, "Do I belong here?" I've thought everyone else is so much smarter than me. I feel like I struggle all the time."

Overall, Ellen described the engineering climate as "lukewarm." She believes that for the most part she is positively perceived by her classmates. She shared, "They see me as a big personality. They see me as sassy." However, she admitted that there have been unsettling isolated incidents. For example, she recalled one particular situation that she believes had a racial undertone. She shared, "One time, I was talking. I was mixing Ebonics and regular grammar. This guy said, "I can't understand you." My response was, "You can't understand English?"

Ellen acknowledged that the climate may be "warmer" for her White female counterparts. She argued, "They don't have it as easy as males. At the same time, they do not have it as difficult as Black women." She stated, "I am always aware that I am an African American female. People don't know what to expect with me. Some expect the stereotypical ghetto girl." Ellen further elaborated, "White female engineering students don't have to worry about color. For example, when I say something and someone says, 'Calm down.' My response is, 'No. I am not mad.'" Like all of the other participants, Ellen was quite aware of the "angry Black Woman" stereotype. Awareness of the "mythical angry black woman" only adds to the stereotype threat already plaguing these students. When I asked Ellen if she thought it was more difficult being Black or female in engineering, she responded, "They are both me. They are each a part of my identity. I can't separate them." This comment is in direct alignment with the idea of intersectionality (Crenshaw, 1988). Crenshaw (1988) contends that African American

women are discriminated against in ways that do not fit into the category of either “racism” *or* “sexism,” but are a combination of both.

In order to persist in engineering, African American women must overcome many hurdles. Ellen confessed that she initially had a fear of asking for help because she didn’t want to look “stupid.” She explained, “My freshmen year was hard. I thought, ‘I’m smart. I am supposed to know this.’ It was hard to ask for help. It seemed as if everyone was much smarter than me.” She described how poor academic performance helped her overcome her fear of “looking stupid.” She admitted:

My grades motivated me. Other students encouraged me to go to office hours.

When I witnessed their grades improve, I realized that it made sense for me to start going to office hours if I wanted to see an improvement in my grades.

Over time, not only did Ellen’s grades improve, but so did her confidence. She tells the story of how a male classmate made a derogatory comment to her and admitted it was intended to make her feel small. She shared how she responded, “I just brushed it off and said ‘whatever’”. She elaborated, “He confessed and told me, ‘I said that to try to make you feel smaller.’ My response was, ‘That’s impossible.’” I was encouraged to learn that Ellen was able to “brush off” a remark that could have reduced her and made her feel inadequate. Even though Ellen seemed to be very self-assured, she admitted that there were times she still struggled with not feeling good enough.

Ellen was grateful to learn about stereotype threat. She stated, “I appreciate having a word to describe what I am going through. It lets me know that I am not alone. This feeling that I am not good enough is not uncommon.” Ellen admitted that she has considered changing her major. When I asked why, she responded: “The academic load,

somewhat. But it is more about me questioning rather or not I am even supposed to be here. Another thing is personality. I have a really big personality.”

After hearing that she has considered changing her major, “all the time”, I wanted to know how she has persisted. Ellen detailed three things that keep her focused and persisting in engineering. She credits: (a) her strong faith in God; (b) the support of her family; and (c) the progress she has already made. Ellen also discussed how being involved in extra-curricular activities is also instrumental in helping her to persevere. She explained:

In my engineering sorority and in NSBE, there are many resources. The other students in these organizations have been through many of the same things I am going through. Having someone to talk to who understands is helpful. When I have students from NSBE or the engineering sorority in my classes, I can easily connect with them. A bond is formed. For my other extracurricular activities outside of engineering, they are just things I like to do. I really like dancing so teaching an exercise class is perfect for me.

In addition to the activities already mentioned, Ellen is also a student ambassador in the College of Engineering. She takes pride in serving in this role because she believes potential students can see her as an example. She elaborated:

For my major, I am an ambassador. I attend open houses and try to encourage students to choose materials science and engineering. I think when a Black woman sees me, she may think, “I can go into that department. I can see myself as her.” I think they may feel more welcomed if they see me or someone who looks like them, opposed to seeing a bunch of White males.

While on the discussion of her wanting to serve as a role model, I asked Ellen if she had one. She responded, “I have to say that my biggest role model is my mom even though she is not an engineer.”

Ellen has a strong sense of self. She asserted, “I accept that I may have to work harder. But in the process of working hard, I am going to be me.” She further avowed, “When people try to change me and have me do things that I don’t want to do, I just brush it off and say, ‘No. I don’t think so!’” She elaborated on the importance of identity and made the following suggestion to other African American females who aspire to be engineers: “Have a strong sense of identity. Know who you are and do not sacrifice that.”

As we wrapped up our first interview, I asked Ellen if she had any final thoughts or comments. Her final remarks were:

When it comes to trying to encourage students to pursue STEM degrees, I think it is important for people to see images of people who look like them. Even if it is just pictures. Also, professors should not have lower expectations or less patience for their African American female students. Instead, they should work with them and try to see the potential in all of their students.

It was obvious throughout our interview that Ellen was very confident and grounded in her identity as an African American woman. She is very comfortable in her own skin. Her outgoing and personable demeanor was infectious as we talked via Skype. The College of Engineering at APU should be very proud to have this persister as one of their student ambassadors. With her optimistic personality and desire to diversity engineering, I would not be surprised if more African American women decide to join the Materials

Science and Engineering Department simply because they are fortunate enough to meet Ellen.

Ursula: an aspiring technical sales engineer who is motivated to “give back.”

Ursula is a fourth year, mechanical engineering major originally from Pittsburgh, Pennsylvania. She initially aspired to study business. However, thanks to her mom, Ursula decided she wanted to be an engineer during her senior year of high school. She shared:

My mom works in human resources for the Department of Energy. She hires minority engineers. She insisted that I go to work with her one day to learn about what engineers do and how it will probably align more with my interest than I thought it would. I shadowed a few engineers. I thought what they were doing was very interesting. That experience led me to choose engineering over business.

Ursula firmly believes she has been a victim of stereotype threat. Out of 400 students in her major, she is the only African American female. She confessed to constantly comparing herself to her peers. She elaborated:

When professors return tests or quizzes, if someone gets a higher score than me, I wonder is it because I didn't study with them; or is it because I am not studying with the right people; or I am not studying the right way. I constantly compare myself to males, especially White males.

Although Ursula admitted that she questions her belongingness, she considered the environment of her engineering classrooms to be “pretty accepting.” She believed the biggest issue was that majority students did not understand the challenges she faced as an African American woman in engineering. She asserted:

I have never experienced any overt racism or hostility towards African Americans. I think there is a misunderstanding. Students don't understand that being the only African American female in a class is extremely intimidating. It is hard for a Black female to have the same level of motivation and believe "I can do it."

Fortunately, Ursula had the support of other minorities who are involved with student organizations focused on their needs and interests. She acknowledged that many of her engineering classmates did not comprehend the necessity of such organizations. She argued:

In the student organizations that I am involved in such as NSBE and SWE, majority students think these societies are unnecessary. I've heard many White male students express that NSBE promotes reverse racism. In my opinion, there really isn't such a thing as reverse racism.

Ursula did not take offense to students' inability to understand the need for NSBE and SWE. She affirmed, "I don't think it is purposeful or done in a hateful way. I think it is just a misunderstanding."

Ursula believes she has a different experience than her White female counterparts. She asserted, "White female engineering students know each other prior to taking classes together." She expounded, "I don't know any of my White female classmates. It might be because I am more involved with NSBE than SWE. There is also a female engineering sorority. A lot of the White female engineering students are members. I am not." She admitted to identifying more with her race than her gender. She asserted, "I identify more with the Black community. I have more Black male friends in my classes than I do White

females.” On the one hand, Ursula stated, “I think they [White female engineering students] may feel the same way as I do when they are in a room full of men. They may think, “I am one of five females in this class.” On the other hand, she asserted, “They are one in five; not one in one.”

While Ursula believed the experience of White female engineering students may not be as threatening as hers, she argued that Black males may have it worse. She shared, “I think African American males really struggle in engineering. I have seen a lot more of them transfer out of engineering than I have females.” Ursula high school graduation class had more than 600 students; only six were African American. She believed the environment in which she was raised afforded her an advantage over African American males. She acknowledged, “Being the only Black student in the class is not anything new to me....I don’t think I feel as ostracized as the Black men do. I think they get lost.”

Ursula described her overall experience in engineering as “difficult.” She admits that it took a while for her to really know what career path she wanted to take in engineering. She argued, “It has been a lot of trial and error. There are things that I learned about myself and my interest in engineering too late.” One of the things Ursula recently discovered is her interest in technical sales. This interest was ignited because she has a desire to “work with people more than with machines.” She affirmed, “My mechanical engineering and economics class was my favorite and most interesting course. I enjoyed learning the business aspects of a product and how design affects sales and demand and the actual economics of a product.” Like the other persisters, Ursula is committed to engineering. While she acknowledged that she wants to work more with

business side of engineering, she is aware that her engineering degree is preparing her for her chosen career path.

Early in the conversation, Ursula admitted that it was difficult for her to connect with the majority of the students in engineering, particularly White males. I was surprised at her response, when I asked her to describe her ideal classroom. She stated that she prefers courses that require group work. Her desire to work in groups was unexpected; considering her apprehension to interact with her White male peers. She explained her rationale for this preference:

As I mentioned, it seems like White guys don't want to talk to me. However, if we are working in a group, they have no other choice. I think once you have the initial conversation, people think, "Oh wow, we get along fine."

She further expounded that working in a group is also "really beneficial for working outside of class." Ursula stated that she does better in classes in which she knows people. People she can rely on for homework or other things she may not understand. According to Ursula, the race and gender of the students in her classes is not important. She stated: "My classes do not have to be extremely diverse for me to succeed. I just prefer if they provide opportunities for students to cross barriers. Barriers of being Black or female"

Despite her being hesitant to ask questions in class and her reluctance to go to office hours, Ursula has persisted. As one who has experienced stereotype threat, Ursula was aware that other African American female engineering students may also question their belongingness. Therefore she encourages professors to do whatever they can to make these students feel welcomed. She asserted, "Sometimes people experiencing stereotype threat feel they do not belong. If there is anything professors can do to make

African American female engineering students feel they deserve to be there, I think they should do it.” She is also committed to doing her part to inspire and motivate other students. She openly discussed her motivation for staying actively involved in NSBE affirming, “I want to make sure everyone has access to the opportunities and resources NSBE provided to me. They were very beneficial. Giving back is my only motivation for being involved with student organizations at this point.”

I commend Ursula for her authentic desire to give back and her continual support of other engineering students. Ursula understands that a career as a technical sales engineer is how she will make her living. However, her commitment to helping others persist in engineering is how she is making a life for herself, a life that young African American girls who aspire to become engineers can model. When Ursula read her “story” and learned more about the woman whose pseudonym I chose for her, she expressed, “Ursula Burns is definitely one of my role models now.” I am certain that there will come a time when a young African American female engineer will express very similar words about this persister.

National University (NU) and Coleman College (CC). The following four participants are earning their engineering degrees at National University, a Predominantly White Institution (PWI). Three of them are part of a dual degree program with Coleman College, a Historically Black College and University (HBCU). As part of the dual degree program, these students completed all requirements for a BS degree in a science discipline at Coleman prior to transferring to National.

National is a public university located in an urban setting in the Midwest region of the United States. It is one of the world's leading public universities, with nearly 30,000

undergraduate and 15,000 graduate/professional students from all 50 states and 113 countries. NU offers over 200 undergraduate majors, nearly 90 master's programs, and more than 100 doctoral programs. According to Best College Rankings, NU ranks in the top 30. For the 2013-2014 academic year, of the nearly 10,000 applicants, only 20% were offered admissions. The mean high school GPA of entering freshmen was 3.9. The median ACT and SAT for admitted freshmen was greater than 30 and over 1400 respectively.

For universities who highest degree is a doctorate, National's engineering program ranks in the top 10. Many of National's engineering undergraduate and graduate programs are continuously ranked amongst the top 10 in the country (Table 4-5). In 2013, NU granted a little less than 10% of all it undergraduate engineering degrees to underrepresented minorities and slightly more than 20% to women.

Table 4-5 *Top Ranking Graduate & Undergraduate Engineering Programs at NU*

	Graduate Program as of Spring 2014	Undergraduate as of Fall 2013
Aerospace Engineering	●	●
Biomedical Engineering	●	●
Chemical Engineering	●	●
Civil Engineering	●	●
Computer Engineering	●	●
Electrical Engineering	●	●
Environmental Engineering	●	●
Industrial and Operations Engineering	●	●
Materials Science and Engineering	●	●
Mechanical Engineering	●	●
Nuclear Engineering and Radiological Sciences	●	●

Coleman College (CC). Coleman College is a historically Black college and a global leader in the education of women of African descent. It is a private, four-year liberal arts college located in the Southern region of the United States. Coleman has amassed an endowment fund of nearly \$300 million. It has consistently ranked number one among Historically Black Colleges and/or Universities. More than 2,000 students from 41 states and 15 foreign countries currently attend Coleman.

Coleman College is a leading undergraduate institution of origin for African Americans with PhDs in STEM disciplines. Since 2000, nearly 20% of its graduates have entered STEM graduate programs. In the past decade more than 100 Coleman graduates have earned doctoral degrees in biomedical sciences. During the past five years, over 30% of the college's student body pursued majors in biology, chemistry, mathematics, computer science, physics, environmental science or engineering (dual degree program). Coleman employs more than 50 full-time faculty in its STEM departments and programs, of which greater than 80% are racial/ethnic minorities and over 50% are women. More than 60% of the female faculty are African-American.

Prior to transferring to National's engineering program, the following three dual degree students completed all requirements for a science degree. Miriam was a Chemistry major at Coleman and is studying Chemical Engineering at National. Euphemia, a Computer Engineering major at National, completed all requirements for a Computer Science degree at Coleman. Lastly, Mary, a Physics major at Coleman, is a senior in Nuclear Engineering at National. Bessie is the only non-dual degree participant. However, she transferred into engineering from the Literature, Science and Arts

department. With hard-work and determination, Bessie is close to earning a degree in aerospace engineering.

Miriam: a dual degree student with confidence. Miriam is originally from Long Beach, California. At the time of our interview, she was a few months away from earning an undergraduate degree in chemical engineering. Like many of the persisters, Miriam credits her mom for helping her decide to pursue a career in engineering. She specifically stated, “My mom planted the seed. I did not really know what engineering was. I only knew engineers solved problems. My mom put a bug in my ear about a career in which I could have financial security.”

Miriam admitted that she has experienced stereotype threat while pursuing her engineering degree. She asserted, “I transitioned from a college where everyone in my classes looked like me to an environment where I was the only African American female. I think subconsciously, I believed I was not as capable as other students.” I asked Miriam to describe the climate of her engineering classes. She responded, “Most of my professors aren’t as approachable as they were at the college I transferred from. The environment feels less welcoming because I am usually the only African American female in my classes.” She shared, “Sitting in the front helps because I can’t see the 115 people behind me.” Miriam believes that the engineering climate is more welcoming for White females. She explained, “They are more accepted by their White male peers. Even though they are female, people are more accepting of them because of their ethnicity.” She also believes African American males are more accepted in engineering. She shared the following story:

There is only one African American male in my chemical engineering classes.

Last year, we were in a group together. There were two White males, him and me.

The two White males seemed most comfortable with each other. They seemed more comfortable with the Black male than they did with me.

I asked Miriam if she thought it was more difficult being Black or female in engineering. She answered, “It really depends on the situation. When I am doing group work, I think it is harder being female.” Miriam believes that being an African American woman in engineering has its advantages. She elaborated:

At times, I feel like it is beneficial that I am an African American woman. I use my social skills as an advantage. I also use the fact that people underestimate me as an advantage. The fact that I am underestimated gives me an opportunity to shine.

I asked Miriam to describe an environment or situation on campus in which she did not experience stereotype threat. Miriam shared that she could recall one occurrence. She disclosed, “My senior design group is all female. Even though we are not of the same ethnicity, I feel we are on an equal playing field. Everyone gives their input. Everyone is able to ask questions.”

I was very interested in learning if there were any differences between the participants who transferred from HBCUs to PWIs compared to those who attended PWIs only. I asked Miriam if she believed attending an HBCU protected her from stereotype threat. She answered:

I think it helps coming from an HBCU. We learn about the diaspora. It is instilled in us that we are agents of change. My HBCU prepared me to be the great person

I aspire to become. When I came here, I did not forget what was already instilled in me.

She further confessed:

At the HBCU I attended, I was definitely challenged academically. However, I was much more comfortable there. When I transferred to my engineering institution, I was presented with new challenges. When I got scores back from my first exam, I thought, “Oh my God. Should I have even transferred?”

She elaborated, “When I came to this university, I was broken down. I began to question, “Am I cut out to do this.” Initially, I questioned my academic abilities.” Fortunately, Miriam had an awakening. She declared, “I discovered that I had to study differently. I had to learn new techniques on how to get things done.”

Consistent with all the other persisters, Miriam is committed to earning her engineering degree. I asked if she ever considered changing her major. She responded:

In my first semester in college I thought about changing. I was struggling with calculus. My dad told me, ‘Give it a try for a year.’ I decided to stick with it. Once I got past my panic attack, I was fine. I never considered changing my major again.

Her parents were instrumental in her persistence. Her mother encouraged her to pursue a career in engineering. Her dad persuaded her to persevere through her challenges with calculus.

In addition to the support and encouragement from her parents, Miriam’s strong identity seems to be an important contributor to her persistence. She acknowledged, “I am definitely confident in my race and my gender.” Because of her remarkable

confidence, I looked forward to hearing the advice Miriam would offer to young African American girls who aspire to become engineers. She provided, “I would encourage African American female students to develop their math skills. I would advise them to take their high school classes seriously.” She also recommended:

Learn to make friends outside of your allies because you will need to work with others to get your assignments completed. Develop good study habits early and learn time management. Get a mentor now. Get involved with NSBE and SWE. Start completing projects that will help you develop your problem solving skills.

