AN ANALYSIS OF STEREOTYPE THREAT IN AFRICAN AMERICAN ENGINEERING STUDENTS AT PREDOMINANTLY WHITE, ETHNICALLY DIVERSE, AND HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

A Dissertation

by

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ABSTRACT

AN ANALYSIS OF STEREOTYPE THREAT IN AFRICAN AMERICAN ENGINEERING STUDENTS AT PREDOMINANTLY WHITE, ETHNICALLY DIVERSE, AND HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

David Sparks
Texas A&M University-Commerce, May 2013

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The purpose of this research was to distinguish the similarities and differences in coping strategies of African American engineering students by analyzing their perceptions of stereotype threat at three academic institution types: Predominantly White Institutions (PWI), ethnically diverse, and Historically Black Colleges and Universities (HBCUs). The researcher collected demographic and survey data using the Stereotype Vulnerability Scale (SVS). The study was offered to the entire population of African American engineering students at each college using an online survey. Results were analyzed using MANOVA and Pearson’s correlational statistical analyses to test the hypotheses.

Findings revealed that few differences exist between students’ scores on an assessment of stereotype vulnerability, with a few areas showing that HBCUs and ethnically diverse universities are doing a similar job in addressing perceptions of their African American
engineering students. Finding also revealed that the percentage of African American students at a university did not correlate with the scores on the SVS accept on questions related to the personal feelings students have about their race. The strongest findings related to the differences in male and female students across the universities. African American female engineering students appeared to perceive more stereotype threat than did their male counterparts although this finding was not statistically significant. Overall, no statistically significant differences were found between students’ perceptions of stereotype threat at the three types of universities. Future research should expand the number of survey participants at the current universities, add more HBCUs to the study population, run similar experiments in different parts of the country, compare stereotype threat in private and elite universities, use ethnically diverse universities as models for minority student development, and use new or improved survey instruments that delineate race and gender stereotype threat as perceived by African American female STEM students.
ACKNOWLEDGEMENTS

This long voyage began in 2008. If you had asked me 10 years ago, I would not have believed anyone who told me I would finish my doctorate in the year 2013 at the age of 45. This has been a dream of mine since the early 1990s, and it is exciting to see it finally come to fruition.

I first want to thank my mom, Sherry Sparks, for encouraging and helping me during a very difficult time in my life. Her love and caring has made a great difference, especially in the last three years. I also want to thank Michele Anderson for her love and patience with me as I followed this dream. It really helps when someone believes in you and pushes you to fulfill your dreams. Her confidence in me kept me going when I doubted it would ever happen. I want to thank my brother, Jimmy Sparks, for encouraging me and giving me advice during the research process. I also want to thank my professors and advisors at Texas A&M University-Commerce who guided me through the entire process. I especially want to thank my son, Caleb, and my daughter, Mauri. They have seen the amount of time and effort it takes to accomplish a goal. I love them with a love that words cannot measure and I hope my example will help them know that it is all right to pursue their dreams. They are the joys of my life and my greatest creations. Finally, I want to thank God for giving me wisdom, patience, and strength to accomplish this goal, and for granting me the gift of life.
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Chapter 1

INTRODUCTION

The United States is undoubtedly one of the greatest countries in the free world, with economic prosperity and opportunities that are envied by many countries. Until the last few years, America’s dominance as a world power has been assumed unmatched. However, Americans are now threatened by forces from within and without. One of the greatest threats to the nation’s security is the lack of education of its citizens, especially in the areas of Science, Technology, Engineering, and Mathematics (STEM). The late 1950s saw concerns of Soviet domination by the Sputnik satellite and global innovation launched the United States into the scientific revolution of the 1960s. During this time, technical training led to many discoveries and ended by putting a man on the moon. Although there have been numerous accomplishments in science and technology, since Sputnik another revolution has not occurred, and the consequences could be devastating to the nation’s future competitiveness and innovation needed to secure a prosperous future. Specifically, experts believe that the United States is still not producing enough engineers, and some say that the current number of 65,000-75,000 new engineers each year needs to be 115,000-125,000 to fuel the U.S. economy (Frehill, Brandi, Di Fabrio, Keegan, & Hill, 2009). Women and students of color can greatly increase their income levels and social status by becoming involved in STEM fields of study and subsequent careers. Rosser (1995) explained it best:

The science and engineering professions typically offer high paying, stable positions, which should be particularly appealing in an economy where unemployment and poverty are increasing for both women and people of color. Attracting more men of color and women to the physical sciences, mathematics, and engineering would provide career
access for these individuals while filling the needs of the increasingly scientific and technological workforce. (p. 2)

Although universities and industries may be tempted to recruit science and engineering students from other countries, the United States has a potential storehouse of scientists in its public school system. This crop of future workers needs only to be cultivated, and includes not only the typical White males who dominate the STEM landscape, but also female and minority students. Chubin, May, and Babco (2005) explained:

STEM workers are overwhelmingly white, male, and disability-free, while the available pool of talented women, minorities, and persons with disabilities remains significantly underutilized. The current and projected need for STEM skills compels policies, programs, and resources that support greater participation by these groups in STEM education and careers. If a nation fails to prepare citizens from all population groups to participate in the technology-driven economy, we risk losing our economic and intellectual preeminence (p. 83).

If engineering truly has reached a critical mass of White men, the United States needs to do a better job of recruiting other groups, especially females and ethnic minorities. This need is important in times of both economic prosperity and deficit. Even during recessions, engineering jobs such as mechanical engineering are virtually recession-proof (Frehill et al., 2009).

Engineering is a broad field of study that includes many areas of science, mathematics, and technology. However, this field has a low representation of females and African American students at both the undergraduate and graduate levels. Prior to the present study, data were collected from the College of Engineering related to gender, ethnicity, and degree completion. Of note, data were available for public and targeted Texas A&M in College Station (main
campus). Based on these data, the percentage of white (non-Hispanic) female engineering graduates was 12% in 2009. Of all African American engineers who graduated, the percentage of African American female engineering graduates in 2009 was 0.63% while African American male engineering graduates comprised 1.51%. The 5-year averages for African American female and male engineering students were 0.81% and 1.09%, respectively. Six-year graduation completion rates for 2003-2008 by ethnicity were 55.7% White, 46.4% African-American, and 40.0% Hispanic (Office of Institutional Studies and Planning [OISP], 2010). Although some progress has been made in recruiting minorities and females into engineering, this country clearly has a long way to go.