She also offered the following recommendations to engineering professors, “Realize that everyone doesn’t learn the same. Also, when assigning group work, try to make groups as diverse as possible.” She suggested, “Make yourselves more available to your students. Give your students incentives for coming to office hours, such as extra points on their homework.” For administrators, Miriam offered, “Highlight the success of African Americans throughout the college. Raise awareness of other ethnicities.” For current engineering students, she encouraged them “to have a community of people who look like them.” She recommended, “If you don’t have a NSBE or NOBCChe [National Organization for Black Chemists and Chemical Engineers] on your campus, you need to find support. If you don’t have support on campus, you will struggle.”

Miriam’s academic advisor introduced her to stereotype threat when she experienced academic struggles at the PWI. When she met with her academic advisor to discuss her challenges, she was asked, “Are you sure you are not inflicting harm to your academics because of stereotype threat?” I asked Miriam if she thought knowing about stereotype threat was helpful or harmful. She answered, “I think it is helpful. It reinforces

the confidence you need to have within yourself. In engineering, you can't really use excuses. Either you study or you don't. However, there are external factors that can impact your grades." Miriam also shared:

I just learned about stereotype threat last semester. I wish I knew about it when I first came here. I think students should take a seminar course during their first semester to learn about stereotype threat and how they to combat it. I think that would be great.

Based on Miriam's suggestion for a required seminar course, I had a question to ask all participants in the second interview. I wanted to know if they also agreed.

Miriam exuded confidence from the beginning of our interview. She is well-grounded in who she is. She knows what she wants. She also knows what it takes to get it. Her experience of attending both a PWI and an HBCU added depth to our conversation. She was able to provide insights those students who have attended only a PWI could not. She acknowledged that attending an HBCU provided a strong foundation for her when she transferred. Although that foundation was shaken, the roots were too deep for her to crumble under the pressure of stereotype threat. Miriam has persisted. By the time this study is complete, she will be another African American woman who remained resilient and earned an engineering degree. She will be one more example of what is possible when victims of stereotype threat learn to persist in spite of it.

Euphemia: a southern belle with pride. Euphemia is originally from a small town in South Carolina. She is a dual degree student working towards a Bachelor's of Science in Computer Engineering. She completed all requirements for a degree in computer science. Euphemia and Miriam have been college roommates since they were

freshmen. There are two other things these young ladies have in common. First, like Miriam, Euphemia also credits her mom for encouraging her to pursue engineering. Secondly, her advisor introduced her to stereotype threat.

Euphemia is aware that she has experienced stereotype threat since transferring to the PWI. She also admitted to having the need to constantly prove herself. Like many of the other participants, Euphemia discussed the hurt she feels when she is the last person picked when groups are formed for class projects. However, she has been able to overcome her pain by realizing that she “should not take anything personally.” At the same time, she confessed that upon arriving at the PWI, she worried about failing. When I asked how she overcame her fear of failure, she attributed it to playing sports. She stated, “You learn not to take it to heart. Your coach will scream at you on the field and then laugh with you and encourage you moments later.”

Euphemia understands that how others perceive her is something she cannot control. She affirmed that the only thing she can control is what she does. She asserted that she always strives to do her best. She acknowledged the HBCU she attended for equipping her with the self-esteem to weather the storms she has experienced at the PWI. She declared, “You need thick skin to survive in engineering.” Despite having Miriam as a longtime and supportive friend as well as the camaraderie of fellow NSBE members, Euphemia admitted that she feels very isolated at the PWI. In the Computer Engineering department, she is one of few African American female students. Nonetheless, she has not considered changing her major or quitting. She stated, “I may question if I made the right decision regarding my concentration in Computer Engineering, but I am certain I want to be a Computer Engineer.” She goes on to say, “It is not if I will finish, but when I

will finish.” I asked Euphemia if she believed there was anything African American men or White women could do to help her finish her engineering degree. Regarding African American men, she responded: “Black men in engineering can recognize that being male in engineering trumps being black. They need to know that we are all struggling.” Concerning how White women can help, Euphemia declared, “I don’t know what I can tell them they don’t already know.”

Euphemia maintained that she is completely comfortable asking questions in class and going to office hours. However, she talked openly about how differently her professors at the PWI teach compared to those at the HBCU she previously attended. She believes that her professors at the HBCU were better able to teach to her learning style. She argued that she has to adjust her learning to how the instructors teach at the PWI. I asked Euphemia, “does it help you feel more comfortable or ease stereotype threat when your engineering professors know your name?” She responded, “No. They always know my name because it is so unique.” Euphemia admitted during our first interview that people had a difficult time pronouncing her name. She explained, “My name always throws people off. Every time a professor calls roll and get to my name, I say, “That is me. This is how it is pronounced.” She also commented about how she had to deal with people constantly “judging” her because of her strong southern accent. According to Euphemia, “I have to deal with the accent thing too. People stop me mid conversation and ask, “Where are you from?” I didn’t even know I had an accent until I left South Carolina.”

Euphemia acknowledged that she believes people are trying to make her change and conform more to the “social norms” in engineering. However, she affirmed, “That is

not about to happen. I am pretty sure that is what people are trying to do. But it will never happen.” Like Miriam, Euphemia radiated with confidence. I was captivated by her self-assurance. I was very interested in knowing how she would advise aspiring engineers. She offered the following advice: “Take school seriously from the beginning. If you plan to major in engineering, take math seriously. The fundamentals matter. If you don’t know the fundamentals, you will struggle.” I also asked her to share any wisdom that would help young girls learn how to cope with the social aspects of being in a field in which they will be grossly underrepresented. She asserted:

I love encouraging young girls to pursue STEM degrees. I think engineering is fun and exciting. However, I believe some people are not built for it. I would tell them, “If you realize engineering is not for you, it is okay to change to something else.”

Her most compelling advice was: “Find people you can connect with in some way. Not just people who look like you.” I was also interested in the advice she would offer to African American women who are currently in engineering school. She recommended that they have something to do outside of academics. She explained, “I like football. During football season, I watch college football every Saturday. I am okay with not getting all my homework done on that day. I am not sitting at a computer all week, just doing work. That is not cool.” As we closed our first interview, I asked Euphemia to share any final comments. She asserted:

I think people have to be okay with being isolated. It is what it is. It can be fixed. But it will not be fixed anytime soon. You need a different mindset when you are in engineering. If African Americans chose to a STEM field, they have to

understand there will only be a few of us. Even when I go to conferences, I am usually one of only a few females. Often I am the only African American.

Euphemia is completely at peace with the fact that she is part of not only an ethnic minority, but also a minority in her chosen career path. She exuded confidence. Her comfort with her identity as an African American woman was apparent during our Skype session. It was observed from her natural hair and her willingness to discuss these sensitive topics while sitting comfortably in the middle of a very busy coffee shop. It was obvious to me that Euphemia does not wish to be anything other than who she is and she is doing that perfectly. She is a true southern belle with both familial and ancestral pride.

Mary: highly educated and single. Mary is also a dual degree student.

Originally from Jacksonville, Florida, she is a senior, Nuclear Engineering major. She completed all requirements for a BS in physics. Mary decided she wanted to be an engineer after she participated in an Upward Bound program at a reputable HBCU in the south. She explained: “During my sophomore year of high school, I participated in a summer program for underrepresented students. For seven weeks, we stayed on campus and completed research-based projects with faculty members. We also took math, writing and Spanish classes.” A professor she met in the Upward Bound program had a BS in mechanical engineering and a PhD in physics. He inspired her to pursue engineering. She stated: “In that program, I met an African American physics professor. He introduced me to physics and what physicists do. He helped me decide that I wanted to study science and engineering.” Mary acknowledged: “I was always a good student, but I didn’t really know what I wanted to do until I participated in the Upward Bound Program.”

After I confirmed that Mary had a clear understanding of stereotype threat, I asked her if she believed she was a victim of it since transferring to the PWI. Without any hesitation she replied, “Yes, most definitely. I grew up in a very multicultural environment. I am half Puerto Rican and half African American. My mom was in the military. As a military kid, I was exposed to all cultures.” She further explained, “I went to college at an HBCU. In college, I was surrounded by beautiful Black women. I was empowered.” Her empowerment was short-lived when she transferred. She confessed, “When I transferred, I learned real quick that I was by myself. I was the only Black female in all of my classes.” She further shared

I could feel everyone’s eyes on me. That made me very uncomfortable. It got worst throughout the semester. If I missed one class, other students would question me, “Why weren’t you in class?” “Where were you?” Things like that ignited the stereotype that Black people are either late or they don’t show up.

I asked Mary, “How would you describe the climate of your engineering classrooms in regards to their inclusion of you as an African American woman?” She responded,

At first, I felt welcomed. Because the number of people of color is very low here, they roll out the red carpet to make you think you are welcomed. When I was first accepted, a group of us came for a site visit. They were very helpful. They took us on tours. They showed us the buildings, the classrooms and the labs. They introduced us to professors. They were really nice. But once the semester started, the professors were pretty cool. But other students made me feel unwelcomed.

I asked Mary if she believed her experience as an African American woman is different than that of White women in engineering. She replied:

Yes, especially in my department. Nuclear is a very White American engineering industry. It started in America. It started with all White males and then White women came along. White women are still viewed as smart and very competent. They don't seem uncomfortable. They are in classrooms with only four other women. However, they are typically all White.

She also argued:

White women are not spoken to in a condescending way. For example, when I ask the same question as one of my White female counterparts, I notice that the professors seem to respond to me as if they are dumbing it down. They explain things as if I am a helpless child. I have to tell them, "No, I understand that. I am asking about this." I noticed this "dumbing down" often. In my opinion, White female students do not have these experiences.

Mary also expressed her frustration when people are "shocked" that she speaks intelligently. She despises when people say to her, "Oh you're so articulate." Even though she feels there is a difference in how White females are treated in engineering, she believes African American men have experiences similar to hers. She asserted, "People are very intimidated by Black men. I think they feel as isolated and alone as I do. At the end of the day, other students don't really want to work with them either."

Like all the other participants, Mary believes that knowing about stereotype threat is very helpful. She explained:

I think students having knowledge of stereotype threat is a threat to some people. They may think, 'Now that people are becoming aware of these different factors, they may try to combat it.' Some may view those who are informed about

stereotype threat as a threat to their perfect utopia. They may think it as an infiltration into their system and how it works.

Mary is aware that she has been a victim of stereotype threat. However, she proudly declared, "I am at the point now where I really don't care what others think of me." Consistent with the other two dual degree students, Mary emanated with confidence. I wanted to know what advice she would offer to other African American women engineering students. She asserted, "It is easier said than done, but do not be afraid to ask for help. You can't do it by yourself." She also advised:

Remember, you are smart. Do not let anyone tell you you're not. You would not be here if you weren't smart. Also, don't be afraid to cry. Honestly, do not hold in. If you have to cry, cry. Eat some ice cream. Take a run. Do something. If not, it will eat at you and you will crash and burn.

For engineering professors, Mary proposed, "You don't have to dumb things down. African American women are competent. They may ask a question differently than what you think, but that does not make them stupid. Also, show more care. We are students. We can learn."

Mary shared her experiences with both an uncaring and a caring professor, She explained, "One thing that helped with my demise last year is that one of my professors honestly did not care." Thankfully, Mary is currently taking a class with a more caring professor. She stated, "He shows more care in answering my questions and responding to my emails. If I am late for class, he pulls me aside and ask, 'Where were you? Why weren't you in class?'" She elaborated, "He makes me accountable. A lot of professors

don't make their under-represented students accountable. Because you are Black, they will not push you as hard as other students.”

Mary also had great advice for aspiring engineers. She explained, “I would definitely not deter them. I would tell them if being an engineer is your dream, go for it.” She also stated that she would have different advice depending on the age of the students. She asserted, “If they are younger girls, I would say, ‘Do it. It is a great opportunity. It is for you.’” However, for students who are in high school or beyond, she cautioned: “I would tell them to do it. But I would be honest. I would tell them, ‘Don't feel discouraged, but you have to be about this life. You really need to know what you are getting yourself into.’” At the same time, she would remain encouraging and tell them, “If this is what you want to do, then do it. Don't let anyone tell you otherwise.”

As we closed our second interview, I asked Mary if she had any final comments she wanted to share or any questions for me. She asked a very compelling question that I plan to investigate in the future: “Have you researched how stereotype threat can effect Black women outside of engineering? Every time I am with a group of Black women, I notice we are all single. Is there a correlation between us being single and stereotype threat?” Although I was intrigued by her question, I was not shocked. Like Mary, I have experienced being in the presence of highly educated African American women who are single, but not by choice. As we continued to discuss the topic of dating, it was clear that although Mary wants to be in a relationship, she is not willing to settle. Like the other dual degree students, this young lady's self-assurance is undeniable. She owns her intelligence. She embraces her ethnicity and honors the resilience of the strong African American women in her life.

Bessie: one who is as curious as she is determined. Bessie is a senior, aerospace engineering major. Originally from Flint, Michigan, she knew from a very young age that she wanted to be an engineer. She shared the following story:

I lived near Bishop Airport in Flint Township. I remember seeing airplanes fly overhead, above my apartment. I remember wondering, ‘How is this big object flying?’ It made no sense to me how that was happening. My mother would say to me, ‘Maybe one day, you will have a job where you will learn how airplanes fly.’

It was her mother’s proposition that initially ignited Bessie’s desire to choose a career that would nurture her curiosity of airplanes. Although she didn’t know it at that time, her inquisitiveness would lead her to engineering. Bessie maintained that she was “always good in math and science.” Her high aptitude in math and science made her an ideal candidate for her high school robotics team. Bessie affirmed:

When I joined the robotics team in high school that confirmed that engineering was for me. In the ninth grade, I went on a college tour and had an opportunity to visit the Aerospace Engineering Department. I toured a wind tunnel lab. At that moment, after touring that lab, I knew I wanted to be an Aerospace Engineer.

Ultimately, Bessie gives herself credit in her decision to pursue engineering. She is grateful that her mom did not discourage her, but she asserts that it was her passion for the subject that cultivated her fortitude to one day become an Aerospace Engineer. She elaborated:

I give my mother a little credit. She never told me, ‘No. Why would you want to do that? That is for guys.’ She didn’t know much about engineering. But she didn’t discourage me. I really give most of the credit to myself. I participated in a

STEM summer program at Kettering University when I was in high school. But that was something I learned about on my own. No one really pushed me to pursue engineering. At the same time, no one discouraged me either.

Bessie had an intuitive desire to be an engineer. Her strong yearning to learn about airplanes kindled a spark that has never dwindled. Despite experiencing stereotype threat, Bessie has persevered. She has faced many setbacks and obstacles, challenges that would have caused most people to walk away in despair. However, this determined young lady continues to beat the odds.

Bessie admitted that she was a victim of stereotype threat as soon as she began college. She described how working with other students on team assignments triggered self-doubt and questioning of her abilities. She acknowledged that negative encounters with her peers continued throughout the years. She shared a recent situation that caused her to wonder if her gender and race were contributing to other students' behavior towards her.

Last semester, in one of my engineering labs, a White guy just switched out of my group. There were instances when the professor would tell us to rotate. However, in this case, this person just rotated, before it was rotation time. I assumed that he thought I was not a good partner. But I always did my work. I always stayed on top of things. I went to class every day. I didn't understand why. Then it dawned on me, 'I am the only female and the only African American in this class.' That experience made me feel very alienated.

This sense of alienation was also revealed when Bessie described why she believed engineering was less inviting to her as an African American female compared to White female students. She asserted:

I think they are more accepted. There are more White females than African American females in engineering. They interact more with other each other than with me. Maybe they are more comfortable with each other. As far as stereotypes, I think they know how White women would act in a setting. Whereas with me, they really do know how I might act. I think they assume the worse.

She also believes African American males experience less isolation than African American females. She contended, “They have a lot of White male friends. I don’t. I think it is because they identify more with their gender than their race. I don’t think they feel nearly as isolated as I do.”

Like most of the participants, Bessie was unable to describe an academic setting in engineering in which she did not feel the effects of stereotype threat. However, she acknowledged that the Center for Engineering Diversity was a place she felt very comfortable and welcomed. She also expressed that it was reassuring for her to be around more Black students. She stated:

We have three campuses. North campus is primarily engineering. Central campus is where the Literature, Science and Arts students are. Most Black students on campus are in communications, African Studies or psychology. When, I am on Central campus, I see more people who look like me. Therefore, I do not feel as awkward. I don’t feel like that one speck.

Bessie's doubts were not only triggered by other students, she also had an advisor that added to her insecurities. She explained that when she participated in a summer bridge program, her advisor, who she expected to encourage her did just the opposite. She shared:

My advisor, a Black female, never supported me. She told me, 'I just want you to have fun during your four years here. I want you to say great things about the university. You just need to graduate. You just need to major in general studies. You can be a manager at Target. They make good money.' She actually told me that.

Bessie also described how her advisor expressed doubt in her ability to earn an engineering degree. She explained, "During my first semester of college, I registered for chemistry and pre-calculus. She told me, 'You can't do that.'"

When Bessie revealed that she was not actually admitted to the college of engineering, I was even more impressed with her resilience. She disclosed:

I wasn't admitted into the college of engineering. I was admitted into the college of Literature, Science and Arts. My recruiting advisor suggested, 'At least you got accepted into the university. If you want to study engineering, do a cross campus transfer.' That was my plan from the beginning. Granted it took four years to actually transfer, but I was persistent about studying engineering. The only other option I considered was Computer Science or Informatics, which are both STEM disciplines.

Bessie further elaborated on her interaction with her academic advisor:

I told her, ‘I want to transfer into engineering. At some point, I am going to have to take math and science together.’ Her response was, ‘No. You don’t have the ACT scores for engineering. You can’t be an engineer.’ She was one of the main people who made me doubt myself. I thought, ‘Maybe she is right. I only got this score on the ACT. I can only be this good.’

Bessie confessed:

Realistically, she was right. My ACT scores were not great. However, I thought, ‘Can you at least give me support or hear me out?’ I didn’t want to do communications. If it was not engineering, I didn’t want to do it.

She revealed more about her resilience when she shared, “I literally just transferred into engineering last semester. I have been in the college of Literature, Science and Arts for four years. But I’ve been taking engineering classes the entire time.”

In no way does Bessie try to deny that she has struggled academically. She revealed that she only had a 2.5 grade point average (GPA). She also shared that because of her GPA, many people, including a trusted mentor, have constantly told her that she will not find a job when she graduates. At the same time she disclosed:

My mom and both of my grandparents passed away last year. Can I put, ‘I planned three funerals in a month on my resume?’ Probably not. But that was real life. That is what I had to do. A lot of my colleagues did not experience the same thing. Of course it affected my GPA. I had to work a full-time job. I didn’t have two parents in the household. The list goes on.

In spite of the many storms, Bessie weathered them all. She remains optimistic. She remains committed to engineering. Despite it all, she expressed her gratitude for the head of the Aerospace Engineering department. She shared:

What's funny about my story is that the only person who actually supported me is the head of the Aerospace Engineering department; an old, White British guy. He said, 'Just take a class and see how you do.' I don't think he was that much invested in me in the beginning. But at the end of the day, he was the one who allowed me to transfer into the department. I didn't have the minimum GPA to transfer. But it was his program. He was really the only person that gave me a shot.

Thanks to the willingness of the head of the aerospace engineering department, Bessie was given an opportunity to spread her wings. This young lady has risen from very meager beginnings. Although she had very little financially, she has all the commitment and passion she needs to succeed in engineering. Given nothing more than feathers, Bessie has created two wings and she is flying, flying like the airplanes that ignited her interest in engineering. She is soaring and headed towards a bright and prosperous future as an Aerospace Engineer. She dreams of working for Boeing. With her strength and perseverance, I am sure Boeing would love to have Bessie become a part of their organization.

CHAPTER 5

FINDINGS

The themes and categories emerged from three different sources for each participant: (a) an initial semi-structured interview; (b) a follow-up interview; and (c) reading reactions are presented. All questions asked during the first and second interviews are listed in Tables 5-1 through 5-4. It is the uncensored responses to these interview questions that gives power to the narratives that evolved into the common themes. As an African American woman with an engineering degree, I was able to form an immediate bond with the participants. To encourage a candid discussion, I shared personal trials I've experienced as well as obstacles I've overcome as an engineer.

Table 5-1 *Interview 1 Introduction Questions*

#	Questions
1	What is your current status? (8 th semester, etc.)
2	Where are you from? (State, City)?
3	What is your engineering major?
4	When did you decide you wanted to be an engineer?
5	How did you make the decision to choose engineering as a major?
6	Is there anyone you give credit for your choice to pursue engineering?)
7	Are there any engineers in your immediate family?

I wanted the participants to reflect on their experiences and search deeply within themselves to express how stereotype threat impacted them beyond the engineering classroom. The participants' reactions were so profound that I included excerpts in this

chapter. Staying in alignment with the CRT tenet of counter-story telling, these reading reactions added depth to the study's finding.

This chapter is divided into three sections. In the first section, the themes and the categories within each theme are thoroughly discussed. The first section closes with a detailed data analysis of the themes and categories. In the second section, the assigned reading article is summarized. Following the article's summary, excerpts from the participants' reading reactions are presented. The third section is an analysis of how the study's findings support and extend the literature.

Themes and Categories

I conducted two semi-structured interviews with each participant. From these interviews, four themes emerged. Within each theme, distinct categories evolved (Table 5-5). The first theme is *'proof that stereotype threat exists.'* This study was grounded on an assumption that African American women in engineering experience stereotype threat. Based on interview data, this assumption was confirmed. This first theme emerged during discussions about the "climate" of engineering classrooms. The proof stereotype threat exists theme also arose during conversations concerning: (a) participants description of an "ideal" engineering classroom; (b) their need to prove themselves; and (c) their overwhelming fear of asking questions in class. The second theme is primary contributors to stereotype threat. Participants' discussions regarding their interactions with professors and other students led to the emergence of theme two. Other conversations that supported the second theme include: (a) participants' interpretations of the "climate" of engineering

classrooms; (b) their opinions of an “ideal” engineering classroom; and (c) an undisputed belief that teaching African American female students about stereotype threat is a helpful strategy to help them combat it. The third theme is secondary factors. These are factors that impacted the participants and are directly tied to them being engineering students. They are not necessarily contributors to stereotype threat but may be the results of it. These secondary factors were revealed when participants shared how their experiences as African American women in engineering are unique. The consequences of their experiences with the intersectionality of their gender and race were revealed. All participants agreed that the “climate” of engineering environments is less welcoming to them compared to either White women or African American men; especially in regards to working on group assignments. They also disclosed that their biggest competitors are White male engineering students. Participants confessed to health issues primarily caused by their academic abilities continuously being questioned along with them constantly feeling alienated.

During data analysis, it instantly became evident that all 10 participants were victims of stereotype threat. It was also clear that there were distinct contributors to this phenomenon. Despite being “stereotype-threatened”, these participants disclosed “tools” they used to help them persist. The fourth theme that emerged is tools for persisting. Participants described environments in which they did not experience stereotype threat. These environments included those in which they were in the presence of other African American students. Discussion-based courses, including African American Studies and Gender Studies, were also popular “non-stereotype-threatening” environments. Students’ passion and commitment to earning their engineering degrees also surfaced during both

interviews. Their strong faith along with support and encouragement from their families contributed to their persistence. Other “tools” for persisting are: (a) active involvement with the Black community on campus and (b) an initiative to find needed resources.

Table 5-2 *Interview 1 Stereotype Threat Existence/Persistence Strategies Questions*

#	Questions
1	Have you experienced STT? If so, how?
2	How would you describe the "climate" of engineering classrooms regarding their inclusion/acceptance of African American female students?
3	How would you compare your experience as an African American woman in engineering to that of a white woman in engineering?
4	How would you compare your experience as an African American woman in engineering to that of an African American man in engineering?
5	Is it more challenging being a woman or an African American in engineering?
6	Can you describe any environments, as a student, in which you did not experience STT?
7	Have you had any African American professors, male or female? If yes, did you feel more comfortable in that class (or those classes)?
8	Have you ever had any female engineering professors? If yes, did you feel more comfortable in that class (or those classes)?
9	Describe your ideal engineering classroom. Do you believe awareness of STT is harmful or helpful to you as an African American female engineering student? Please explain.
10	Does it help you feel more comfortable, included and/or accepted if you professor calls you by your name?
11	Does it bother you if professors only use the pronoun "he" when giving examples or during classroom discussion?
12	Are you afraid to ask questions in class?
13	Are you comfortable going to office hours?
14	Have you considered changing your major?
15	Do you have the need to prove yourself or your belongingness in engineering?
16	Do you feel most of your negative experiences in class come more from male students or professors?
17	Are you actively involved in extracurricular activities?
18	Do you know any African American women who have left engineering?
19	Do you notice African American female engineering students isolating themselves from each other?

Table 5-3 *Interview 1 Mentors/Advice Questions*

#	Questions
1	Do you have a mentor (or mentors)?
2	Do you have a mentor (or mentors) outside of engineering?
3	Do you believe a mentor has to have characteristics similar to yours? (<i>Examples: same race, gender, age, etc.</i>)
4	What advice would you give to African American female students in engineering who consciously choose to isolate themselves from other African American women?
5	What advice would you give other African American female engineering students to help them succeed in engineering? To overcome/combat/resist STT?
6	What advice would you give engineering professors that you think would assist African American female students persist in engineering? To reduce STT?
7	What advice would you give engineering professors that you think would assist African American female students persist in engineering? To reduce STT?
8	What advice would you give young African American girls who aspire to be engineers?
9	How do you feel about the science of make-up strategy to engage young African American girls in engineering?
10	Do you have any final comments or questions?

Table 5-4 *Interview 2 Questions*

#	Questions
1	Describe how you felt after reading the article. Did it resonate with you? If so, how?
2	Do you think reading the article was harmful to you in anyway? Please explain.
3	Do you think a seminar course that teaches engineering students about issues such STT, impostor syndrome and micro aggressions would be helpful? Please explain.
4	Have you experienced any health related issues because of STT? (<i>Mental, physical, emotional?</i>) Please explain.
5	Does faith play a role in your ability to persist? Please explain.
6	Does your family play a role in your ability to persist? Please explain.
7	Does your community play a role in your ability to persist? Please explain.
8	Do you believe SES play a role in a student's ability to persist in engineering? Please explain.
9	In what ways do you think white women can help African American women with our struggles in engineering?
10	In what ways do you think African American men can help African American women with our struggles in engineering?
11	Do you think African American women who attend HBCUs are immune from STT?
12	Do you have any final comments or questions?

Table 5-5 *Themes and Categories*

Themes	Categories
Proof Stereotype Threat Exists	Alienation/Isolation (A/I) Need to Prove Self (NTPS) Self-Doubt/Questioning of Belongingness (SD)
Primary Contributors to Stereotype Threat	Assumptions/Expectations/Perceptions (<i>of others</i>) (AEP) Lack of awareness/understanding (<i>of others</i>) (LAU) Microaggressions (MA) Uncaring/Discouraging Professors (UDP)
Secondary Factors	Group Dynamics (GD) Health Issues (HI) White Males (WM)
“Tools” for Persistence	Active Involvement with Black Community on Campus (ACTIV) Desire to give back/Inspire next generation (D2GB) Faith, Family and Community (FFC) Identity/Strong Sense of Self (I/SSS) Pride/Passion/Commitment to be an engineer (PPCE) Self-Advocacy (SA)

During data analysis, it instantly became evident that all 10 participants were victims of stereotype threat. It was also clear that there were distinct contributors to this phenomenon. Despite being “stereotype-threatened”, these participants disclosed “tools” they used to help them persist. The fourth theme that emerged is tools for persisting. Participants described environments in which they did not experience stereotype threat. These environments included those in which they were in the presence of other African American students. Discussion-based courses, including African American Studies and Gender Studies, were also popular “non-stereotype-threatening” environments. Students’

passion and commitment to earning their engineering degrees also surfaced during both interviews. Their strong faith along with support and encouragement from their families contributed to their persistence. Other “tools” for persisting are: (a) active involvement with the Black community on campus and (b) an initiative to find needed resources.

Theme 1: Proof Stereotype Threat Exists

The different interview questions that resulted in participants revealing information that confirmed the existence of stereotype threat are presented in Table 5-6.

The proof stereotype threat exists theme emerged when I directly asked, “Have you experienced stereotype threat?” All 10 participants responded with a resounding, yes. There are three categories in this theme: (a) alienation/isolation; (b) need to prove self and (c) self-doubt. These three categories surfaced when participants discussed their overall experiences of being an African American woman in engineering.

Alienation/Isolation. The “*alienation/isolation*” category within theme one was easily established. All 10 persisters asserted that they are typically the only African American female in their engineering classes; and sometimes the only African American. For example, Ursula shared: “I am the only African American female in my major. There are about 400 of us. Most of my classmates are White males. If there is another Black person in my class, it is a male.” When discussing the climate of her engineering classrooms, Bessie revealed:

I had one friend in my major. She graduated last fall. Now that she is gone, I am all alone. Everyone else has their own cohort. Until there is a project in which I am randomly selected on a team and you have to deal with me, no one is friendly.

No one speaks or says anything to me. That makes me feel uncomfortable when I need to ask for help.

Table 5-6 *Interview Questions leading to Theme 1 (Proof Stereotype Threat Exists)*

Question	A/I	NTPS	SD
Experienced STT?	●	●	●
Climate of Engineering Classrooms?	●	●	●
Experience: African American woman vs. White Woman in ENGNRG?	●		●
Experience: African American women vs. African American men in ENGNRG?	●		
More Challenging: w vs. African American in ENGNRG?	●		
No STT Environments?	●		
Have/Had Female Professors?		●	
Ideal Engineering Classroom?	●		
Awareness of STT: Harmful or Helpful?	●		
Helpful if Professor knows your name?	●		
Afraid to Ask Questions?		●	●
Thoughts of Changing Major?			●
More Problematic: Male Students vs. Prof.?	●	●	
Do African American isolate from each other?	●		
Advice to African American women who isolate themselves?	●		
Final Comments after 1st Interview?	●		
Did Article Resonate with You?	●		
Need to Prove Self?		●	

(A/I = Alienation/Isolation; NTPS = Need to Prove Selves; SD = Self-Doubt)

Jewel described how her experiences as an African American woman compared to the experiences of White women in engineering. She asserted:

In most of my classes, I was the only Black woman and often the only Black person. There were more of them. Pretty much all the White girls in my major knew each other. They were in the same sorority. It seemed easier for them because they were more comfortable with one another. They were taking classes with their friends. I was always the outlier.

Each participant articulated how their alienation made them question their belongingness.

Ellen admitted that the isolation made her wonder, “Do I belong here?”

Need to Prove Selves. Theme 1 also includes the category “*need to prove self*.”

Several participants described how their need to prove themselves was a constant worry.

Miriam, one of the dual degree students, confessed: “Yes. I have the need to prove myself. Being a part of the dual degree program, I want to prove that I can finish. Being a transfer student adds pressure.” Bessie openly discussed her constant need to prove that she belongs in engineering. She shared:

My whole collegiate experience I’ve had to prove myself. I have to prove myself to the Aerospace Engineering department head. I have to prove myself to my family and friends. This is something that I have wanted to do my entire life. I have to prove to myself that I can do it. ‘Why would I want to do something so badly, if it wasn’t for me?’ In the department, I have to prove that I am smart. I am not here just to fill a quota. I take it upon myself to do a little extra than my teammates. I go above and beyond so that I can have a technical explanation to give to the professor and my teammates. I want them to know that I can do more than scribe.

Shirley also confessed to constantly feeling the need to prove her worth. She explained:

Every single day I wake up, I think of what I have to do to prove myself. One of things I have struggled with since starting graduate school is living up to the name of the institution that I got my Bachelors. I talked to a lot of people about graduate school. But no one ever mentioned how pressured you feel to perform because people are going to think, ‘You got your degree from where and you don’t know this?’

The need to prove their belongingness and “disprove” stereotypical assumptions about African American women were clear illustrations that all 10 participants were victims of stereotype threat.

Self-Doubt. Self-doubt also emerged as category within theme one. Mary, a dual degree student, expressed how her self-doubt manifests. She shared, “In class, when people ask questions, they sound so smart. I think, ‘Oh my God. I just pretty much finished a degree in Physics and I don’t know what they are talking about.’” Miriam described a similar feeling, “I think subconsciously I believe I am not as capable as others.” Self-doubt also emerged when participants discussed their fear of asking questions in class. Every participant who admitted to being afraid to ask questions in class attributed this fear to them not wanting to appear “stupid.” Rebecca shared her reluctance to ask questions: “I would think, ‘This is probably a stupid question. This has probably already been answered or the answer is obvious.’” Jewel asserted:

I can count on my fingers how many times I actually raised my hand to ask questions in lectures. In the back of my mind, I thought, ‘I don’t want to ask a

stupid question. If I ask a question, people are going to look at me like, ‘you don’t even know that?’” I constantly feared that if I asked a question everyone was going to think I was not smart.

Ellen also explained her concerns around asking questions:

I typically don’t ask questions in class. If I get enough courage to ask, I want to make sure I can form the question properly. Sometimes I get a little nervous. I think I am being hindered by stereotype threat.

Based on our discussion, Ellen was able to recognize that her fear of speaking up in class and agonizing about how she speaks are signs that she is experiencing stereotype threat.

All 10 women described three major issues which revealed that they are definitely victims of stereotype threat. First, they shared the pain of feeling alone and alienated. Secondly, each participant admitted to having a constant need to prove herself. Finally, they all discussed their struggles with self-doubt.

Theme 2: Primary Contributors to Stereotype Threat

See Table 5-7 for the specific interview questions in which participants’ responses strengthened the emergence of the primary contributors to stereotype threat theme.

The second theme surfaced primarily during discussions around two opposing ideas.

These contrasting views are the participants’ beliefs about the current “climate” of engineering environments and their optimistic thoughts of an “ideal” engineering classroom that they believe would help them feel more accepted and respected as competent students. The 4 categories within this theme that materialized during data analysis are:

1. assumptions/expectations/perceptions
2. lack of awareness/understanding
3. microaggressions; and
4. uncaring/discouraging professors

Table 5-7 Interview Questions Leading to Theme 2 (Primary Contributors to STT)

Question	AEP	LAU	MA	UDP
Experienced STT?	•		•	
Climate of Engineering Classrooms?	•	•		•
Experience: African American women vs. White women in ENGNRG?	•			•
Experience: African American women vs. African American men in ENGNRG?	•		•	
Have/Had African American Professors?				•
Have/Had Female Professors?				•
Ideal Engineering Classroom?	•	•		•
Awareness of STT: Harmful or Helpful?	•	•		
Helpful if Professor knows your name?				•
More Problematic: Male Students vs. Prof.?	•		•	•
Did Article Resonate with You?	•			
Seminar Course, Helpful?		•	•	
Family and Persistence?		•		
Community and Persistence?		•		

(AEP = Awareness/Expectations/Perceptions; LAU – Lack of Awareness/Understanding; MA = Microaggressions; UDP = Uncaring/Discouraging Professors)

Assumptions/expectations/perceptions. The first category within theme two is “assumptions/expectations/perceptions.” All 10 persisters candidly discussed others’: (a)

assumptions about their academic incompetence; (b) expectations for them to lose their identity and conform; and (c) negative perceptions about African Americans in general and African American women specifically. When Sara described the “climate” of engineering classrooms, she shared, “I need to give a lot more details to be perceived as someone who is knowledgeable in my field. Therefore, I am very aware of how I present myself at all times.” Jewel touched on the notion of expectations when she described how the engineering “climate” is different for her as an African American woman compared to African American men. She shared, “Being Black has its effects for sure. However, in engineering, being male, gives them a few bonus points. Other students will trust Black men more because they are expected to know math and science better.”