The success and retention of African American students in engineering programs may be dependent on the climate to which they are exposed as well as their ability to withstand the stresses of being an underrepresented minority in a STEM field. Although there has been much research about African American students at both Historically Black Colleges and Universities (HBCUs) and Predominantly White Institutions (PWIs) (Aronson, Fried, & Good, 2002; Brown, Morning, & Watkins, 2005; Fries-Britt & Griffin, 2007; Hendricks, 1996), few studies have look at a third school designation, ethnically diverse. For the purposes of this research, PWIs has an African American population of 10% or less, an ethnically diverse university is one that had an African American population of between 11% and 20%, HBCUs included universities with an African American population of over 80%. This research focused on comparing the presence of stereotype vulnerability in students at PWIs, HBCUs, and ethnically diverse universities.

**Statement of the Problem**

A strong and competitive U.S. economy requires a new generation of innovative and creative students. Therefore, it is vital that colleges and universities recruit and train as many
engineers as possible including female, minority, and disabled students. A notable shortage of African American male and female engineering students exists in the United States (Frehill et al., 2009). A variety of factors may apply to the persistence of African American students in engineering majors; one important consideration is their perceptions of stereotype threat (Moore, Madison-Colmore, & Smith, 2003). The problem this quantitative study addressed was comparing the cognitive coping strategies, specifically how students respond to stereotype threat among African American engineering students at three types of universities.

**Purpose of the Study**

This research focused on the following two purposes:

1. Identify how African American engineering students cope with adversity as they approach graduation to understand how colleges and universities can retain African American students in engineering programs.

2. Distinguish the similarities and differences in coping strategies, specifically perceptions of stereotype threat, of African American engineering students in three different classifications of universities, PWIs, ethnically diverse institutions, and HBCUs.

**Research Questions**

The following research questions formed the basis for this investigation:

1. What are the perceptions of stereotype threat of African American engineering students enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?
2. Do differences exist in the perception of stereotype threat of African American students between or among those enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

3. Do relationships exist between the percentages of African American students and their perceptions of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

4. Do gender differences exist in the perception of stereotype threat within the African American engineering student population across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

**Hypotheses**

The researcher proposed three hypotheses to address the aim of the study and the research questions.

**Hypothesis 1**

**Ho₁.** No differences exist in the perception of stereotype threat of African American students between or among those enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Ha₁.** Differences exist in the perception of stereotype threat of African American students between or among those enrolled 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Hypothesis 2**

**Ho₂.** No relationships exist between the percentage of African American students and the perception of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.
Ha2. Relationships exist between the percentage of African American students and the perception of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

Hypothesis 3

Ho3. No gender differences exist in the perception of stereotype threat among African American engineering students across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

Ha3. Gender differences exist in the perception of stereotype threat among African American engineering students across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

Significance of the Study

Substantial increases in Hispanic and African American students entering engineering fields will be needed to keep up with the changing demographics of the United States over the next 20 years (Trenor, Yu, Waight, Zerda, & Sha, 2008). Therefore, research on what makes students successful in college is warranted, specifically in the area of STEM. McSherry (2005) noted the following four reasons why more females and minorities are needed in engineering fields:

There is a shortage of skilled workers. Society benefits from a more diverse engineering community. Businesses benefit from engaging women in research, design, and development…Engineering can be a rewarding lifetime career, which includes competitive salary, benefits, and job security. (para. 5)

Although there a number of ethnic groups (e.g., Hispanic, Asian, or Native American) and STEM fields (i.e., science, technology, engineering, and mathematics), this research analyzed
African American engineering students to determine whether successful students share similar perceptions of stereotype threat.

While working on a master’s level research project in 2005, this researcher became interested in the lack of women and minorities in engineering (Sparks, 2005). In this study, an informal survey was sent to members of the Society of Women Engineers as part of a quantitative and qualitative assessment concerning the lack of women in engineering. The sample was a group of professional female engineers aged 25-50 years. One survey question asked respondents what prompted them to consider a career in engineering. The top three answers indicated that respondents recognized their abilities in math and science, experienced support from parents or friends and had early successful experiences in math and science. Additionally, respondents considered these factors as being more important than income potential, challenging and supportive teachers, and advice of counselors and adults (Sparks, 2005).

The current research focused on male and female African American engineering students. However, Physics and Information Technology (IT) and Computer Science are other content areas that were not within the scope of this research. Physics and its lack of female students and professionals is another area of possible research; however, a paucity of studies were found that related to women in Physics. Ong (2005) explored how women change their behaviors and personalities socially to fit into the physics culture. Women of color have an especially low representation in Physics. Between 1995 and 2001, out of about 3,800 bachelor’s degrees awarded in Physics each year, only 56 (1.5%) were awarded to African American women (Ong, 2005). This number limits the potential research to qualitative investigations among a population that is extremely difficult to track.
Information Technology and Computer Science also have few female students and graduates. Simard (2008) showed that although African American women represent 7% of the U.S. population, they represent only 4.8% of the graduate student enrollment in Computer Science. Simard also found that 10.78% of Computer Science bachelor’s degrees were conferred to African American males and 4.37% to African American females in 2006. Margolis and Fisher (2002) looked at female Computer Science majors at Carnegie Mellon University. Of the 51 female Computer Science majors, only three were African American female students in their interviews. This finding demonstrates an extremely small sample to investigate, which also limits research to that of a qualitative nature. Therefore, this researcher did not focus on IT and Computer Science in the present study.

While there is a dearth of female engineering students in general, the low number of African American engineering students in particular, is also troubling. According to Frehill, Di Fabio and Hill (2008) and Perna et al. (2009), only 5.8% of all engineering majors are African American; of these students, 1.6% is female and 4.2% is male. Additionally, 36% of engineering degrees awarded to African American students were to females.

Data on student retention in engineering are also an area of concern. According to the National Center for Education Statistics (NCES, 2009a), White, African American, and Hispanic students enter STEM fields at 4-year institutions at similar rates. However, White STEM students exhibit a much higher 6-year graduation rate (43.9%) compared to African American (31.7%) and Hispanic (33.1%) (NCES, 2009a). More than two-thirds of all African American male students leave college before finishing their undergraduate degree (NCES, 2009a). This trend has not changed in a quarter of a century. However, Stephens (2010) gave some reason for hope. Using data from the Integrated Postsecondary Education Data System (IPEDS), he found
that 60% of public 4-year colleges and universities experienced improved minority graduation rates from 2002 to 2010. Heilbronner (2009) found that STEM students who believe in their ability to succeed were more likely to graduate. Mau (2003) tracked students from high school through college and found that confidence, academic proficiency, and math self-efficacy were important factors in students graduating in a timely manner. Variables that were not found to be important for persistence included parental expectations, school involvement, and the specific program of study chosen (Mau, 2003).

Climate and negative messages received by African American females in STEM careers may make college a difficult place to navigate (Seymour & Hewitt, 1997) given their double jeopardy or double consciousness status (Logel, Peach, & Spencer, 2012). However, Hanson (2004) found that African American females possess many characteristics that could make them successful in engineering. For example, African American females exhibit strong cultural beliefs about womanhood and family structure, have high self-esteem, are independent and assertive, and have high educational and occupational expectations. These characteristics are similar to those found among successful scientists, and may make better candidates for engineering majors compared to African American males or females from other ethnic groups (Hanson, 2004).

Despite these positive characteristics, African American females struggle in STEM majors because they do not fit the typical profile of successful STEM students. Students who are most likely to finish a STEM major include those who started their degree at a 4-year institution, attended school full-time rather than part-time, and initially enrolled in a bachelor’s degree program (NCES, 2009b). Therefore, students who come from diverse backgrounds may have different needs.
African American female engineering students also need ethnically similar role models and mentors in school and in the field, which is a problem as only 1% of the engineering faculty in the United States is African American females (Concannon & Barrow, 2009; Hill, Corbett, & St. Rose, 2009). Tate and Linn (2005) found that women of color have a naïve understanding of what takes place in the field of engineering and given little consideration to what being an engineer entails. These thoughts and perceptions could point to the reason why few women of color enter the field of engineering as freshmen. May and Chubin (2003) called for media to show more examples of successful African Americans in STEM careers to provide examples of role models for future minority STEM students.

Another factor to consider is the demographics of the institution. Rodgers and Summers (2008) showed that African American students at PWIs reported lower academic self-concept and lower achievement than did their counterparts at HBCUs. Rodgers and Summers found that addressing African American students’ coping skills could reduce stress and increase self-confidence. Some PWIs seem to be getting the message. For example, Georgia State University, the University of Wisconsin-Madison, and Western Oregon University have made success for minorities a primary focus by taking steps such as addressing high failure rates in introductory courses and introducing first-year learning communities, which have resulted in increases in the percentages of African American graduates over the last few years (Stephens, 2010).

Perna et al. (2009) found that HBCUs graduated 22% of all African American students nationwide, but only 30% of all bachelor’s degrees awarded to these students were in STEM fields. The data were even more profound for African American females; at HBCUs 33% of the bachelor’s degrees awarded to these females were for STEM majors (Perna et al., 2009).
Research on African American students who attend HBCUs has revealed that these students have higher grade point averages (GPA), more positive perceptions of campus climate, and higher academic self-efficacy and self-concept compared to African American students at PWIs (Cokley, 2000; May & Chubin, 2003). African American students who attend HBCUs also demonstrate less social isolation, alienation, personal dissatisfaction, and overt racism than do their counterparts who attend PWIs (Harper, Carini, Bridges, & Hayek, 2004).

One psychological barrier that students of color in all colleges face is stereotype threat. Steele (1997) defined stereotype threat as follows:

The event of a negative stereotype about a group to which one belongs becoming self-relevant, usually as a plausible interpretation for something one is doing, for an experience one is having, or for a situation one is in, that has relevance to one’s self-definition. (pp. 616-617)

African American students face negative stereotypes every day they attend college, which could be connected to their low graduation rates and low achievement compared to their White peers (Steele, 2011; Steele & Aronson, 1995; Walton & Cohen, 2007). Even though a number of studies point to less stereotype threat at HBCUs (Cokley, 2000; Harper et al., 2004; May & Chubin, 2003), more research is needed to determine whether this trend is true.

Not all studies draw the same conclusions about the difficulties that African American students face in engineering programs. Trenor et al. (2008) found no perceived stereotype threat and adequate institutional support among a group of African American engineering students at an ethnically diverse campus. To this researcher’s knowledge, the Trenor et al. (2008) study is the only one that has incorporated the designation of ethnically diverse university. Of note, their
research did not include HBCUs or PWIs (for a comparison of stereotype threat at HBCUs and PWIs see Dodson-Sims, 2005).

Researchers also need to determine factors that give students at HBCUs an advantage. Such research could encourage PWIs to learn from HBCUs in the way they form organizations and small groups that encourage students to study and socialize with their same-race peers (Rodgers, 2009). Perna et al. (2009) believed that all institutions must develop a peer culture that encourages the attainment of STEM degrees for male and female African American students. To accomplish this goal, colleges and universities must discover how they can help male and female students learn to cope with adversity and negative stereotypes. These skills could help increase the level of minority STEM-related professionals for years to come. Chubin et al. (2005) felt that all institutions could be minority serving, which might be the best way to diversify the engineering workforce in the United States.

It was the intention of this researcher that the findings lead to a greater understanding of the level of stereotype threat is perceived by male and female African American engineering students at universities with differing African American populations. The present findings may also increase the understanding of a third designation of university, ethnically diverse, which is lacking in existing research on stereotype threat. Considering these intentions, this research attempted to determine (1) whether there is a statistical difference in the stereotype threat experienced by students at different universities, (2) whether there is a correlation between the percentage of minority students at each type of school and their perceptions of stereotypes, and (3) whether there are differences in the way male and female African American students perceive stereotype threat.
Method of Procedure

Design of the Study

The purpose of this study was to determine the factors that contribute to success for African American male and female engineering students at three different types of universities (PWIs, ethnically diverse institutions, and HBCUs). The selected universities fit the parameters of their designation concerning African American student populations (i.e., 10% or less for PWIs, 11%-20% for ethnically diverse universities, and over 80% for HBCUs). Data on these characteristics were obtained from the College Results Online database (Education Trust, 2009). The NCES offers this database to the public and includes data provided by colleges as part of IPEDS. The researcher selected five universities located in Arkansas, Texas, and Louisiana.