Rebecca also believes engineering environments are warmer for African American men. However, she asserted that expectations for African Americans were low, regardless of gender. She stated, “Black men have a greater advantage getting their foot in the door. At the same time expectations are just as low for Black men as Black women.” Sara described what she believed to be a primary difference between African American women and White women in engineering. “As a woman, people expect me to be less aggressive, less forward. And as a Black woman, if I am too forward in challenging the perception that women aren’t leaders, then I risk coming across as an angry Black woman.”

Lack of awareness/understanding. The second category that arose in theme two is “*lack of awareness/understanding.*” Participants believed that both students and professors lacked an awareness of the obstacles they face as African American women in a White male dominated field. Many of them also shared that even though their families

did their best to support and encourage them, they truly did not understand the academic pressures and social challenges African American women face on a daily basis in engineering. When describing the climate of engineering classrooms regarding their inclusion of African American women, Ursula shared: “Students don’t understand that being the only African American female in a class is intimidating.”

Rebecca and I had a frank conversation concerning the potential effectiveness of a required seminar course for engineering students to inform them of issues such as stereotype threat and microaggressions. She believed that such a course would be beneficial for both minority and majority students. Most of the other participants agreed. Mary stated, “I can see such a course being very impactful. The curriculum needs to be helpful and empowering to minorities and at the same time insightful and educate majority students.”

Microaggressions. Microaggression is a term used to describe “unintended discrimination.” Microaggressions are behaviors and words unconsciously expressed and not intended to be offensive. However, they can have the same effects as conscious, intended discrimination. Six out of 10 participants shared experiences in which they were victims of microaggressions, making it a category within theme two. Shirley mentioned microaggressions when she explained how she experienced stereotype threat:

One of the main ways I experience stereotype threat is being a Black woman and walking into a classroom. The environment changes in general. First of all, people think that I am lost, initially. I get questions like, “*Can I help you?*”

Microaggressions like that are really common. People think I don’t belong because I don’t look like the typical Medical Physicist or Nuclear Engineer.

Mary shared a similar experience when she described the engineering “climate.” “When I come into the engineering building late at night to work on homework and ask other students questions, they look at me like, ‘Who are you? Why are you even asking this question? Why are you asking me?’” Ellen shared how comments from other students ignite stereotype threat and cause her to question her belongingness in engineering. She stated, “People say that it is easier for minorities to get into college. Then I feel that maybe I am not as smart.” Ursula also expressed how comments from other students are discouraging. She shared a question she has heard too many times from her White male peer, ‘What if we had a society of White engineers?’ I tell them, ‘We don’t need that. Everything is a society of White engineers.’”

Even though some participants are aware that some of their classmates frequently deliver microaggressions, they doubt much can be done to change it. For example, during our discussion concerning the effectiveness of a required seminar course, Euphemia confessed, “It would definitely be useful. But would it have any affect? I don’t know. If you have been contributing to microaggressions your whole life, your behavior is not going to change from one class.”

Uncaring/discouraging professors. Professors play an integral role in helping African American female students resist or combat stereotype threat. They can also have an equally powerful influence igniting it. The final category in the primary contributors to stereotype threat theme is uncaring/discouraging professors. All three dual degree participants discussed how their professors at their PWI are much less approachable than their professors at the HBCU they previously attended. When attempting to explain the “climate” of her engineering classrooms, Miriam asserted, “It is so hard to explain since I

do not have something to compare it to. I feel that most of professors aren't as approachable as they were at [Coleman College]." The other two dual degree students expressed similar comparisons.

I asked Jewel, "In your opinion, is it the behavior of the male engineering students or the professors that ignite stereotype threat more?" She responded:

I fault some of the professors because they didn't correct inappropriate behavior. Ultimately it was the students who were saying things that caused me the most stress. However, I was in a learning environment. When I didn't participate, the professors were not encouraging. They did not encourage me to speak up and get more involved.

At least two participants believed that when professors knew their name, it lessened stereotype threat. Miriam shared:

I think it gives you more confidence. It makes you feel as if you have a relationship with that person. You are more engaged in that class. If a professor cares about what you are doing and what is going on with you, you want to perform better.

Ellen's sentiments were similar, "It makes things more personal. It shows that they care about your welfare." However, the majority of the participants believed that if a professor knew her name it was because she was the only African American in the class.

Theme 3: Secondary Factors

See Table 5-8 for the specific interview questions in which participants' responses materialized into the secondary factors theme. Secondary factors are the third theme to

emerge during data analysis. There are three categories within this theme: (a) group dynamics; (b) health; and (c) White males. These factors influenced the participants, but did not necessarily contribute to stereotype threat.

Table 5-8 *Interview Questions leading to Theme 3 (Secondary Factors)*

Question	GD	HI	WM
Experienced STT?	●		●
Climate of Engineering Classrooms?	●	●	●
African American women vs. White women?	●		●
African American women vs. African American men?	●		●
More Challenging: White vs. African American?	●		
No STT Environments?	●		●
Ideal Engineering Classroom?	●		●
More Problematic: Male Students vs. Prof.?	●		●
Do African American isolate from each other?		●	
Advice to African American women who are isolated		●	
Did Article Resonate with You?			●
Seminar Course, Helpful?	●		
Health Issues because of ENGNRG?		●	
Need to Prove Self?			

(GD = Group Dynamics; HI = Health Issues; WM = White Males)

Group dynamics. Bessie explained how working with groups ignited stereotype threat. She shared:

In my department, we have something called team homework. Three or four students are grouped together to complete homework problems. Each member of the group is responsible for a particular role. I noticed that nearly every time we had an assignment, I was assigned the role of the scribe. On the rare occasion that I was the team leader, my work would be double-checked by everyone else in the group. However, if someone else

was the leader, their work would never be second-guessed. Everyone would just take their word.

She further explained how being the team's scribe is a role she can't seem to escape.

“Even now, working on my senior design project, I am on a team where I am always the one to send off an email to a professor. They always look towards me to write everything.” Shirley also described discouraging experiences with group dynamics:

People always assume that they don't want me in their group. I always end up in the minority group. I get pigeonholed into being around people who look like me. I don't have a problem being around people who look like me. But ideally, I would like to broaden my network.

The comments from these two women nicely sum up what the other participants had to say regarding this category. The most common issues persisters expressed that led to the emergence of the “*group dynamics*” category were: (i) not being selected; (ii) intellect constantly being questioned by others; and (iii) assigned menial roles, such as the scribe.

Health issues. Participants candidly discussed a range of health issues ranging from severe depression and anxiety to migraines and insomnia. Mary stated, “People don't think you are smart enough to be here. This brings on an air of depression and anxiety.” Rebecca expressed a similar experience with anxiety:

Although I did not experience depression, there was day-to-day anxiety. Every time I stepped out of my dorm, I had thoughts about how people perceived me. As a Black person, you are always thinking about what people think of you. You are worried about how they are judging you before they even get to know you. You are always on the defense. You are always thinking, ‘How can I set myself apart

to make them see that I am not what they probably see on TV?' There was definitely a lot of anxiety.

Jewel concurred that being an African American female in engineering was very stressful. She credits her uncaring advisor for adding to her stress. Jewel's advisor blatantly told her that she would not survive in graduate school. Her advisor was a woman she met with only once a year. When discussing her health issues, Jewel shared, "I had to deal with the negative things my advisors said. There are always people who feel that you don't belong or you will not do well. This adds a lot to your plate and causes a lot of anxiety." Bessie also confessed to health issues brought on by constantly being doubted and alienated. She has experienced, "stress and migraines."

White males. The third category in the secondary factors themes is "*White males*." When referring to their classmates, participants rarely discussed anyone outside of White males, unless they were asked specific questions about particular students. Their focus on White males may stem from the fact that engineering is dominated by them. Ursula shared, "I am constantly comparing myself to males; especially White males. Not necessarily day-to-day, but pretty often." When comparing her experiences as an African American woman in engineering to those of African American men, she asserted: "I feel White males are less likely to talk to me or any other female in the classroom. They are more likely to talk to other guys, White or Black." Ursula also asserted, "There are people who choose to conform to the standards of a White male, instead of holding on to the fact that they are Black or female." Both Miriam and Bessie made reference to White males when I asked them, "In your opinion, is your experience as an African American woman different than that of African American men?" Miriam responded, "I think White

men are comfortable with each other and they seem more comfortable with Black men than with me.” Bessie had a similar response, “There are currently four African American` males in the Aerospace Engineering Department. I am the only African American female. They have White male friends. I don’t.” When Jewel described an environment in which she did not experience stereotype threat, she stated that it was White males who experienced it instead. She shared: “In my Black studies course, I was totally comfortable. The White males seemed most uncomfortable in that class.” Despite having to contend with unfavorable group dynamics, health issues and difficulties working with White male students, these 10 African American women persisted in engineering degree programs.

Theme 4: Tools for Persisting

The interview questions that were effective in garnering responses that led to the development of the ‘*tools for persisting*’ theme are showcased in Table 5-9. Theme four includes six different categories:

1. active involvement with the Black community on campus;
2. desire to give back and inspire the next generation of engineers;
3. faith, family and community;
4. firm identity/strong sense of self;
5. proud/passionate/committed to being an engineer; and
6. self-advocate

Table 5-9 Interview Questions Leading to Theme 4 (Tools for Persisting)

Question	ACTIV	D2GB	FFC	I/SSS	PPCE	SA
Experienced STT?					•	
Climate of Engineering Classrooms?				•		
Experience: AAW vs. WW in ENGNRG?	•		•	•		
Experience: AAW vs. AAM in ENGNRG?			•	•		
More Challenging: W vs. AA in ENGNRG?	•	•		•		
No STT Environments?	•	•	•			
Have/Had AA Professors?				•		•
Have/Had Female Professors?						
Ideal Engineering Classroom?			•	•		
Awareness of STT: Harmful or Helpful?				•		•
Helpful if Professor knows your name?						
Use of "He" Problematic?				•		
Afraid to Ask Questions?						•
Comfortable going to Office Hours?						•
Thoughts of Changing Major?		•	•	•	•	
Actively Involved?		•	•			
Know any AAW who left ENGNRG?						
Do AA isolate from each other?	•	•	•			
Advice to AAW who isolate themselves?		•	•			
Have mentors?	•		•	•		
Have mentors outside of engineering?			•	•		
Important Characteristics for a Mentor?	•		•	•		
Final Comments after 1st Interview?	•			•		
Did Article Resonate with You?				•		
Need to Prove Self?			•		•	
Desire to Inspire Other AA/AAW/Youth?	•	•				
Faith and Persistence?			•			
Family and Persistence?	•		•			
Community and Persistence?	•		•	•		
Final Comments after 2nd Interview?	•					

(ACTIV= Active Involvement in the Black Community on Campus; D2GB = Desire to Give Back; FFC = Faith, Family & Community; I/SSS = Identity/Strong Sense of Self; PPCE= Proud/Passionate/Committed Engineer; SA = Self-Advocate)

These six categories highlight the key characteristics that proved to be instrumental in helping the participants resist or combat stereotype threat and persist in engineering.

Active involvement with the Black community on campus. All 10 women described the importance of being actively involved with student organizations on campus that focused on the needs of African American students. The ones most commonly mentioned are the National Society of Black Engineers (NSBE) and organizations dedicated to nurturing camaraderie between Black women including sororities. The majority of the participants held leadership roles within these organizations. Sara, Shirley, Rebecca, and Jewel all served on the executive board of the Black women's Alliance and the Black Student Union on their campus. When I asked Shirley, "Were you actively involved with student organizations while in college?" She responded, "Yes. That is what kept me sane." She further explained, "I was on the executive board for the Black Student Union. I was on the executive board for NSBE. I was really active in the Black women's Alliance. These were the things that kept me afloat." Ellen, a student ambassador for her engineering department, responded to the same question stating, "Yes. Actually, I think I do too much. I am involved with NSBE. I am also in AOE, an engineering sorority. I work on campus and I am a fitness instructor at the gym." Ursula, the president of her college's chapter of NSBE also admitted to being very involved. She explained,

I am involved with a lot of activities. I participate in a peer mentoring program for freshmen. I was a freshmen mentee. I became a mentor my sophomore and junior years. Now I am a peer leader. I assist the mentors if they have students who they think might be depressed or really overwhelmed or homesick. They may not

know how to handle these situations. Since I have been a mentor before, I help them and make sure they are being the best mentors they can be.

As the captain of the cheerleading squad, Sara credits this sport for helping her get through college. She asserted, “Cheerleading was my life through most of college. It was my daily dose of socializing. It was like a family. We shared challenges together, physical and emotional. It was something that kept me going.” Participants were actively involved to not only help them remain “sane”; but they also used these activities to encourage and inspire younger students. The desire to give back and inspire the next generation of engineers is the second “tool” participants used to help them persist.

Desire to give back. All 10 persisters expressed their desire to encourage and inspire the next generation of engineers, especially those who look like them. Ursula expressed this attitude when she shared her reasons for remaining actively involved in student organizations. She explained:

I am noticing that now more than ever, everything that I am doing is aligned with my desire to inspire younger students. At first, I joined the mentoring program because I wanted a mentor. When I initially joined NSBE, it was because I wanted to attend the national conferences and the career fairs to find a job. Now, I pretty much have my job on lock. At this point, I have enough activities to add to my resume. I don't do things for those reasons anymore. I do them because I received so much help from NSBE and other campus organizations. I want to make sure everyone has access to these opportunities because they were so beneficial for me. Giving back is pretty much my only motivation at this point.

Rebecca had a similar story. She explained why she remained so committed to the Black

Women's Alliance: "We started a tradition. We had big-little matches. I had a couple of "littles." In my heart, I could not let that organization dissolve; even if I had to take on the bulk of the responsibilities myself." All the persisters detailed similar reasons for their involvement with both on campus activities as well as outreach programs to engage young kids in STEM.

Faith, family and community. The third category in theme four is "*faith, family, and community.*" When participants discussed how they have been able to persist, most of them mentioned their strong faith, the encouragement from their families and a supportive community, which typically included other Black students on campus. The majority of the participants made powerful statements affirming how their faith and family helped them persist. Rebecca asserted:

I am a very religious and spiritual person. Faith is a big part of my life. It is one of the first things I turn to. If I go to a family member to talk, it is the first thing they will bring up for coping. Faith has definitely helped me to put things in perspective. It helps me to not react, but to be more proactive. Rather than getting angry when something happens, I will reflect on it and think about how I can handle things in the future.

Regarding her family, Rebecca stated: "Whether or not they understand, they definitely have a way about giving me advice. The fact is not that they don't understand. The fact is they want to encourage me. They give me the encouragement to push forward." Miriam shared how faith and community are integral in helping her persist. Concerning her faith, she stated, "When I don't believe in myself, I have faith. Faith plays big role in helping me persist." As far as a community of supporters, she shared:

Academically, my main community advocates are friends who graduated before me and are now working as engineers. I go to them for support and they let me know that everything is going to be okay. I also have the support of my line sisters from my sorority.

Euphemia also credited faith, family and community. She asserted: "I am a Christian. I have motivation and a belief that I will succeed." Like Rebecca, Euphemia confessed that her family does not completely understand her struggles as an engineering student. However, she shared that she enjoys going home because her community lets her know that she makes them proud. Similar to Miriam, Euphemia considers other students who are part of the same dual degree program as her community of supporters. She explained, "We stick together. We always hang out. We are pretty much going through the same thing." Mary summed up the role of faith when she avowed, "As a whole, I believe that with Black women, faith is sometimes all we have.

Firm Identity/Strong Sense of Self. The six categories in the tools for persisting theme are highlighted in Figure 5-1. "*Identity/Strong sense of self*" is the category that garnered the most coded statements. All 10 women discussed the importance of having a firm identity and unwillingness to conform. Ellen offered, "Students need to have a strong sense of identity. They need to know who they are." Many of the persisters also discussed the importance of having mentors who share a part of their identity. Ellen asserted, "For me, I need a mentor who looks like me. Someone I can talk to who understands the struggles that I go through." Ursula spoke of the importance of identity when she stressed the importance of reaching out to other African American students and engineers. She expressed, "Being able to talk to other African American engineering

students about being Black in general and being Black in engineering specifically, helps us all get through it together.” She also described the significance of NSBE. “It is nice to be in a room with other Black people in a NSBE meeting...At NSBE conferences and annual meetings, there are thousands of Black engineers. We are all going through the same thing.” Ursula offered advice to other African American women in engineering: “If you identify with being Black, join NSBE. If you identify with being female, join SWE. Being around people who are going through the exact same things as you really makes a difference. It helps with success and persistence.”

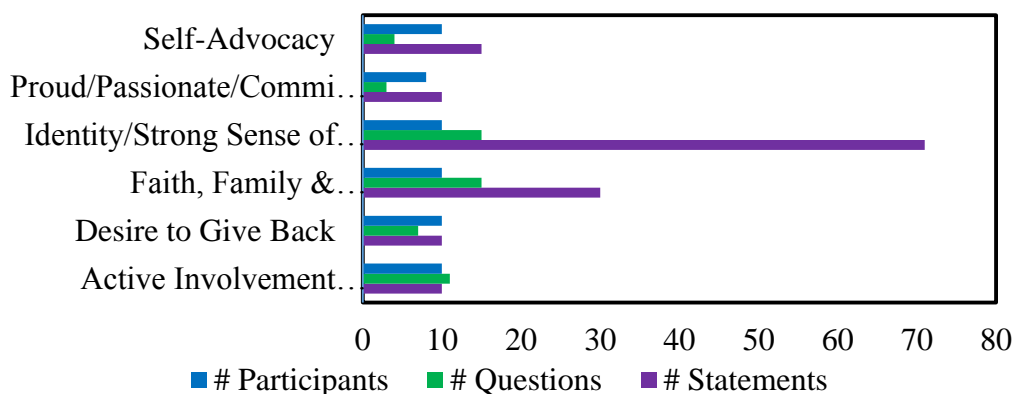


Figure 5-1 Theme 4 (Tools for Persisting)

Proud/Passionate/Committed Engineers. Eight out of 10 participants expressed: (a) how proud they are to call themselves an engineer; (b) their passion for the work engineers do; or (c) their commitment to earning their degree.

Sara professed: “The fact that I am changing the culture around STEM and challenging the status quo is something that I am very proud of and passionate about.” She asserts, “I try to remember that the reason I am in this field is because I am

passionate about it. I feel happy and strong that I am forging my path based on my interest and not what society tells me to be.”

Participants were asked if they have ever considered changing their major. Only two answered yes. Jewel graduated with a BS in Biological Engineering. After all the trials she endured during her time as an undergraduate, Jewel expressed her desire to pursue a Ph.D. in Clinical Psychology. Ellen also answered yes. Her reason for wanting to leave engineering had little to do with her academic or career interests. She explained why she has contemplated changing majors: “I like fashion. I like to dress up. I feel like people think I am doing too much. It just seems like I stand out more.” Two participants considered changing from one department into another, but never from engineering. Ursula disclosed, “I have thought about changing to a different engineering. Like Industrial Systems or Computer science, but never from engineering.” Rebecca had a similar response, “I considered changing only because I thought another engineering major may be of more interest to me.”

Bessie is the sole participant who transferred into engineering. This determined young lady was not initially accepted into the college of engineering. However, she did not allow this setback to stop her. While still in the college of Literature, Science & Arts, Bessie began taking engineering courses. It took three and a half years before she was officially accepted into the department of Aerospace Engineering. Bessie was not the only participant with such impressive resilience and determination to be an engineer. The majority of the other participants shared her ambition and fortitude.

Self-Advocate. The final category in the tools for persisting theme is “*self-advocate*.” All the participants took the initiative to do what was necessary for them to

persist. If they needed a supportive community, they found it. If it was mentors they desired, they sought them out. Rebecca demonstrated how she advocated for herself in two different ways: (a) she started a student organization and (b) she nurtured a relationship with the only African American professor in her department. She explained:

I started a chapter of the minority association of pre-medical students. I asked the only African American professor in our department to be the faculty advisor. I had to find a way to get him involved with something that I was doing. I never had the chance to take his class. I had to connect with him in some way.

Miriam also took the initiative to form a relationship with an African American professor in her department. When discussing her mentors she shared, “I have a mentor in the Chemical Engineering department. Someone told me about him. So I made sure to foster a relationship with him.” Other participants also described how they were proactive in forming relationships with African American professors in their departments. They also sought mentoring and support from other African Americans on campus, including older students and university staff. The most common staff members they sought include African American women who work in the admissions or financial aid office and those who manage programs focused on minority students.

The 10 African American women also discussed how they learned to overcome their fear of failure and to no longer allow others’ negatives views of them impact their desire to become engineers. Mary, a dual degree student, openly shared how she struggled academically when she first transferred to her engineering institution. Although she failed a couple classes, she remained steadfast. She learned strategies to help her succeed. She offered:

I am performing a lot better. I moved close to campus. That helps. Now I understand that I have to put in more work. I know that balance of what to study and what not to study and who to ask for help. I also started asking for help and not being afraid to ask.

Sara exhibited '*self-advocacy*' when she explained how learning about stereotype threat impacted her. She asserted:

It was really relieving to give it a name. You know how they say that giving it a name can feel powerful. The thing I said about fear no longer controlling my life; that was actually a result of me learning about stereotype threat. I felt, "Wow, this is something that happens to so many people. It upsets me that so many people's potential is being affected by this." So it incentivized me to learn coping mechanisms in order to lessen its' negative impact in my life.

The majority of the women admitted to initially being afraid to ask questions in class. They also were reluctant to go to office hours. However, they realized these things were necessary for them to succeed academically. They either conquered their fears or learned to do what was necessary for their success despite them. Rebecca shared:

I was okay going to office hours if I knew that was the only way I was going to learn the material. In some instances, it was a nerve-wracking situation. However, at the end of the day, I did not allow that to stop me from going.

Bessie also discussed the importance of going to office hours. She understood there were benefits beyond her getting help on her assignments. She asserted, "Going to office hours gives me time to build a better relationship with the professor." These young ladies demonstrated not only remarkable resourcefulness, but also impressive resolve.

Data Analysis of Themes and Categories

An overview of the four themes and the categories within each theme is displayed in Table 5-10. The data presented include: (a) the number of statements made by the participants; (b) the number of questions that contributed to the emergence of each category within the theme; and (c) the number of participants who made relevant comments. The number of statements represents the quantity of comments that were coded and ultimately led to the emergence of a category. The number of questions revealed how many interview questions led to a response that fit into a category. The interview questions are unique in each category, but not necessarily within the overall theme. For example, 11 questions contributed to the category “*active involvement in the Black community on campus.*” Some of those same questions may have also contributed to the development of the “*desire to give back*” category. In some cases, not all the participants made statements that were coded for a particular category. For example, only eight participants made statements that were coded for the “*proud/passionate/committed engineers*” category within theme four.

Based on number of coded statements, the ranking of the four themes from most to least is as follows:

1st = Tools for Persisting (146)

2nd = Proof STT exists (93)

3rd = Primary Contributors to STT (49)

4th = Secondary Factors (41)

Table 5-10 *Overview of the Four Themes*

Category	# of Statements	# of Questions	# of Participants
Theme 1: Proof STT Exists			
Alienation/Isolation	54	14	10
Need to Prove Self	15	6	10
Self-Doubt	24	5	10
Total	93		
Theme 2: Primary Contributors to STT			
Assumptions/Expectations/Perceptions	19	8	
Lack of Awareness/Understanding	13	6	
Microaggressions	7	5	
Uncaring/Discouraging Professors	10	7	
Total	49		
Theme 3: Secondary Factors			
Group Dynamics	19	9	
Health	10	4	
White Males	12	8	
Total	41		
Theme 4: Tools for Persisting			
Active Involvement w/Black Comm.	10	11	
Desire to Give Back	10	7	
Faith, Family & Community	30	15	
Identity/Strong Sense of Self	71	15	
Proud/Passionate/Committed Engineers	10	3	
Self-Advocacy	15	4	
Total	146		

Theme four garnered the most number of statements. In total, 146 statements were coded that developed into the tools for persisting theme. Within theme four, the category of “*identity/strong sense of self*” garnered the most number of statements. This category had 71 coded statements, the highest number of all 16 categories. Theme one garnered the second highest number of coded statements. Within theme two, the category “*alienation/isolation*” had 54 coded statements, the second highest number of all 16 categories. These numbers support the underlying assumption of this study. These women are experiencing STT (Theme one) and they have developed strategies to help them resist or combat this phenomenon (Theme four) and persist in engineering.

The most prevalent issue that confirmed that 10 African American women experienced STT was their overwhelming feelings of being alienated/isolated. These feelings of being alienated/isolated are in alignment with Brown (2004) who noted that African American women are often the most socially isolated group of students on campus. Other researchers have stated that this alienation/isolation foster feelings of incompetence and cultivates fear of failure (Ellis, 2000; Jordan, 1998). These two issues are clear signs that one is a victim of stereotype.

The participants candidly discussed having to contend with feeling incompetent and being perceived as such by others. They also shared how their reluctance to seek assistance stems from the fear of looking “stupid.” Despite their fears, the participants expressed how they embraced being African American women and aspired to encourage others African Americans to pursue engineering degrees. All 10 women revealed that their strong identity and pride in being African American women helped them to resist or combat STT and persist.

Reading Reactions

After the first interview, students were asked to read a short, eight page journal article entitled *Snow Brown and the Seven Detergents: A Metanarrative on Science and the Scientific Method* (Subramanin, 2000). This article is a fable about a young woman named Snehalatha Bhrijbhusa. Snehalatha left her homeland and traveled to a far-away place (“Land of the Blue Devils”) to pursue her lifelong dream of becoming a scientist. Upon her arrival, she entered into the “Department of the Pursuit of Scientific Truth.” Within this department was the “House of Detergents” and “The Great Mirror.” The mirror “confronted” Snehalatha and “informed” her that she did not have the “right characteristics” to become a scientist. She was also poorly advised by a Wise Matriarch and several “Patriarchs” including, an all-knowing Supreme White Patriarch, the Emeritus Patriarch, the Associate Patriarch, the Assistant Patriarch, and the Young Patriarch. They all “warned” Snehalatha that in order to succeed in the “Land of the Blue Devils” as a scientist, she needed to change among other things, her name, accent, and physical appearance. She was given “detergents” to assist her in “washing away” her “unacceptable” traits and characteristics. In an effort to succeed in the “Land of the Blue Devils” as a respected scientist, Snehalatha changed her name to “Snow Brown.” After making all the other “suggested” alterations, Snehalatha was still not “accepted.” The fable has alternative endings. Ending one is the most tragic. Snehalatha sadly takes her own life. This “death” can be interpreted as a death to her spirit and her drive to become a scientist: a ‘death’ that many African American women may have faced. The author explained the first ending:

The Patriarch stood around the body. “It is so sad,” he said. “But she was too emotional, a very fuzzy thinker. Some people are just not meant to pursue Scientific Truth. I wish they would learn, accept it, and leave instead of creating all this melodrama.” The other Patriarchs nodded in agreement at the unfortunate event. “There is no reason for anyone to see this story, is there?” The others concurred. They poured the last detergent on her. There was nothing left. No pathetic face, no ugly reminders, no evidence. (Subramanin, 2000, p. 303)

Ending two was more positive:

Snow Brown in her subversive wisdom sent copies of her story and insights to all in the department. There were some who kept it alive. It soon became apparent that there were dissenters within the Patriarchy. They broke their silence and the movement slowly grew. Scientists began forming coalitions, talking and supporting each other in forming pockets of resistance. They questioned the power inequities. Why are most Patriarchs White? Why are most men? Over many decades, the negotiations continued. Women scientists and scientists of color rose up in the power structure. The collective consciousness was now male, female, and multicolored. But it was still supreme. It was privileged. The Pursuit for Truth continued, although new truths emerged - truths from the perspective of women, from the black, brown, yellow, red, and the white. The world had become a better place. (Subramanin, 2000, p. 303)

The third ending was encouraging. The author described this idealistic ending:

The story of Snow Brown spread like wildfire. The Land of the Blue Devils was ablaze with anger and rage. The Wise Matriarch and a number of budding

Patriarchs stormed the Department of the Pursuit of Scientific Truth and took it over. The Great Mirror was brought down. The Room of Judgment was transformed into the Room of Negotiation. In their first, historic meeting, all the scientists sat together. “We need a different model,” they said. They dismantled the positions of the Supreme White Patriarch, the Emeritus Patriarch, the Associate Patriarch, the Assistant Patriarch, and the Young Patriarch. “We will be self-governing,” they decided. They debunked the myth that truth is a monolithic entity. “Truth is a myth,” they said. One person's truth is often privileged over someone else's. This is dangerous. The White Patriarchs privileged their worldview over all others. This distorts knowledge and an accurate description of the world. Together they decided they could help each other in reconstructing science and rewriting scientific knowledge. They ushered in the age called the Age of Celebrating Difference. The House of Detergents was dismantled and the detergents were rendered invisible. The new Department of Scientific Endeavor was very productive. They solved many problems that had eluded the world for years. They became world renowned and their model was adopted far and wide. (Subramanin, 2000, pp. 303-304).

After reading the article, the participants were asked to share how the article resonated with them. They were informed that there was not a “right” or “wrong” way to respond. They were also encouraged to be as candid and detailed as possible. Exerts from the submitted reading reactions are presented below.

Sara: 2014 graduate, BS in computer science and engineering; project manager at a software development company. The article was a very enjoyable

read. I shared it with some friends after finishing! I often say that every education has a cultural undercurrent. In my final semester at [TII], I wondered how this would affect my abilities when tackling issues that aren't often prioritized by the majority. Issues like encouraging more underrepresented minorities to pursue careers in STEM or working to engineer solutions in third world countries. This story reminded me of Audre Lorde's quote, 'The master's tools will never dismantle the master's house.' Power and privilege go hand in hand, even in environments where people claim that meritocracy is key (like academia). It also reminded me of Foucault in thinking about how there is no objective truth and that much of the conservative rhetoric around issues like racism rely on neoliberal arguments. The very American 'you can get anywhere with hard work' mentality doesn't take into account institutionalized racism or structural inequalities. It reaffirmed my belief that one of the things that makes us so special is our differences. And that if we truly want to leave room for innovation, we need to remember that everyone we meet knows something we don't.

Shirley: 2014 graduate, BS-double major, physics and nuclear engineering;

first year graduate student in medical physics. One of the questions I had while reading this article was, "Where was the accountability in the mentor who had the detergents?" If she's watched it time and time again, after a while you'd expect her to want to convince these minorities that there are other options; or to give them hope, even if it's false. I was disappointed in her, because there are far too many people in positions of authority who have the power to encourage struggling students but instead don't and tell them to assimilate instead..... When I read, '*this was no place for the weak, the emotional, or the fickle,*' I chuckled. It's so hard to feel when you're in the sciences. You

have to be so tough, so put together. Especially since men are so quick to label women as emotional. You have to be strong. You have to be assertive. You can't be gullible or emotional at all. They want you to be better than them just to secure a spot below them, because you're still different.

Ellen: 4th year senior, materials science and engineering. The story really made me mad. I grieve at the loss of Sneha's identity. I call her Sneha because I believe that her name is an important part of her identity and should be kept. The suggestions reminds me of "helpful" advice that people give to females and other minorities in order to make them "fit in" the scientific community. Cultural identity is one of the most important traits someone can have. Everyone's experiences give them something that they can contribute, a different way to approach a situation. Those differences should be celebrated rather than viewed as a setback. Sneha reminds me of myself in a way. I was the "smart, scientific one" in the family. My family would tell me I would do amazing things and that I could do anything I wanted. But I had trouble maintaining self-worth in college.

Ursula: 4th year senior, mechanical engineering. I imagine many young minority females would say that they began their trek into undergraduate studies of a STEM major much like Snehalatha Bhrijbhushan did. The kind of students who pursue engineering typically have it pretty easy throughout high school. They're in a place where they are comfortable and have lived all their lives. They test well on material they didn't need to study. They enter college believing that this is their life path and the next four years will be similar to the previous four years, but with more fun. No matter the fact that they've been warned that college is much harder than high school. The alarming ratio of

minorities and females in engineering doesn't scare them. Until they arrive on day one and realize how truly dominating White males are in the field of engineering. It's amazing that the author is truly able to capture that beginning narrative. The seven detergents and "cleansing" one's self of their identity to fit in is a sad and true story. However, it is the initial shock after so many days, weeks, months, and years of building excitement for beginning this journey that is the hardest.

Rebecca: 2014 graduate, biological engineering, AmeriCorps member.

Where should I start? There were so many feelings that came up as I read Snow Brown and the Seven Detergents. The overwhelming feeling was of course frustration, stemming from how similar Sneha's (because I refuse to accept her "European" name) story is to mine; but also many other women of color who develop an interest in any STEM field.... The rampant racism and then sexism that fills this story is not at all exaggerated, but strongly a valid depiction of what too many women of color face in the STEM world. I felt sad for Sneha because she truly had the potential to be great. She was brilliant, but she was defeated by something out of her control, something that shouldn't even be a factor in the field she wanted to pursue. Sadness, pity, anger, frustration, but also feelings of affirmation ran through me. Although it is unfortunate, it is relieving to have it documented; to have our encounters and our horror stories printed and made evident to the world. I want more women of color to have access to this story because many of us are not affirmed in our experiences, so we drudge on in depression and confusion.

Miriam: Graduating senior, dual degree student, chemistry and chemical engineering.

I can see how women/minorities can find themselves using "detergents" to be more accepted within the STEM fields. I found it quite sad that even

when Snow had completely changed her identity, she still was not accepted and left with nothing. As it relates to me, I am glad that I received my first scientific training at [Coleman] which allowed me to have confidence in myself and ability. Being in a diverse environment allows you to know that you can excel while still being yourself. I cannot say I would have had the same confidence if I had started at [APU]. However, I am still grateful for both experiences. This story was a great reminder of how conforming doesn't mean you will be automatically accepted.

Euphemia: 4th year senior, dual degree student, computer science and computer engineering. As far as my reaction to the story, there was an initial feeling of 'oh here goes the same old stuff.' That was my reaction before she decided that she would actually go through with changing herself. After she actually changed herself, I couldn't believe it. I have never actually thought about changing myself because other people thought I was different. That was never an option, so all in all, I equated the story to what it's like being Black and female in the STEM fields. We have this pressure to do things the way they've always been done just for the sake of uniformity. However, conforming doesn't guarantee you will advance in your career.

Laura: 4th year senior, dual degree, physics and nuclear engineering. I absolutely loved this article. It is an accurate representation of the perspective of the black/brown girl as she enters academia, or any industry for that matter. When we enter into engineering, we have to do so much to be the ideal person in this field, which is usually a White male. However, we have to contribute so much more. We are seen as stupid, ignorant and not classy or sophisticated. We are viewed as lazy because of our skin tone, accents, and culture. To fit in, we are expected to change to be like them. We

are expected to change the way we speak, our appearance, our way of thinking, and our personality. But all the while still putting in double the effort for half the respect, recognition, pay, positions, etc....When you change even the little things, you are seen as being different than other Black people. People say things such as, 'Oh you're so articulate.' 'Your hair is so different. You look pretty. You should wear it straight more often.' At the end of the day, you are not seen equally as everyone else. You are never good enough because of your color and background.