After receiving Institutional Review Board (IRB) approval from Texas A&M University-Commerce, additional IRB approval was granted at the five selected universities. Following the approval process, an initial inquiry letter was sent to the engineering departments of all five universities requesting that the online survey be distributed to their African American engineering students. The online surveys were distributed in the Spring 2012 and Fall 2012 semesters. Engineering department advisors distributed the surveys via email mailing lists and through members of their local chapter of the National Society of Black Engineers (NSBE).

The survey included a short demographics section (see Appendix B) and the Stereotype Vulnerability Scale (SVS; see Appendix A). The survey was filled out completely online via a link provided to participants in the email correspondence that was distributed by each university. If students agreed to participate after reading the informed consent, they were directed to a link for the survey. After completing the survey, students were thanked for their participation. All results were compiled using Free Online Surveys, an online survey creator and database, and
statistics were stored in a database on the website. The survey was offered to all African American engineering students at the five selected campuses. The selected universities included two PWIs, two ethnically diverse universities, and one HBCU.

This study was designated as a quantitative investigation. To measure the perception of stereotype threat, a modification of the SVS was administered (Spencer, Steele, & Quinn, 1999). Barnard, Burley, Olivarez, and Crooks (2008) used the SVS and showed an internal consistency of $\alpha = .60$ and, when administered with a specific domain (i.e., mathematics), the SVS revealed an internal consistency of $\alpha = .82$. Although the researchers did not use the scale specifically with African American students, they did use a group of minority students to test the validity of the instrument. The instrument was also used in a study to test stereotype threat in the female population, which was relevant to the current study. The SVS includes eight items with a Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. Participants also filled out a standard demographic form that asked for information such as age, sex, and classification (public vs. public). Because the overall population of African American male and female engineers is low, a convenience sample of students who agreed to participate was used.

**Treatment of the Data**

Of students who were offered the survey, 48 returned completed surveys. All students were African American (38 male and 10 female), and 17 students were from the PWIs, 20 from ethnically diverse universities, and 11 from HBCUs. Demographic analysis showed that the average age of participants was 21 years. Respondents included 13% freshman, 27% sophomore, 33% junior, and 27% senior. All universities were designated as public universities. The average percentage of African American students at the selected universities was 4.0% at PWIs, 18% at ethnically diverse universities, and 96.8% at HBCUs.
Analysis of the Data

For the quantitative portion of the study, statistical analyses were conducted using SPSS software and a level of significant of $\alpha = .05$. The hypothesis that no significant difference exists between African American engineering students at the universities in terms of stereotype threat was tested using a 3X2 Multivariate Analysis of Variance (MANOVA) (Trochim, 2006). A similar analysis was conducted with male and female participants across the three universities to determine whether there were significant gender differences in the scores on the SVS. A Pearson’s one-tailed bivariate correlational analysis was conducted to compare the scores on the SVS to the percentage of African American students at PWIs, ethnically diverse universities, and HBCUs. The SVS used a Likert rating scale and data were classified as ordinal numbers. Although there is some debate on the applicability of using ordinal data for MANOVA analysis, this test was justified in this study for the purposes of making comparisons because the scores were not considered equally important or rigid in their scale values (Velleman & Wilkinson, 1993).

Definitions of Terms

The following provides definitions of keywords used in this study.

**Self-efficacy.** This term refers to the perceived ability to perform a specific task (Bandura, 1997). The type of self-efficacy depends on the task and differs from self-concept or self-esteem.

**Stereotype threat.** Stereotype threat refers to the threat of being evaluated, judged by, or treated in terms of a negative stereotype, which can cause individuals to perform worse in a domain where negative stereotypes exist about a group (Singletary, Ruggs, Hebl, & Davies, 2009).
**Predominantly White universities (PWIs).** For the purposes of this study, the researcher decided that PWIs would be those with an African American population of 10% or less.

**Ethnically diverse universities.** For the purposes of this study, the researcher decided that ethnically diverse universities would include those with an African American population of between 11% and 20%.

**Historically Black Colleges and Universities (HBCUs).** For the purposes of this study, the researcher decided that HBCUs would include those with an African American population of more than 80%.

**Retention.** For the purpose of this study, retention refers to the number of students who stay in a college degree program (i.e., not changing majors or dropping out of an engineering major).

**Persistence.** For the purpose of this study, persistence refers to making meaningful progress toward graduation (i.e., graduating with a Bachelor’s degree in no less than six years).

**Limitations**

The following limitations were considered in this study:

1. The study was limited by the level of participation of engineering students.
2. The study was limited by the relatively small number of African American engineering students in PWIs and ethnically diverse universities, which possibly reduced the testable sample population.
3. The study was limited by the applicability of the SVS in a way that was not originally designed by its developers (i.e., use with the African American population) (Spencer, 1993).
4. The study was limited by the ability to recruit volunteers for the study.
Delimitations

The following delimitations were considered in this study:

1. The study was delimited to universities in the states of Arkansas, Texas, and Louisiana.
2. The study focused stereotype threat, which is only one aspect of coping strategies among students.
3. The study was delimited to a small number of colleges: two PWI, two ethnically diverse universities, and one HBCU.

Assumptions

The following assumptions guided this research study:

1. Participants were not biased by preconceived notions regarding the implications and purposes of the study.
2. Participants were open and honest in their communications with the researcher.
3. Participants were both African American and engineering majors.

Organization of Dissertation Chapters

Chapter 1 includes the statement of the problem, purpose of the study, research questions, hypotheses, significance of the study, method of procedure, definitions of terms, limitations and delimitations, and assumptions. Chapter 2 features a thorough review of the literature. Chapter 3 presents a detailed discussion of the methods of the study. Chapter 4 includes a presentation and analysis of the data. Finally, Chapter 5 concludes the dissertation with a summary of the study, and a discussion of the findings, conclusions, implications, and recommendation for further studies.
Chapter 2

LITERATURE REVIEW

Female and minority students are underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields (Frehill et al., 2009; Perna et al., 2009). However, the causes for this underrepresentation and the processes by which students are retained in STEM are largely unknown. This literature review focuses on the psychological construct of stereotype threat, the unique differences between male and female students, and problems associated with African Americans pursuing college degrees. The focus is on the retention of African American students in engineering degree programs and the differences between threats faced by students at colleges with differing percentages of minority students. This literature review also focuses on the effects of and remedies for students who experience the threat of negative stereotypes.