Jewel: 2013 graduate, BS biological engineering, research assistant. Her failed pursuit to fit the demands of the Mirror definitely hit home for me. Basically, it is a no-win situation. Either you completely change who you are both in appearance and behavior to the point that those from your past don't even recognize you. Or you stay true to yourself and do not succeed in the scientific world because you do not fit the norms. I tried my best to balance both, which I feel is impossible. It is stressful and required so much energy that I had to question if my pursuit was worth it...This story pretty much summarizes my experience as an undergrad and even my current position...The section of the story where the Patriarchs tell Snow Brown that she cannot be a scientist but they fight for her to be their lab technician caused me to stop and re-read those lines. This is exactly what happened to me! My White, female advisor told me that I probably would not succeed in graduate school because she found it difficult for herself. Therefore, it was going to be too difficult for me. This caused me to believe that I needed to take time off between undergraduate and graduate school. Guess what I'm currently doing with that break? Being a lab technician. The coincidences between this story and my life makes me want to email Banu Subramaniam and ask if we've met before.

Bessie: Graduating senior, aerospace engineering. I enjoyed this story and I understand why she felt the need to change. I felt like Snow Brown to a certain extent. She was singled out, given advice that made her unconfident. I personally have felt this way at times. As far as how I speak and act around my colleagues. Snow Brown felt the need to change everything about herself in order to be successful. Although, I do not particularly feel that I need to change everything about myself, I feel that I want to sound as intelligent as possible when speaking to my colleagues and professors. I subconsciously believe that if I come off sounding 'ghetto' or 'too black' that will hurt my chances of becoming successful or respected by my White counterparts.... As far as the ending goes, I feel that the first ending is probably most likely to happen. Snow Brown was very insecure and really wanted to fit in. The White scientists wouldn't tell on themselves and how they treated Snow Brown. So her existence would just be swept under the rug. I like the second ending the best. It starts with Snow Brown speaking up for herself and drawing positive attention with her story. This ending gives people of color hope that they can work collaboratively and live happily ever after. I think the third ending is more of a "black power" ending. My interpretation is that Snow Brown became the supremacists of the college and made blackness the norm. It shows how blacks can be the elitists of science; however, it does not incorporate every one.

Analysis of Findings

Similar Studies from the Literature

This chapter presented the four emergent themes along with the categories which surfaced within each of them. The four themes are: (a) proof stereotype threat exists; (b) primary contributors to stereotype threat; (c) secondary factors; and (d) tools for persisting. This study was grounded on the assumption that African American women in engineering degree program are victims of STT. Data analysis revealed this to be an accurate assumption. Data also disclosed those things which ignite STT as well as strategies the persisters employed to resist or combat it.

The participants' feeling alienated and isolated in engineering environments was a prominent category in the proof that stereotype threat exists. This is consistent with Sandler (1999) who uncovered that women and minorities in engineering encountered a chilly climate in male dominated work environments. It is also consistent with Malcolm and Malcolm (2011) who revealed that minority women in STEM careers are isolated due to their low representation in these fields. The "*alienation/isolation*" category also aligns with Bush's (2013) research in which African American female engineers described the culture of their engineering workplaces as challenging and isolating (Table 5-11). For example, one of the engineers in Bush's (2013) study asserted, "I do feel alienation on my job because there's only one other Black woman among the five female engineers." The persisters in this study expressed similar remarks regarding their feelings of alienation. For example, when contrasting her experience as an African American to

that of a White woman in engineering Ursula stated, “They may think, ‘I am one of five females in this class.’...They are one in five; not one in one.”

Table 5-11 *Themes Compared, Bush (2013) and This Study*

Bush, 2013 Themes	Bush, 2013 Categories	This Study's Themes
Determination & Resilience	<ul style="list-style-type: none"> • Internal Perseverance • Love of & Confidence in Mathematics/Science • Faith & Prayer 	Theme 4: Tools for Persisting
External Supports	<ul style="list-style-type: none"> • Role Models • Programs for Women/ Minorities • Church Community 	Theme 4: Tools for Persisting
The Reality of the Chilly Climate	<ul style="list-style-type: none"> • Learning Environments • Double Standards & Workplace Barriers • Racism and sexism 	Theme 1: Proof STT exists Theme 2: Primary Contributors Theme 3: Secondary factors
The persistence of black women engineers	<ul style="list-style-type: none"> • Coping Strategies • Defining Moments • Helping/Caring • Giving Back 	Theme 4: Tools for Persisting

Self-doubt also emerged as a category within the proof stereotype threat exists theme. This category is consistent with findings from Frillman's (2011) phenomenological study on the experiences of African American women in engineering (Table 5-12). Several of her participants made comments that she coded as “self-doubt.”

For example, one of the students in Frillman’s study confessed to wondering “Is this what I really want to do? I’m trying so hard. It doesn’t seem like I’m getting anywhere.” Sara, one of my participants, made a similar statement, “I feel that I work so hard and nothing that I do is enough.”

Table 5-12 *Themes Compared, Frillman 2011 and This Study*

Emergent Themes (Frillman, 2011)	This Study’s Themes
Demographic Information/Special Circumstances	Theme 3: Secondary Factors
Personal Attributes and Characteristics	Theme 4: Tools for Persisting
Sources of Negative Stress	Theme 2: Primary Contributors Theme 3: Secondary Factors
Success Strategies	Theme 4: Tools for Persisting
Being African American & Female in Engineering	Theme 1: Proof STT Exists

E.O. McGee (2009) analyzed the experiences of 23 high-achieving Black mathematics and engineering students. She explored the students’ racial and mathematical identities as a means to ascertain factors that accounted for their resilience. She performed a cross-case analysis on all 23 students and dissected the experiences of three using the life-story approach. Results from E.O. McGee’s (2009) study revealed two major findings regarding how students remain resilient: (a) they achieve to prove

racial stereotypes wrong and (b) they achieve to serve as role models for Black learners. E.O. McGee developed a model to demonstrate trajectories of resilience. In her model, there are two forms of resilience: fragile and robust (Table 5-13).

Table 5-13 *Themes Compared, McGee 2009 and This Study*

Forms of Resilience (McGee, 2009)	Themes from this Study
<p>Fragile</p> <ul style="list-style-type: none"> • Succeeds to prove the stereotype wrong • Perseveres because of fear of failure 	Theme 1: Proof STT Exists
<p>Robust</p> <ul style="list-style-type: none"> • Succeeds to serve as a role model • Perseveres, despite obstacles, to encourage others • Tests and refines self-defined criteria • Seeks like-minded people, spaces and places • Learns math and engineering for self-satisfaction 	Theme 4: Tools for Persisting

Within the fragile form of resistance is the category “succeeds to prove the stereotype threat wrong” (E.O. McGee, 2009). Their need to prove to prove themselves was also expressed by the 10 African American women in this study. They discussed how they felt constant pressure to prove that they were intelligent enough to be engineers. They also described having to work extra hard to prove their engineering problem solving skills when working on team projects. They shared how this constant need to prove themselves caused anxiety.

The anxiety the women experienced is consistent with Steele, Spencer, and Aronson's (2002) assertion that groups who are negatively stereotyped tend to experience higher anxiety on tasks in stigmatized domains than others not subject to the negative stereotype. A stigmatized domain is an area in which a particular group is negatively stereotyped to underperform. For African Americans, the stigmatized domain is academic achievement (Steele & Aronson, 1995). According to Steele (1997), this anxiety is due to the constant fear of being viewed through the lens of the stereotype and having to constantly strive to prove the stereotype wrong. Individuals in these negatively stereotyped groups worry that any personal failure will be a confirmation of the negative stereotype (Steele, Spencer, & Aronson, 2002).

The African American women in this study candidly discussed how particular experiences with their White male peers ignited STT. They specifically described how White male students exhibited behaviors that were both racist and sexist. This is consistent with Bush's (2013) findings in which the African American female engineers described both overt and covert racist and sexist encounters with their White male colleagues. Vaccaro (2010) also argued that women with multiple identities, such as ethnicity and sex, commonly experience both sexism and racism. This dual encounter with racism and sexism is also consistent with Crenshaw's (1988) theory of intersectionality.

Bush's (2013) participants discussed specific experiences with intersectionality. For example, one of her engineers expressed, "...the company and people were more comfortable putting me in the female box gender box and totally ignoring the fact that I have this ethnicity barrier as well." The women I interviewed has similar responses

regarding intersectionality. For example, when discussing how White women can help support African American women in engineering, Rebecca stated: “They can acknowledge the fact that as women of color, our race also plays a role. It is not something that can be separated for us, unfortunately.”

Lack of awareness and understanding also emerged as one of the contributors to STT. The persisters described how other students and professors did not understand what it was like to be an African American woman in engineering. Many of them described how students made racially insensitive comments regarding the existence of organizations such as the National Society of Black engineers. This finding is consistent with the CRT tenant centrality of racism (Bell, 1992, 1995; Lawrence, 1995). Ladson-Billings (1998) asserted, “Because racism is so enmeshed in the fabric of our social order, it appears both normal and natural to people in this country” (p. 11). Delgado and Stefancic (2000) argued that racism is so deeply ingrained in the cultural landscape of America that it looks ordinary and natural.

The African American women in this study described several strategies they used to help them persist in engineering. The importance of a strong support system emerged as an important tool for helping them persist. Findings from Bush (2013), Frillman (2011), and E.O. McGee (2009) also revealed the critical role a strong support system played in the persistence of African American females in engineering. The women in Bush’s (2013) investigation identified their mothers as role models who demonstrated great inner strength and courage. Many of the persisters in this study also detailed the critical role their mother’s played in their decisions to become engineers as well as their grit to earn their degrees. This finding is consistent with Beishline (2008) who found

positive parental support influenced students' decisions to pursue engineering degree programs and mothers were more influential than fathers.

In addition to strong familial support, encouragement from other African Americans on campus, including students and staff, also proved to be effective in helping the women in this study persist. This finding is consistent with a response from one of Frillman's (2011) participants: "I have a support group on campus. We mentor each other. If we didn't, it would be hard to get through engineering without a support system." Rebecca, a participant I interviewed, made a similar comment, "As Black women, being the minority of the minority, we need a strong support system." E.O. McGee (2009) described how students who exhibited a robust form of resilience "frequently chose people, spaces, and places that they felt the most comfortable around and who had similar goals for success" (p. 129). Participants in her study surrounded themselves with others who enhanced their self-worth. They encircled themselves with other "self-defined" students and groups to help them maintain academic success and personal fulfillment (E.O. McGee, 2009, p. 129). According to E.O. McGee (2009):

Most respondents sought out individuals, networks, and ideologies that provided increased opportunities to pursue their mathematics and engineering goals. The majority of the respondents found or created spaces where their talents could be embraced, mentored, and acknowledged in ways that promoted and highlighted their racial identities. (p. 129)

The persisters I interviewed also described the importance of being around other African American students. They expressed that since the university did not provide adequate support, they created their own opportunities and spaces to serve each other.

The 10 African American women in this study described the importance of their faith in helping with their persistence. They spoke openly about the solace that their spiritual beliefs and practices provided. Attending religious services, prayer and meditation were the most cited spiritual practices the persisters described. Many of the women considered their church communities as extended families and additional support systems. This is consistent with an investigation conducted by Brodsky's (2000) on how Black, single mothers relied on their spiritual beliefs to deal with the pressures of raising kids on their own.

In 2011, E.O. McGee & Martin used data from E.O. McGee (2009) to further explore how racial stereotypes can potentially motivate African American students to strive for high achievement in mathematics and engineering. The researchers introduced the phenomenon, stereotype management, to explain the academic resilience of these students. They described stereotype management as “a tactical response to the ongoing presence of stereotype threat” (E.O. McGee & Martin, 2011, p. 1354). Based on their data analysis, the authors proposed at least three themes to explain how students manage stereotypes (Table 5-14). The three themes are closely related to specific categories within the tools for persisting theme that emerged from this study (Table 5-14).

As presented in the above, this study supports the literature regarding the specific strategies African American women, at various stages in their education and careers, employ to help them persist in engineering. The themes that emerged in this study are consistent with those presented in earlier works (Bush, 2013; Frillman, 2011; E.O. McGee, 2009; E.O. McGee & Martin, 2011).

Table 5-14 *Stereotype Management and Tools for Persisting Comparison*

Stereotype Management	Tools for Persisting
<ul style="list-style-type: none"> • Sense of Agency & Self-efficacy • Supportive Academic & Social Organizations • Family 	<ul style="list-style-type: none"> • Identity/Strong Sense of Self • Active involved with Black community on campus • Faith, family and community

This Study Extends the Literature

The literature is replete with examples demonstrating the negative impact that STT can have on task performance. However, “understanding of the range of potential responses to stereotype threat is limited” (Block et al., 2011, p. 573). Additionally, the majority of STT studies are laboratory experiments that use short-term academic tasks or tests with college populations. There is compelling evidence for the immediate detrimental effect of STT on performance. Yet, little is known about the long-term effects of STT. Unlike laboratory settings, educational and workplace environments “place few constraints on behavior, thus there is likely to be a wide range of responses to stereotype threat” (Block et al., 2011, p. 573).

Shapiro and Neuberg (2007) stressed, “There has been relatively little explicit exploration of the coping and compensatory strategies individuals spontaneously employ in response to experiences of stereotype threat” (p. 121). Block et al. (2011) contended,

“We also need to know more about when and under what conditions these various reactions to stereotype threat will occur” (p. 74). This study adds to the literature by revealing how 10 African American women responded to STT and the strategies they utilized to resist or combat it and persist in engineering education. Specifically, this study validates and expands the model proposed by Block et al. (2011). They offered a three-phase model to better understand the long-term impact of STT beyond laboratory settings. They posited that in settings such as work environments in which individuals may continuously experience STT, there are three primary responses to this phenomenon (Block et al., 2011):

1. fending off the stereotype
2. discouraged by the stereotype
3. resilient to the stereotype

The authors suggested that in each of these response phases, individuals employ specific strategies in an effort to offset the negative consequences of STT (Block et al., 2011). Individuals in “*fending off the stereotype*” phase work vigorously to demonstrate that the stereotype does not apply to them. These individuals are overachievers who strive for perfection on the job. Block et al. (2011) contended that individuals in the “*discouraged by stereotypes*” phase are likely to become angry and withdraw, psychologically or behaviorally, from their work. There are consequences for individuals who engage in the strategies presented in the first two phases, including decreased performance and reduced motivation (Block et al., 2011).

The authors assert that individuals in the “*resilient to stereotype*” phase are likely to strive to change the environment to improve the working conditions for their social

group. However, they confessed that “less research that has been conducted on the resilience strategies than either the fending off the stereotype or the discouraged by the stereotype strategies” (Block et al., 2011, p. 583). The findings from this study add to the limited research regarding the resilience strategies employed by those who have experienced long-term exposure to stereotype threat.

Based on data analysis, the 10 African American women in this study clearly demonstrated characteristics that place them in “*resilient to stereotype*” phase. Although this work investigated educational settings and not workplace environments, the conditions are similar. They are both “real-world” settings in which participants were “stereotyped threatened” over an extended period of time. Thus, application of this model to explain the participants’ response to STT in engineering education is appropriate.

As proposed by Block et al. (2000), individuals who respond to STT with resilience are motivated to change the environment so that it is more welcoming to their group. The participants of this study discussed how their desire to serve as role models and inspire aspiring engineers helped with their persistence. They viewed themselves as change agents who desired to increase the presence of African American women in engineering. Their active involvement with the Black community on campus was a tool they employed to engage and support other African American women. Serving on the executive boards of student organizations including, NSBE, Black Women Associations and Black Student Unions, presented them with opportunities to recommend suggestions to college administrators on how the engineering climate could be improved. For example, Rebecca detailed an example of how she and her peers tried to work with administrators to help them improve diversity on campus:

At [TII], the matriculation rate of Black students is only 6%. When I was co-chair of our Black Student Union, we came up with a plan to create a campus preview weekend for Black students who have been accepted to [TII]. We drafted a plan detailing how we would contribute. We sat down and had a meeting with the associate director for diversity and recruitment. He seemed really receptive. A few weeks later, we reached out to him because we never heard back. We asked, “Can we do this?” He said, “There is no money.”

Although the program was not immediately implemented, it later became a huge success.

She shared:

Our alumni, who have a lot of power and a lot of say in what the institution does, told them, “You guys cannot maintain this rate. You cannot allow this to happen one more year.” A few months later, the admissions office reached out to the Black Student Union. We put the program in place. In one year, the percentage of Black students matriculating increased from 6% to 11% because of that program. This is an example of administrators not listening to us in the first place. We could have fixed the problem earlier if they had just listened. When they got pressured by alumni, they decided to reach out to us.

Participants’ desire to improve diversity on campus was also revealed when they discussed their motivation for serving as student ambassadors for the college of engineering and attending recruitment events. They expressed their hopes of encouraging potential African American students to select their departments.

The participants also provided suggestions on how White women and African American men can serve as allies to African American women in engineering. For example, Sara asserted:

I think people are so ashamed of privilege. They just don't want to admit it. White women should be more receptive when we voice our experiences and our pain. I feel there is this defensive wall. "Oh another Black girl playing the race card." That kind of response is so unhealthy. It is so genius for the majority. It invalidates our emotions. It invalidates our opinions and forces us to confront the stereotype of the angry Black woman. How useful has that angry Black woman excuse become for the majority to invalidate us and our feelings?

Sara candidly expressed how the engineering climate can be improved for African American women if those who are privileged are more willing to listen and not minimize their experiences.

The participants' desire to transform the engineering climate so that it is more welcoming to African American women was also demonstrated when they discussed the potential impact of a required seminar course. They described the benefits of a course designed to inform engineering students about issues such as stereotype threat and microaggressions. For example Rebecca shared:

Even if it [seminar course] was for students of color only, I honestly think it will be a good place for them to not only put words to what they are going through, but to understand that they are not alone. For students who aren't of color, I think it would help them become aware that there is really something traumatic that people of color go through when they come into environments that are

predominantly White. Maybe there aren't ways that they can alleviate the issues we face, but there are definitely ways for them to stop doing things that are damaging to us.