Stereotype Threat

Theoretical Constructs

Steele (1997) defined *stereotype threat* as follows:

The event of a negative stereotype about a group to which one belongs becoming self-relevant, usually as a plausible interpretation for something one is doing, for an experience one is having, or for a situation one is in, that has relevance to one’s self-definition. (pp. 616-617)

A negative stereotype becomes self-threatening when it is self-relevant and the individual has the possibility of being treated or judged by that stereotype (Steele, 1997). Steele believed that stereotype threat has been neglected as a possible causal factor in differing test scores between White and African American students. Specifically, Steele stated, “tests used to measure
students’ potential for some subsequent level of schooling, under a common set of testing conditions, can underestimate the actual potential of stereotyped students” (p. 189).

To test theories of stereotype threat and performance, Steele and Aronson (1995) compared two groups on a measure of aptitude. African American students who were told that the test was not a measure of intellectual ability scored nearly the same as their White counterparts. Therefore, academic deficits are not caused by innate intellectual differences, as some have believed (Herrstein & Murray, 1994). In the controversial book The Bell Curve, Herrstein and Murray (1994) claimed that biological differences in the IQs of African Americans and Latinos and their inferior intelligence were to blame for gaps in achievement. However, researchers have identified other factors for these gaps. Aronson and Inzlicht (2004) conducted a longitudinal study and found that students who were vulnerable to stereotypes showed lower performance in laboratory testing and were less accurate when asked to assess their test performance. The researchers suggested that the tendency not to understand fully the reasons behind their lower performance (i.e., inaccurate performance assessment) might account for some variation in achievement gaps. A meta-analysis by Walton and Spencer (2009) showed that individual difference in stereotype vulnerability predicted between 9% and 10% of variation in grades and helped account for the entire gap in GPA between White and African American students.

Research has also shown that the threat of being evaluated, judged by, or treated in terms of a negative stereotype can cause individuals to perform worse in a domain in which negative stereotypes exist for a group in which they are members (Singletary et al., 2009). Additionally, students do not need to believe the stereotype to feel its burden. Rather, they only need to be “aware of the stereotype and care enough about performing well in the domain to want to
disprove the stereotype’s unflattering implications” (Aronson et al., 2002, p. 114). This awareness and burden is known as stereotype vulnerability.

Stereotype vulnerability is the tendency to “expect, perceive, and be influenced by negative stereotypes about one’s social category” (Aronson & Inzlicht, 2004, pp. 829-830). Specifically, stereotype vulnerability impairs self-knowledge by increasing the level of mistrust of performance feedback and by increasing the level of stereotype threat perceived by the individual. When such mistrust occurs, students can develop inaccurate academic self-concepts, especially in areas in which they are deeply invested. In other words, stereotype vulnerability impairs self-knowledge by increasing the tendency of the target of the stereotype to distrust their own performance feedback in domains in which the stereotype is made clear (Aronson & Inzlicht, 2004).

It is likely that stereotype threat is applied to oneself when the individual has a strong identification with the stereotyped group (Schmader & Beilock, 2012), which means that the individual will be more vulnerable to the stereotype. A longitudinal study by Fischer (2010) showed that, over time, the pressures of stereotype threat might result in disidentification of the domain, specifically academic achievement. This disidentification can cause students to underperform. For example, Steele and Aronson (1995) found that African American students scored consistently lower in standardized tests compared to their White counterparts.

Stereotype threat and its subsequent disidentification can also be seen among high school students. Osborne and Walker (2006) examined minority high school students who were highly identified with academics. Findings revealed that these students were more likely than were White students to withdraw from school because their stronger academic identification made school a more difficult environment in which to be successful. This finding suggests the
question of whether some students are more susceptible than others are to the effects of stereotype threat. Cadinu, Maass, Lombardo, and Frigerio (2006) showed that minorities with an internal locus of control were more susceptible to stereotype threat. This finding is paradoxical because students with internal locus of control are usually recognized as conscientious and high-achieving students. Further, Aronson et al. (2002) found that students who held an incremental view of intelligence (intelligence is malleable and expandable) were better able to withstand the effects of stereotype threat than those who held an entity view (intelligence is fixed and unchangeable).

Additional research on factors that activate stereotype threat in some individuals and not in others is required. According to Aronson et al. (1999),

Is stereotype threat self-threatening because it arouses a fear of being a bad ambassador of one’s group to mainstream society? Or is it simply the apprehension of appearing incompetent—for the sake of one’s own reputation? Or alternatively, is it merely the result of worrying that one might lack ability? Or is it some combination of these concerns. (p. 43)

Considering these questions, the following section discusses the physiological processes that cause students to underperform in the face of stereotype threat.

**Physiological Processes**

Schmader and Beilock (2012) found that stereotype activation (or sensing that the stereotype is being applied) leads to a reduction in working memory capacity among women and minorities who are in the stereotype threat condition. Stereotype threat taxes working memory capacity, which is the short-term memory system that controls and regulates limited memory and helps complete the task at hand (Schmader & Beilock, 2012). Schmader and Johns (2003)
showed that minorities who were exposed to stereotype threat (they were told the task was a measure of academic abilities) had lower working memory scores on an assessment test. The mechanism by which the reduction in performance occurs is unknown; however, it is possible that added stress caused by the threat interferes with attentional resources (Schmader & Johns, 2003).

Stereotype threat requires individuals to juggle cognitive resources between the actual task and the awareness of their stereotypical differences. Because of this division of resources, individuals are unable to give the task their complete attention. Additionally, individuals may become uncertain of themselves, anxious, monitor their every thought, and attempt to suppress feelings and emotions related to the threat, which leads to decreased performance (Schmader & Croft, 2011). Steele (2011) referred to this thinking process as rumination and believed that it can affect students’ scores on standardized tests as well as their interactions with persons of different races.