According to Block et al. (2011):

One strategy for changing the work context so that it is more inclusive for others who share one's identity is to educate members of the dominant group about the stereotypes that they hold and the impact of these stereotypes on behavior. (p.583)

Rebecca's comment, along with discussions with the other persisters, support this strategy described by Block et al. (2011).

Responding to STT with resilience is consistent with the CRT theme critique of liberalism (Crenshaw, 1988). One of the liberal ideologies that critical race theorists critique is the incremental change discourse which strives for equality rather than equity (DeCuir & Dixon, 2004). When equality is pursued, the ideologies that justify inequity are not adequately addressed and dismantled (DeCuir & Dixon, 2004). According to DeCuir and Dixon (2004), solutions grounded in equity takes into consideration the different racial experiences of people of color and acknowledge that the playing field is unequal and strives to address the inequality. The 10 African American women in this study described their desire to help transform the culture of engineering education to be more inclusive and accepting of African American women. They described how the intersectionality of their race and gender presented them with unique challenges that neither African American men nor White women encountered. In response to STT, these persisters implemented strategies that afforded immediate benefits, opposed to long-term incremental changes. Forming support groups and striving to increase the number of

African American women in engineering degree programs were common strategies they employed. They acknowledged the equal representation in engineering was a utopia that would take many years to manifest. They also understood that having more African American engineering professors was an ambitious goal that could not be accomplished immediately. However, they argued that engineering colleges could implement changes offering immediate benefits. Teaching students about STT, professors being more cognizant of how groups are formed and highlighting the success of African American engineers were a few of the short-term strategies they discussed.

The participants also supported the critique of the liberal ideology of colorblindness. They shared how the colorblind mentality was ineffective and actually ignited STT because it ignored a major part of their identity. The women in this study responded to STT with resilience by embracing both their gender and ethnicity. Having a strong identity and sense of self actually served to help this women overcome STT and persist.

Recent studies have investigated how African American women have persisted in engineering. This is the first of its kind to study specifically how persisters resist or overcome stereotype threat. However, the similarities between the findings from previous studies and the discoveries from this investigation are evident. In order to persist, African American women rely on their determination, support from other Black students, and their desire to serve as role models. This study extends the literature by supporting a model that suggests how those who respond to STT with resilience accept that stereotypes exist and will affect how others judge them. The model suggests that these individuals do not become discouraged. Instead they redirect their energy toward the goal

of changing the environment so that it is inclusive of members of their identity group (Block et al., 2011). They are “likely to employ group-focused coping strategies, such as trying to improve the treatment of their group’ (Block et al., 2011, p. 583).

The ultimate goal of this study was to share the journey of African American women while they were at beginning of their quest to become successful engineers. Although these women encountered “kinks,” they were not “broken.” They were optimistic and their stories were inspiring. This study exposed some of the small “cracks” that have not caused major breaks in the foundation. However, the foundation that these women stand on must remain strong in order to build and maintain pipelines to ensure not only their entrance into engineering degree programs, but also their successful exits. The longer we wait to hear their authentic voices, the more likely temporary fractures will become permanent breaks. The more negative pressure that is “applied” and the longer they must sustain it, the less likely African American women who are improperly supported will persist in engineering.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE RESEARCH

In this final chapter, conclusions, recommendations, and areas for future research are presented.

Conclusions

This study captured the voice of 10 African American women who have persisted in engineering degree programs. The following conclusions are based on personal and candid discussions with these women.

- All African American women who were a part of this study had experienced STT. They expressed how they often felt alienated/isolated in engineering environments. They also discussed a constant need to prove themselves. These two factors caused the women to question their belongingness in engineering degree programs.
- Data analysis revealed three primary contributors to STT. Professors' and other students' lack of awareness of the issues African American women face in engineering was a major contributor. Microaggressions and uncaring/discouraging professors also ignited STT.
- Group dynamics was a major issue all 10 participants discussed. They shared how being the last person to be picked for group projects or not being picked at all triggered STT. They described how their knowledge

was constantly questioned and how they were typically assigned administrative roles when completing group assignments.

- Many of the participants also candidly shared their struggles with health issues including depression and severe anxiety brought on by constantly having to contend with STT.

- All 10 African American women in this study described “tools” that helped them to persist in engineering despite experiencing STT.

Embracing their identity as African American women was a prevalent theme. They also discussed how they were passionate about engineering and committed to earning their degrees. The support of family and friends and the desire to give back were other “tools” that help them to persist. A strong faith and an active involvement with the Black community on campus were additional “tools.”

Recommendations

The five recommendations described below stem from suggestions provided by the 10 participants. Four of the five recommendations are very useful for professors and administrators. The final recommendation is pertinent for those individuals responsible for developing outreach programs to expose and engage young African American girls in engineering.

Recommendation One: Encourage mentorship and have measures in place to ensure African American female students have access to appropriate mentors.

In 1997, the National Academy of Sciences (National Academy of Sciences 1997) released a report revealing that many in academia consider a student's faculty advisor as a mentor. Researchers assert that students may find it difficult to develop a close relationship with faculty advisors (Fish, 1993; Olson & Ashton-Jones, 1992). Instead, many might look to others to serve as a mentor; including a fellow student, another faculty member, a friend, or someone from industry with the right kind of experience who can offer continuing guidance and support. According to Fisher and Margolis (2002), over twenty years of research documents the importance of emotional support, particularly for women and minority students, in the hostile engineering climate.

The first recommendation is based on participants' discussion of the meaningful role mentors played in their persistence. There is an extensive inventory of studies highlighting the benefits of exposing stigmatized groups to positive role models as a means to offset STT (Aronson et al., 2009; Cohen et al., 1999; Cole & Barber, 2003; Marx & Roman, 2002; Marx et al., 2009; McIntyre et al., 2003; Stout et al., 2011). According to Mueller (2004):

A mentor should have enough technical expertise and career experience to be able to give specific feedback on performance-related questions (e.g. resume for internships, successful project presentations). Mentors also offer ongoing emotional and moral encouragement and therefore should be good listeners.

Based on research, a mentor typically takes on at least the 3 different roles: (a) instructional; (b) psychosocial; and (c) role modelling (Clutterbuck, 2000; Ensher, Heun, & Blanchard, 2003).

The persisters in this study also discussed the importance of a mentor having the same race and/or gender. Miriam shared:

I think race is important. I feel someone of the same race can relate a lot more to what I am experiencing in the classroom, especially if they are engineers. They probably struggled in the same ways that I am. My advisor in my department is a minority female. She is not Black. I feel I can talk to my African American male mentor, who is a Chemical Engineering Professor, about things that I cannot discuss with her.

Several women also shared that having a mentor close in age was helpful. For example, Ursula asserted:

I think that any commonality helps. If you have only one mentor, I think it is important that they are close to you in age. I prefer a mentor who is either Black or female. I think there needs to be something that I can relate to. My primary mentor is an engineering graduate student. He is African American and only 25. However, he has more experience and more authority than I do. I think it helps to have someone who has recently experienced what you are currently going through, especially someone in the same program at the same school. I really think it is important that you have at least one thing in common.

Being relatable, supportive, and encouraging also proved to be critical traits for a mentor to possess. Experience of the mentor also mattered. Similar life experiences, particularly,

those of other minorities fostered better mentoring relationships. Mentors with industry experience or experience as an engineering student helped to build trust. Participants valued the advice of those who have walked the path they are currently traveling. Mary explained:

It depends on what the mentorship is for. For some things, I say yes. I would prefer one that is the same race and/or gender. I also prefer a mentor to be in engineering and in the same industry I am interested in pursuing. They can give me real advice. For certain things, it doesn't matter. One of my mentors is a white male. He taught at [Coleman]. He was very honest. When I went to his office, he would say, "Honestly. You are about to fail if you don't do this." He also shared his life experience. I think you need people of different ethnicities and genders to diversify your experiences and to tell you things someone else may not.

Engineering colleges should strive to ensure that their African American female students have access to supportive and encouraging mentors. Upper level engineering students are a great resource. For example, Rebecca shared:

I started out my undergraduate career not thinking I had mentors. It was really because my mentors were fellow students. I think I had this concept in my head that a mentor had to be a faculty member or an adult. I had so many student mentors. Literally from the moment I stepped on campus, they told me, "These are the student groups you need to join. You need to live in this dorm." They invited me to different events on campus. They told me about different classes I should take and which ones I should avoid. I started to understand that they were really looking out for me. They knew that during their time at [TII], there were

things that they did wrong and wanted to make sure others would not make the same mistakes.

Also, there should be adequate measures in place to help any African American professors in the college connect with African American female students. Several participants shared that their colleges hosted regularly scheduled networking dinners for faculty and students of color. These events proved to be successful in fostering communication and providing role models/mentors for students.

Engineering administrators should be open to the idea that African Americans and specifically African American women outside the college can serve as very effective mentors to their African American female students. On most college campuses, these individuals can be found in admissions, financial aid, or bursar's offices in great numbers. Reaching out to other departments across the campus to find potential mentors for their African American female students is highly encouraged. Rebecca offered:

When I worked for the admissions office, my direct supervisor became a mentor. She was a Latina. She was only a few years older than me. I felt like we were able to communicate more because we were so close in age. She was a great mentor for me. Also, our dean for the office of minority education was a very welcoming person. She took time out of her busy schedule to get to know the students. In our student activity office, the director of multicultural programs was an amazing person who also became one of my mentors.

Developing relationships with African American engineers employed at local companies is a great way to expose African American female students to mentors in the industry.

Industry mentors can increase students' awareness of career opportunities. Mentors from

industry can offer unbiased feedback and advice regarding academic performance and career choices because they are not the mentees' academic advisors (Mueller, 2004). Researchers assert that industry mentors are particularly important for undergraduate students who tend to drop out of engineering during the first 2 years (Seymour and Hewitt, 1997; Wulf and Fisher, 2002). They provide a perspective in which mentees can explore and visualize future career options.

Recommendation Two: Promote the importance of seeking academic assistance and create conditions so that African American women feel secured enough to ask for help.

There are three primary ideas that professors and college administrators must take into account in order to implement this recommendation effectively. These key concepts are: (a) awareness; (b) encouragement; and (c) teaching.

First, college administrators should consider requiring all faculty and staff to take the IAT. IAT is an abbreviation for Implicit-Association Test. It is a "tool" used in social psychology to measure a person's unconscious associations and beliefs that can play a role in biases and prejudices (Greenwald, McGhee, & Schwartz, 1998). This measure can enlighten professors of any implicit biases or prejudices that can negatively impact their interactions with African American female engineering students. Sara offered:

There were environments where there were different jokes. There was an undertone of how the professor communicated that bothered me. I couldn't put my finger on it. I think it is those nonverbal things that people do to make people

feel uncomfortable or not included. People need to be very aware of those nonverbal cues.

She further stated:

This is a concrete piece of advice. I wish that every professor was required to take the IAT to be aware of their biases. Especially in engineering where most of the professors are White men. I feel that no matter what, people are going to have biases. I believe some professors vehemently deny having biases. But everyone does have them because we are human. It would be cool to have my professor say I have taken the IAT and I am aware that I have these biases.

Professors also need to be more aware of nonverbal cues they communicate to students who are experiencing STT. There are nonverbal cues that suggest that a professor lacks the care and support that all participants confessed to wanting. These cues include not looking at African American female students when they are lecturing. Eye-contact is a sign of acknowledgement. Feeling unacknowledged added to the feelings of alienation the persisters described.

Just as persisters encouraged students to ask for help, professors should learn to do the same. A professor can directly ask an African American female student what he or she can do to make her feel more included in the classroom. Although some may find this to be problematic, Shirley offered, "I hate when people get singled out in public. But I think professors should pay extra attention to the women and people of color in their classes." Paying extra attention may help professors better understand the role they can play in easing STT with these students.

Encouraging African American female students is the second idea that engineering professors must be willing to adopt. A professor simply affirming an African American female student's ability can help her believe in herself more. Professors must also realize that sometimes not encouraging a student is the same as discouraging her. Ursula offered, "Sometimes people experiencing stereotype threat, like African American women, feel like they do not belong. If there is anything a professor can do to make us feel that we deserve to be there, I think that would be very beneficial."

The third concept that professors must embrace is effective teaching strategies. These strategies include: (a) forming groups properly; (b) using diverse examples, and (c) setting "ground rules" for expected classroom behavior. Jewel is a recent college graduate who earned a Biological Engineering Degree. Her experience in engineering led her to abandon the profession. However, she had very meaningful advice to address each of the above teaching strategies. First she offered:

Professors need to be more aware of the social dynamics that goes on in class.

Don't be hands off about study groups and partnerships. If you notice that the Black students are pairing up every time, it may be because all the other students are avoiding them. Change up the dynamics.

She also affirmed, "I would tell engineering professors to include more diversity in their examples." Lastly, Jewel proposed, "On the first day of class, a professor should state that his or her classroom is a respectable environment and that anyone doing or saying things to offend other students is unacceptable."

Recommendation Three: Provide resources, including “safe” meeting spaces for African American female students to form student groups in which they can support and encourage each other.

Throughout the interviews, participants shared the importance of African American women supporting and encouraging each other. Many of them were actively involved in organizations that catered to the needs of African American women. They also stressed that societies opened to female engineering students, such as the Society of Women Engineers (SWE), were not welcoming to them. Mary shared, “In our SWE chapter, there are almost no Black women. There are White and Asian women. I wanted to get involved. I went to a meeting. I felt like people were looking at me wondering, ‘Why are you here?’” Although persisters were less inclined to be involved with SWE, they were very active with organizations that tailored specifically to their needs as African American women.

It is imperative that African American women have a community that not only supports them, but reminds them that they are intelligent enough to be engineers. At the same time, they need to be reminded that the struggles they are experiencing are not unique. If colleges do not have systems in place to nurture relationships between African American women, these students must take it on themselves to do it. Rebecca asserted, “As Black women, being the minority of the minority, we need support systems. The college is not going to do it adequately for us. We must do it ourselves. We know ourselves. We need something for ourselves.” “Safe” environments include those in which African American women feel welcomed and accepted. Such environments may

need to be located outside the college of engineering. A possible location on campus is a multicultural center.

Recommendation Four: Host networking socials to foster relationships between African American women and other students in the engineering college.

African American women are typically the most isolated group of students on a college campus (Brown, 2004). In engineering, this isolation is magnified because of their limited representation. These students need allies while they are pursuing their engineering degrees. Shirley was the first participant to mention the importance of allies. She candidly shared: “I think Black women should have more allies in Science and Engineering. Not only White women and Black men. For some reason, Black women are always left out.”

Based on the persisters’ responses, other students can serve as allies to support and encourage African American women in engineering. Even though many participants considered having allies as an impactful strategy to enhance their persistence, they admitted that they lacked the networking skills to form relationships with their peers. There are limited opportunities for students to get to know each other in class. However, regularly scheduled networking events can allow students to meet in a relaxed environment.

Ideally, networking socials should take place at least once a semester. They should include coordinated activities to encourage students to meet others with whom they may not ordinarily socialize. These socials can afford African American women opportunities to get to know their peers. Such events offer a means for all students to

build bonds and better understand each other. Majority students can realize that African American women are not nearly as “angry” as they may have thought. They can get to know these women personally and not rely on the stereotypical images of them portrayed in the media.

Recommendation Five: To inspire young African American girls to pursue engineering careers, teach them “real” engineering and avoid strategies that perpetuate stereotypes.

The persisters in this study shared how they became interested in engineering. Many credit their involvement in outreach programs, particularly STEM summer camps. They described how doing “hands-on” activities, such as taking a computer apart and programming robots initially ignited their interest in engineering.

There has been some debate regarding effective strategies to introduce young girls to engineering. One strategy is to teach them the science of make-up. Several participants expressed their aversion for this tactic. For example, Jewel asserted:

I think this will do more harm than inspire girls to pursue STEM. We should not perpetuate the stereotype that, “As a girl, make-up must be interesting to you.”

When you go to an engineering school that is not a reality. Strategies need to be more realistic about what engineering is.

Euphemia had similar remarks:

All girls don’t like makeup. You don’t have to break it down so that it fits girly things. Maybe girls like video games. Teach them how these games work. That

will teach computer science. The make-up strategy is a sexist way to teach chemistry. It contributes to the stereotypes.

Rebecca vehemently opposed the idea:

No to the make-up idea. If someone did that to me when I was a little girl, I would have just stared at them for like three seconds and then walked out. I hate makeup. I was one of those girls who wanted to take things apart, figure out how to put them back together and see if they work.

Recommendation five is grounded in the participants' responses to how they would advise young African American girls interested in pursuing engineering. Their sentiments on the effectiveness of engaging girls in STEM via the '*Science of Make-up*' also contributed to this recommendation. To create a pathway to help diversify engineering by inspiring young African American girls to pursue engineering careers, program administrators need to ensure that these young girls are exposed to "real" engineering. Also, strategies that perpetuate stereotypes should be avoided.

Areas for Further Research

This study provided insight into how African American women victimized by STT resisted or overcame the phenomenon and persisted in engineering degree programs. To further investigate the findings from this study, there are several suggestions for areas of further research:

- More research on African American women in engineering education is recommended.

- Including students at the beginning of their engineering education will allow engineering degree programs to “catch” students early. Intervention strategies can be implemented and hopefully prevent students from transferring out of engineering because of STT.
- Including African American women in graduate school may expose additional issues with STT that they do not encounter as undergraduates. Additional tools for persistence may also be exposed.
- Research on the intersectionality of ethnicity and sex with other minority populations in engineering education is also necessary.
- Investigating how STT impact African American males and males from other populations underrepresented in engineering is recommended.
- Studies designed to investigate how STT effect African American in other STEM disciplines, and fields outside of STEM are also suggested.
- Studies designed to investigate the impact of STT on African American women outside of STEM. Specific studies designed to examine how STT may effect African American women’s dating, marriage and family lives are encouraged.