Stereotype threat can have many long-term effects on stigmatized groups. According to Inzlicht, Tullett, and Gutsell (2012), students who experience stereotype threat end up paying a tax. This tax could be the loss of a sense of well-being and happiness or could contribute to health problems such as obesity and high blood pressure. Repeated images of negative stereotypes of African American students (e.g., more aggressive, less intelligent) can damage the psyche and cause them to internalize these messages and assign the stereotyped behaviors to their group and, ultimately, to themselves. Internalization of negative stereotypes could lead to higher unemployment, unsuccessful marriages, low educational achievement, and even criminal behavior (Steele, 2011).
Females in STEM Careers

Women who choose STEM careers are typically described as pursuing nontraditional careers. Nontraditional careers for either sex are those that have less than 30% of same-sex workers. In terms of vocational choice, nontraditional careers are gender atypical and may be seen by society as gender inappropriate (Chusmir, 1990). In this sense, women, and especially women of color, are underrepresented in STEM careers. Of note, the term *underrepresented* describes populations that have lower representation than the population as a whole (Towns, 2010). According to the United States Census Bureau (USCB, 2000), the total U.S. population includes 6% African American women, 6% Hispanic women, 1% Native American women, 2% Asian women. Thus, the phrase *underrepresented women* refers to African American, Hispanic, and Native American women because they are represented in STEM occupations and in academia at lower percentages than their representation in the entire population (Towns, 2010).

The Leaky Pipeline

Marra, Rodgers, Shen, and Bogue (2009) examined gender differences in abilities and skills among first-year engineering students. While the researchers did not find significant gender differences in ability, women self-reported lower competency in basic engineering skills and knowledge, problem-solving ability, and engineering abilities. This finding is an important distinction because it shows that women perceive themselves as having lower engineering-related skills, which may not be the case. This finding also points to the notion that the self-perception of women in STEM fields may not reflect a realistic assessment of their true abilities. Additionally, a new generation of female engineering students has strong academic preparation in high school and expends much effort to succeed in college; however, these women still fall
behind in the area of grades during their college years. Grades are reinforcing and students who are confident and efficacious are successful academically (Vogt, Hocevar, & Hagedorn, 2007).

In light of this disparity between high school and college academic performance, it is important to consider whether precollege preparation is related with female underrepresentation in STEM fields. According to Vogt et al. (2007), women who enter engineering programs straight from high school share similar characteristics. Vogt et al. (2007) discussed these women as follows:

(1) at the top of the mathematics test score range, (2) as likely as males to have taken the appropriate mathematics, science, and physics courses in high school, (3) definite about their academic and career choices, and (4) are confident in their academic abilities. (p. 338)

However, females are still not entering engineering in significant numbers; when they do enter the academic field, they are lost through attrition and fail to enter the STEM workforce.

Since the early 1990s, pipeline theory has been the dominant conceptual framework used to explain the STEM gender disparity. According to this framework, the gender gap in science and engineering exists because fewer women take science and math courses prior to college and are lost at various leakage points along the pipeline from school to work (Schreuders, Mannon, & Rutherford, 2009). Although women are less likely to enter science and engineering, those who do enter these majors are likely to do well and graduate (Adelman, 1998; Seymour & Hewitt, 1997) and are not lost in significant numbers as pipeline theory suggests. Specifically, the retention rate for both women and men in engineering stands at about 60%. However, women make up a smaller number of STEM students from the start; therefore, the loss of women from these majors is of special concern (Hill et al., 2009).
One area in which females tend to conform to the leaky pipeline is in the area of academic faculty and researchers in science fields. Very few women who complete a bachelor’s degree in engineering or other STEM subjects go on to careers in academia. Etzkowitz, Kemelgor, and Uzzi (2000) pointed out that, in the late 1990s, 19% of mathematics, 12% of physics, and 11% of engineering PhD graduates were women. Etzkowitz et al. explained female PhDs leaking from the pipeline as follows:

Although the genders are almost equally represented in the early stages of the pipeline (graduate school), they increasingly diverge at the later stages, resulting in a much smaller proportion of women than men emerging from the pipeline. At the point of career choice, many women are diverted from the academic and research tracks, even though some who are trained as scientists pursue science-related careers such as scientific writing or administration. (p. 6)

Mau (2003) studied student persistence of science and engineering career aspirations and found that those who persisted in their interests from eighth grade through college had higher self-concepts. She also found that males were more likely to persist in their interest than were females. Further, about 60% of all individuals who enter engineering programs graduate within six years (National Science Board [NSB], 2007). Adelman (1998) conducted an 11-year longitudinal study and found a 61.6% retention rate among men in undergraduate engineering programs compared to a 41% retention rate among women. A longitudinal study by Brainard and Carlin (1998) showed that the freshman and sophomore years were the most likely time when women switch out of engineering or science programs. The primary reasons for switching include a combination of loss of interest, being attracted to another field, and being discouraged by academic difficulties and low grades. Women who leave engineering consistently express
less confidence in their abilities than do men and women who persist, regardless of whether their actual performance is the same or better than their persisting peers (Brainard & Carlin, 1998).

Schreuders et al. (2009) found that women lack comfort and experience with the tools and machinery that are a part of engineering. They suggested that stakeholders diversify areas where engineering is applied, including biomedical and biotechnology applications, which would appeal more to female students because of the direct human benefits of such areas. Certain STEM subdisciplines that have clear social purposes, such as biomedical engineering and environmental engineering, have succeeded in attracting higher percentages of women than have other subdisciplines such as mechanical or electrical engineering (Gibbons, 2009). Therefore, additional research should be conducted to determine why these subdisciplines are successful and how other engineering subdisciplines (i.e., more mechanical disciplines) can attract women in greater numbers.

Seymour (1995) found that women do not leave STEM majors because of a lack of natural aptitude. Rather, she found that women who persist “enter with sufficient independence to adjust quickly to… impersonal pedagogy…bond to their major through intrinsic interest and a strong sense of career direction; and develop attitudes and strategies in order to neutralize the effects of male, peer hostility” (p. 470). Therefore, the more girls and women believe that they can learn what they need to be successful in STEM fields (as opposed to being “gifted”), the more likely they will be successful in STEM fields. Women need to know that hard work in STEM is much more important than natural intelligence (Hill et al., 2009). Evidence also suggests that participation in professional organizations enhances women’s coping capabilities (Hartman & Hartman, 2008), which could lead to higher retention.
Women of Color in STEM

In 2001, African American women received only 36% of all bachelor degrees awarded to African Americans in engineering (Perna et al., 2009). This finding is especially concerning because African American females outnumber African American males on college campuses by nearly 2 to 1 (Osborne, 1995). In 2004, African American women received 10.9% of all engineering and science degrees conferred (Rodgers, 2009). Academically, African American women are underrepresented; however, this population tends to be well represented in the STEM workforce. According to McSherry (2005), African American women account for 35.4% of all African American STEM workers. Compared to other ethnic groups, Hispanic and Asian women constitute 23.6% and 26.6% of the STEM workforce, respectively (McSherry, 2005).

Women of color face a double jeopardy in science-related careers via their positions as female and minorities. However, no research supports this supposition (Hanson, 2004). Seymour and Hewitt (1997) indicated that, for women, the classroom climate includes negative messages about their presence in engineering, which may have even greater implications for African American women. However, due to cultural beliefs regarding womanhood and family structure, African American women in particular should be ideal candidates for survival in STEM programs (Hanson, 2004). Specifically, in the African American community, gender is constructed very differently from that in the White (non-Hispanic) community. Many characteristics that are considered appropriate for African American females (e.g., high self-esteem, independence, assertiveness, and high educational and occupation expectations) are consistent with characteristics that contribute to success in science (Hanson, 2004). In fact, because of these characteristics, African American women may be more recruitable for engineering than females from other ethnic groups or even African American males. However,
women of color hold naïve understandings of the field of engineering and give little consideration to the questions of the field itself or the nature of engineering practice. This lack of consideration may account for the few women of color who enter engineering programs as college freshman (Tate & Linn, 2005).

Women of color face many barriers on their way to careers in STEM fields. Based on ideas developed by W.E.B Dubois, female African American students face double consciousness, “being motivated to avoid the negative implications of a stereotype and at the same time needing to be vigilant for the signs that the stereotype could be applied to the self” (Logel et al., 2012, p. 160). Research has found that African American students are more vulnerable to stereotype threat as evidenced in a lack of academic self-efficacy and self-knowledge of personal academic skills and underperformance (Logel et al., 2012). Therefore, it would be beneficial to increase awareness among females of stereotype threat and ways cope with this threat. For example, Logel et al. (2012) found that women performed equally to men on a math test when they are taught about stereotype threat before the test.

Stereotype endorsement may be difficult to reduce because, for women, it may be rewarding. Burkley and Blanton (2008) found that women’s self-esteem is buffered from future math failure when they are given the opportunity to endorse the math gender stereotype. This buffering may occur when women are not as invested or committed to STEM fields and are more flexible to change majors. Logel et al. (2012) found that many African American and Hispanic men withdraw from their majors or drop out of school when they experience failure in quantitative fields; however, woman may simply avoid quantitative fields when faced with failure rather than completely withdraw from college. In these cases, women might opt instead to change majors to one with fewer negative stereotypes for their gender (e.g., psychology).
While the number of African American females in STEM majors is low, research has found that their potential is evident. Riegle-Crumb and King (2010) found that African American females were more likely than were White females to declare a STEM major when academic preparation in high school was held constant. They were also more likely to succeed when given adequate support. In a study on women of color at an ethnically diverse university, Trenor et al. (2008) found no presence of negative stereotypes; however, they did find that students form a diverse set of peer groups and ample support systems were present at the college, which helped them belong and succeed academically.

Female students might be less susceptible to the negative effects of stereotype threat. Nguyen and Ryan (2008) conducted a meta-analysis of the effect of stereotype threat activation cues and threat removal strategies on minority and female college students. Although explicit and overt threat activation cues seemed to have no effect on women, explicit stereotype threat removal strategies caused a boost in the performance of female test takers (Nguyen & Ryan, 2008).

**African American Students**

**Challenges**

Similar to the lack of female engineering students, few African American students are enrolled in engineering majors in the United States. In 2005, only 5.8% of African Americans who were enrolled in college majored in engineering (1.6% females and 4.2% males) (Frehill et al., 2008). To increase the number of African American engineers, students need opportunities to work with and observe engineers in the field early in their degree programs. Additionally, these students need African American mentors who have successful engineering careers (Concannon & Barrow, 2009).
Research from the NCES (2009a) illustrated the characteristics necessary for minority students to finish their STEM degrees. For example, students who started their postsecondary education at a 4-year or selective institution, initially enrolled in a bachelor’s degree program, and attended school either exclusively full-time or mixed full and part-time generally had higher STEM degree completion rates than did their counterparts without these characteristics (NCES, 2009b). If these characteristic are essential, then many African American women may have trouble being successful because very few fit this successful profile. Therefore, practitioners must learn new ways to work with female students who come to college and do not fit the traditional model.

African American males represent less than 5% of all undergraduates nationwide—the same figure as in 1976. In other words, there has been little or no progress in increasing the enrollment rates of this population in a quarter of a century. Furthermore, more than two-thirds of African American men leave college before finishing their undergraduate degrees (NCES, 2006). However, an analysis of U.S. institutions that report to the IPEDS system showed that 60% of public 4-year institutions have seen improved graduation rates for students of color since 2002 (Stephens, 2010). Public Predominantly White Institutions (PWIs) that have seen successful increases in the percentage of minority graduates include Georgia State University, the University of Wisconsin-Madison, and Western Oregon University (Stephens, 2010). However, there are mixed messages of this improvement in terms of African American males in the sciences within academia. Using the field of chemistry as an example, Kumar (2003) noted:

African American scholars have kept pace with their Hispanic peers in number of chemistry PhDs earned, yet, since 1991, not a single African American scholar has been hired to a tenure track position at one of the top 50 chemistry departments. (p. 130)
Successful African American males with high self-efficacy share a few traits in common including “(a) high resilience, (b) high self-confidence, (c) high self-control, (d) a strong sense of self-responsibility, and (e) a clear understanding of the tasks they face and the belief that they can accomplish all subtasks associated with their goal” (Whiting, 2009, p. 228). They also tend to be strong students, reject stereotypes of intelligence imposed upon them, and are willing to seek out academic challenges. Moore et al. (2003) proposed the prove-them-wrong syndrome, which describes how African American males adapt to and succeed with degree program requirements. Specifically, Smith suggested that African American males develop coping mechanisms that manifest into positive vigor in spite of adversity. Moore et al. found that “rather than passively ignore the adversity…African American males assume a more assertive academic posture and a stronger sense of purpose, commitment, and confidence in their academic persistence and performance” (p. 65). The development of these traits particularly occurs when the population is small such as in the case of engineering (Moore et al., 2003). The prove-them-wrong syndrome should be explored in further research and interventions, and engineering programs should be developed to support the strength and tenacity of African American males.