Final Remarks

After spending 5 years pursuing a PhD, I abandoned graduate school during my final year of study. With no doctoral degree in hand, I felt defeated. I had given up on myself. I failed to reach my fullest potential. Why did I make such a drastic decision? Was I just too lazy to complete the degree? No. I was devoted to working ridiculously

long hours, which included late nights, early mornings, weekends and holidays. Moreover, I expended an enormous amount of time and energy researching the literature, designing and building equipment, performing experiments, collecting data, and analyzing results. I also meticulously prepared a one-hundred and fifty page proposal that described my research plans. Was I academically incapable? No. I successfully passed rigorous written and oral exams that tested my academic knowledge. Maybe I just did not like what I was doing? Again, this was not the case. I enjoyed the scientific and engineering design challenges I encountered in the laboratory. Moreover, I greatly appreciated the overall atmosphere of a college campus. There really seemed to be no logical explanation to explain why I made this life-altering decision.

Twelve years after walking away from my pursuit of a doctoral degree in materials science and engineering, I returned to graduate school with the hopes of finally completing what I started. As a graduate student in Engineering Education, I was introduced to stereotype threat while writing a paper on the status of women in engineering. After learning about this phenomenon, I was convinced that it greatly impacted my earlier decision to abandon graduate school. As an African American female, I am constantly bombarded with an abundance of negative stereotypes. The media and popular culture present African American women as overly sexualized, overweight and ignorant. We are portrayed as promiscuous, single moms living in poverty and uneducated. We are not perceived as intelligent and hardworking. A Black woman with a PhD in engineering is an anomaly. I even questioned if, as a Black woman, I was capable of being an engineer. When I sat in classrooms surrounding by a sea of White male faces, I often asked myself, “Do, I belong here?” When I was one of few

women and often the only African American presenting at engineering conferences, I felt different and misunderstood. The expressions on the faces of my colleagues when I spoke said, “Who is that woman and what is she talking about?”

With this newfound knowledge, I was on a personal mission to better understand, if, like me, other African American women were victims of stereotype threat. I intended to reveal if there are there others who can serve as witnesses to my wounds. If data suggests this to be the case, are there effective intervention strategies to counter the detrimental impact of this phenomenon? Also, I wanted to know how African American women who may be victims of stereotype threat are persisting in spite of it.

Based on the personal and candid discussions I had with these 10 amazing African American women, it was evident that they indeed shared my struggles. This realization was both enlightening and disheartening. It was enlightening to know that I am not alone. However, it was disheartening to hear how others have had to face many of the challenges that led to me ultimately abandon a career path I had dreamt of traveling since the age of 12. Like these women, I am responding to STT with resilience. Inspired by their stories, I am on a mission to help change the culture of engineering. I dream of the day when engineering is more inclusive of people who look, speak and dress more like me.

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APPENDICES

APPENDIX A: Email to University Contacts

Dear [University Contact],

My name is Stacie Gregory. I am a Ph.D. student in Engineering Education at Utah State University. I am sending this message in an effort to assist you and your diversity initiatives at University X.

I am in the process of conducting a qualitative study to investigate the role that stereotype threat may have on the high attrition of African American females in engineering education.

In the spring of 2014, I conducted a pilot study with female undergraduates majoring in engineering. The findings from this study were compelling. I am now in the process of expanding my study. I am specifically seeking to interview African American females majoring in engineering. My goal is to learn more about stereotype threat and its role in the high attrition of African American females in engineering. My hope is to develop strategies to increase the retention of females in engineering.

I am reaching out to University X because I am well aware of its long and successful history of attracting some of the top African American students in engineering.

Please forward this email to all African American female students in your engineering program *and* those alumni who are no more than two years past earning their Bachelor's degree in an engineering discipline.

The research has been approved by the Institutional Review Board of Utah State University. A Letter of Information with more details about the study is attached to this email. Participants who complete the two interviews will receive a \$50 gift card. If you are interested, please contact me no later than Monday, November 3, 2014.

Interested students should contact me by email or phone. Due to the nature of the study, the number of participants will be limited to 10. Efforts will be made to include students from various disciplines and universities. The first 10 students to respond to this email will be given priority.

If you have any questions or concerns, please feel free to contact me directly.

Sincerely,

Stacie L. Gregory

APPENDIX B: Email to Potential Participants

Dear [Potential Participant]

Thank you for your willingness to serve and make a difference! This research aims to ascertain what ‘tools’ and ‘techniques’, as well as, personal characteristics have supported your journey in engineering. Your participation in this study will provide meaningful data that may assist other African American women persevere in engineering.

I would love to schedule an interview with you sometime within the next seven days. My schedule is very flexible. I am conducting interviews via Skype or telephone; whichever is most convenient or preferred by you.

I am attaching an informed consent for your review. Please read it carefully. If you have any questions or concerns, please do not hesitate to let me know. This study is completely voluntary and a coding system will be employed to ensure confidentiality. If you chose to complete the entire study, you will be awarded a \$50 American Express gift card

I am attaching several papers that I would love for you to browse through prior to our interview. They will give some details about stereotype threat. Please do not feel overwhelmed by the articles or spend too much time trying to read and digest them all. They are provided for you to browse and get an overview of stereotype threat. Browsing through any one of them is sufficient. My desire is to give you options.

Please send me three dates and times when you are available to chat with me for about an hour. If you prefer Skype, please send me your Skype ID. Also send a contact phone number if you prefer to conduct the interview via the phone. Actually, I would love a contact number regardless of your preferred method. Sometimes Skype fails and I have to use the phone as a back-up.

Again, I am grateful for your assistance and I look forward to talking to you in the very near future.

If you have any questions for concerns, please do not hesitate to call or send me an email. I can be reached by phone, anytime, at [###-###-####].

Thanks again!

Stacie

APPENDIX C: Interview 1 Questions

Background Questions:

1. What is your current status? (8th semester, etc.)
2. Where are you from? (State, City)
3. What is your engineering major/?
4. When did you decide you wanted to be an engineer?
5. How did you make the decision to choose engineering as a major?
6. Are there any engineers in your immediate family?

Stereotype Threat Questions:

7. Have you experienced stereotype threat in engineering classrooms? If so, how?
8. How would you describe the “climate” of engineering classrooms regarding its inclusion/acceptance of African American female students?
9. In your opinion, how is the “climate” of engineering different for you as African American female in engineering compared to white women? Black men?
10. How would you describe your overall experience as an African American female student in engineering?
11. Have you considered changing your major from engineering?
12. How does it make you feel if and when professors use only the pronoun “he”?
13. Can you think of any class experiences with professors and/or classmates where you did not experience stereotype threat? If yes, describe.
14. Have you had African American (male or female) engineering professors? If yes, was your experience in their courses different than with other professors? If so, how was it different? Please describe.
15. Have you had any female engineering professors? If yes, was your experience in their courses different than with other professors? If so, how was it different? Please describe.
16. Describe your ideal engineering classroom.
17. How important is it for a professor to call you by your first name? Why?
18. Do you feel empowered or afraid to ask questions in class? Why?
19. Do you feel comfortable going to office hours?
20. Do you feel pressure to prove yourself or prove that you belong in engineering? If yes, how so?
21. Are you involved with NSBE, SWE or other academic/outreach organizations on campus?
Why/Why not? If yes, do you believe that your involvement with these organizations is helping you persist in engineering?
22. Do you notice African American female engineering students isolating themselves from other African American female students in the program? If yes, why do you believe this occurs?
23. Do you believe that having an awareness of stereotype threat is harmful to you as an African American female engineering student? If yes, please explain.

24. Is there anything else that you would like to talk about regarding stereotype threat and your experience as an African American female student in engineering?

Advice Questions:

25. What advice would you give to those African American females who chose to isolate themselves from other female engineering students?
26. What advice would you give other African American female engineering students to help them resist or overcome STT and persist in engineering?
27. What advice would you give to engineering professors to assist their African American female students with their persistence?
28. What advice would you give to engineering administrators to assist African American female students persist in engineering?
29. What advice would you give young African American girls who aspire to become engineers?
30. A strategy to engage girls in STEM is to teach them the “science of make-up.” What are your thoughts about this strategy?

Next Steps: State the following to the participants

In an effort to better understand your overall experience as an African American female student in engineering, especially related to how you may or may not experience stereotype threat, I am requesting that read a short article and write a reflective essay. In the essay, please describe how the story did or did not resonate with you. If you can relate to the article in anyway, please give details on how and why? Please be specific.

Please submit your reading reaction to the email provided within the next two weeks. Once it is received, a schedule second interview will be scheduled.

APPENDIX D: Interview 2 Questions

1. Describe how you felt after reading the article. Did it resonate with you? If so, how?
2. Do you think reading the article was harmful to you in anyway? Please explain.
3. Do you think a seminar course that teaches engineering students about issues such STT, impostor syndrome and micro aggressions would be helpful? Please explain.
4. Have you experienced any health related issues because of STT? (Mental, physical, emotional?) Please explain.
5. Does faith play a role in your ability to persist? Please explain.
6. Does your family play a role in your ability to persist? Please explain.
7. Does your community play a role in your ability to persist? Please explain.
8. Do you believe SES play a role in a student's ability to persist in engineering? Please explain.
9. In what ways do you think white women can help African American women with our struggles in engineering?
10. In what ways do you think African American men can help African American women with our struggles in engineering?
11. Do you think African American women who attend HBCUs are immune from STT?
12. Do you have any final comments or questions?

APPENDIX E: Email to Participants Inviting them to Review Transcripts

I have completed transcribing our interview! Thanks again for your assistance. Your input is very valuable.

Based on my research approach, I believe participants should have a right to review transcripts. I ground my work in Black Feminist Theory and Critical Race Theory. These frameworks advocate for ensuring that the story of the "other" is told appropriately.

Therefore, I am attaching the transcript for your review. Please do not feel obligated to review it. ***I am making it available to you. However, I ask that you please do not share this with anyone. The data is not published and is for our eyes only.***

I transcribed the interview verbatim. I did, however, remove filler words such as like and um. I also summarized some parts of the conversations; particularly some of the things that I said. You will notice time stamps [ex. 23:31] throughout the transcript. These are markers for me to know where to go in the recorded interview to retrieve text.

If you chose to review the text, please make any comments or suggestions as you feel necessary. If there are personal topics that you would like to remain off record, please let me know. Also, if there are specific topics you would like to expound on, please do.

When I present this data, you will not be identifiable. Due to the similarity of the stories, you may not be able to identify yourself! However, if there are specific topics you are passionate about and want to make sure that I include as part of your story, please share. If there are direct quotes you would love for me to publish, please let me know.

Again, thanks for your service. It was honored hearing your inspiring story.

Stacie

CURRICULUM VITAE

Stacie LeSure Gregory

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EDUCATION

- 2013 – 2015 Doctorate of Philosophy in Engineering Education, Utah State University
Dissertation: “African American Female Engineering Students’ Persistence in Stereotype-threatening Environments: A Critical Race Theory Perspective”
 Advisor: Dr. V. Dean Adams
 GPA: 3.83
- 1994 – 1996 Master of Science in Materials Science & Engineering
 Georgia Institute of Technology
- 1990 - 1994 Bachelor of Science in Physics
 Spelman College

FELLOWSHIPS & AWARDS

Utah State University Martin Luther King Jr. Academic Scholarship
 NSF-GE/RAMP-UP Graduate Fellowship
 GEM Ph.D. Fellowship
 NSF Electron Materials Science & Engineering Fellowship
 Corebest (*Corning Incorporated*) Academic Scholarship
 General Motors Academic Scholarship
 Delta Sigma Theta Academic Scholarship

PUBLICATIONS

Gregory, S.L. (2014). Book Chapter: “*Wouldn’t take nothing for my journey now: from discouraged to resilient.*” An autoethnographic account of the trials and tribulations I have faced as an African American woman in engineering. In B. Polnick, B. Irby, & J. Ballenger. (Eds.). *Girls and women of color in STEM: Navigating the double bind*. Charlotte, NC: Information Age Publishing Inc.

CONFERENCE PRESENTATIONS AND POSTERS

Gregory, S.L. (2014). *African American Female Engineering Students’ Persistence in Stereotype -Threatening Environments: A Critical Race Perspective*. Poster presented at the 2014 Engineering Leaders for Grand Challenges Conference. Doha, Qatar.

Gregory, S.L. & Haley, C. (2014) Female Engineering Students' Experience with Stereotype Threat: A Narrative Inquiry. Poster presented at the ASEE Region IV Conference, Long Beach, CA.

Gregory, S.L., Becker, K., & Mentzer, N. (2013) *African American High School Students' Human-Centered Approach to Design*. Poster presented at ASEE National Conference, Indianapolis, IN.

RESEARCH EXPERIENCE

2014 *University of Washington, Pioneer Interviewer*
 Conducted interviews and created profiles of engineering education pioneers for the Center for Engineering Learning and Teaching (CELT) at the University of Washington (Project funded by NSF). The interviews were done via Skype and the audio files were transcribed and used to draft a profile of the engineering education pioneer. The objective of the project was to document and analyze the participants' contributions, influence, challenges, and successes in engineering education.

2013 - 2015 *Utah State University, Graduate Research Assistant*
Female Engineering Students' Experience with Stereotype Threat: A Narrative Inquiry. Data from semi-structured interviews and journal reflections was triangulated to capture how female engineering students experience stereotype threat. What meaning this stigmatized group construct of the events that trigger stereotype threat and situations that protect them from it were analyzed. How does a *Women in Engineering* course influence female students' engineering self-efficacy, interests in engineering, and perceptions of engineering?

Conducted research on using literacy and writing instruction to Enhance elementary students' engineering design thinking. This study examined how explicit literacy and writing instruction influenced elementary students' engineering design activity.

Conducted research on African American high school students' human-centered approach to design. A mixed-method approach was employed to assess African-American high school students' approach to open-ended design from a human-centered perspective.

2007 - 2009 *Louisiana State University, Graduate Research Assistant*.
 Synthesized and Characterized Ionic Liquid, Dual Property Nanomaterial
 Synthesized dual property ionic liquid nanoparticles using an in situ ion exchange emulsion preparation. Characterized nanoparticles using transmission electron microscopy and UV-Vis-near-IR scanning spectrometry.

- 2005 - 2007 *Oak Ridge National Laboratory, Research Engineer.*
Fabricated and Analyzed the Effects of Thermal Barrier Coatings Systems used to Protect Gas Turbine Engine Components. Fabricated (Ni,Pt)Al bond coatings using Chemical Vapor Deposition (CVD). Investigated the oxidation and degradation of state-of-the-art commercial thermal barrier coating (TBC) systems.
- 2003 - 2005 *Oak Ridge National Laboratory, Research Engineer.*
The influence of super alloy composition, bond coat surface preparation and exposure temperature on the thermo-mechanical degradation of TBC systems were evaluated using Scanning Electron Microscopy, Transmission Electron Microscopy, Auger Electron Spectroscopy, Electron Microprobe Analysis and X-Ray Diffraction.
- 1996 - 1998 *North Carolina State University, Graduate Research Assistant.*
Optimal Design of a High Pressure Organometallic Chemical Vapor Deposition Reactor. Used computer simulations as a fundamental design tool to develop a prototype High Pressure Organometallic Chemical Vapor Deposition (HPOMCVD) reactor for use in thin film crystal growth.
- 1996 *Oak Ridge National Laboratory, Research Engineer.*
Characterization of Thermally-Grown Surface Oxides Using Scanning Electron Microscopy. Analyzed and compared thermal oxide layers grown on polycrystalline and amorphous silicon films using scanning electron microscope (SEM) and ramp-voltage-stressed current-voltage measurements.

TEACHING EXPERIENCE

- 2014 *Utah State University, Teacher Assistant*
Engineering 1940: Women in Engineering. Created and taught lectures on social issues in engineering education including gender and racial biases, microaggressions, stereotype threat and impostor phenomenon. Developed and graded homework assignments and exam questions.
- 2003-2004 *North Carolina State University, STEM Outreach Coordinator*
Imhotep Academy Math/Science Enrichment Program Developed and taught hands-on activities to engage middle-school students in science and math.
- Fall 2003 *North Carolina State University, Teacher Assistant*
MSE 200L: Mechanical Properties of Materials Lab
Led laboratory demonstrations and graded lab reports.
- Fall 1994 *Morehouse College, Teacher Assistant*
Physics 253L: Electricity & Magnetism Lab

Led laboratory demonstrations and graded lab reports.

Spring 1993 *Morehouse College, Teacher Assistant*
 Physics 154L: Mechanics Lab
 Led laboratory demonstrations and graded lab reports.

PROFESSIONAL EXPERIENCE

2009 - 2012 HEaRT-SMaRT of Georgia, LLC., *STEM Outreach Director*

2001 - 2002 Pfeiffer Vacuum, Milpitas, *Applications Engineer*
 Semiconductor Manufacturing

1996 - 1998 ADE Optical Systems, *Applications Engineer*
 Semiconductor Manufacturing

1991 - 1995 Corning Incorporated, Corning, *Engineering Intern*
 Optics & Telecommunications

1989 - 1991 Allison Transmission, Indianapolis, *Engineering Co-op*
 Commercial Transmissions

SERVICE

2014 Review activities for American Society of Engineering Education

2014 Review Activities for Frontiers in Education

2014 *NSF Review Panelist*, Broadening Participation in Engineering

2013 NSF Ideas Lab Participant

2012 *NSF Review Panelist*, Research Experiences for Undergraduates

2011 Chairperson of a non-profit, community based organization

2010 Board Chair of a Charter School

2005 *NSF Review Panelist*, Research Experiences for Undergraduates GK 12

PROFESSIONAL MEMBERSHIPS

American Society of Electrical Engineers (ASEE)

Society of Women Engineers (SWEE)

National Society of Black Engineers (NSBE)