Trenor et al. (2008) pointed to four factors that are unique to students of color and have contributed to their attrition in STEM fields, “(1) differences in ethnic values and socialization, (2) internalization of stereotypes, (3) ethnic isolation and perceptions of racism, and (4) inadequate support systems” (p. 450). Syed, Azmitia, and Cooper (2011) believed that many students drop out of STEM majors because the early college years are a critical time when they are learning about themselves in a social context and, therefore, they flock to humanities and social sciences. They suggested that STEM departments adopt more diversity into their
curriculum, such as highlighting minorities in STEM fields and researching the historical and cultural backgrounds of STEM subjects.

**Predominantly White Institutions**

Rodgers and Summers (2008) found that African American students who attend PWIs reported lower academic achievement in college and exhibited lower academic self-concept than did students who attended Historically Black Colleges and Universities (HBCUs). Therefore, an appropriate retention model for African American students who attend PWIs must consider students’ motivations and self-systems within the context of their racial or ethnic identities (Rodgers & Summers, 2008). Rodgers and Summers stressed the importance of coping skills, “An effective coping process is shown to lead to stress reduction and increased confidence, while attribution assessments (control over learning) can result in increased motivation” (p. 173). The researchers used a model of college student retention, first proposed by Bean and Eaton (2000), which incorporates psychological theories of coping, self-efficacy, and attributional theory, among others. This model shows that minority students focus less on the intrinsic side of academic achievement to prove that they can succeed academically.

Cokley (2003) proposed that minority students’ tendencies toward external forms of self-regulation may be attributed to a view of intrinsic motivation as a luxury that seems irrelevant to doing well in school in light of the more important goal (in their perceptions) of finishing college or getting a good job. Dodson-Sims (2005) examined African American students who attended a PWI and found that these students felt less supported and less identified with the university. These students also experienced more stereotype threat than did similar students at a HBCU (Dodson-Sims, 2005). Steele (2011) believed this lack of support and identification is because students at PWIs experience more identity threatening cues such as an elite academic program, a
low number of minority faculty members, and a small number of minorities enrolled at these universities. He suggested that schools need fewer identity threatening cues, more ways for students to be successful, an abundance of minority leadership, and a critical mass of students and faculty (Steele, 2011).

Fries-Britt and Griffin (2007) examined students at PWIs who reported experiencing subtle and less overt forms of racism known as *microaggressions*, which they defined as “subtle and unconscious racist acts that cumulatively add stress to the experience of people of color” (p. 511). They found that African American students felt compelled to dispel myths and stereotypes about their peers, felt pressure to behave in non-Black ways, and constantly tried to prove that were accepted into an honors program, not by affirmative action but by their own merit. African American students at PWIs felt their energy was always averted from academics by constantly having to educate their White peers about minority stereotypes (Fries-Britt & Griffin, 2007). African American students also felt that they needed space where their minority status was not made aware because they worried that their peers and faculty members might consider their academic skills as less than the other students. Steele (2011) found that this student population was very conscious of the number of African American faculty and felt that African American interests, styles, and preferences were marginalized, at best, and stigmatized at worst.

Some studies conflict with the assumption that all students of color face social and racial difficulties in engineering programs. Trenor et al. (2008) conducted a study with students at an ethnically diverse urban campus. These students perceived no stereotype threat and acknowledged the presence of ample support structures. This study differed from previous studies because it did not focus on an HBCU or PWI, and it used a mixed-method research protocol. Female students of all colors and African American students, in general, have similar
needs when it comes to engineering and success. Steele and Aronson (1995) likened the situation of females in mathematics-intensive environments (i.e., predominantly male settings) as comparable to their study of African Americans at PWIs because they both face the challenges of being a minority and experience stereotype threat.

**Historically Black Colleges and Universities**

An analysis of the IPEDS in 2004 revealed that HBCUs were the source of 22% of all bachelor’s degrees awarded to African-Americans; however, only 30% of all bachelor’s degrees awarded to African Americans were in STEM fields (Perna et al., 2009). HBCUs were also shown to be more important to African American women compared to men. Specifically, the analysis showed that 33% of all bachelor’s degrees awarded to African American women in STEM fields were from HBCUs, compared to only 26% to African American men at similar schools (Perna et al., 2009). Additionally, HBCUs graduated 31% of the African Americans who earned degrees in the hard sciences, which include biology, computer science, earth sciences, mathematics and statistics, physical sciences, and engineering. Twelve institutions that graduated engineers were among the top 20 institutions that produce African American baccalaureate degree recipients who go on to obtain doctoral degrees. In 2005, of the 166 African Americans who received bachelor’s degrees in Physics, 85 (51%) were from HBCUs (NSB, 2007).

Research on self-efficacy and self-concept of African American students suggests that those who attend HBCUs may have a positive edge in GPA, perceptions of campus climate, academic self-efficacy, and self-concept over African American students who attend PWI (Cokley, 2000; May & Chubin, 2003). Harper et al. (2004) found that, compared to their counterparts at PWIs, African American students who attend HBCUs experience less social
isolation, alienation, personal dissatisfaction, and overt racism. Brown et al. (2005) showed that African American engineering students at HBCUs have favorable perceptions of college, experience less racism, and have higher GPAs compared to their African American counterparts at PWIs.

Hendricks (1996) found that African American students at HBCUs exhibit strong racial identity. However, all types of institutions can be minority serving. In fact, improving graduation rates may be the chief mechanism to diversify engineering in the United States (Chubin, May, & Babco, 2005). Finally, the social aspect of African American student development at HBCU campuses cannot be ignored. For example, Taylor, McGowan, and Alston (2008) found that a learning community approach may be effective in the development of African American students at HBCUs.

### Remedies to Stereotype Threat

Researchers have found remedies that may mediate the negative effects of stereotype threat (Aronson, Jannone, McGlone, & Johnson-Campbell, 2009; McGlone & Aronson, 2006; Shih, Pittinsky, & Ho, 2012). These remedies can range from simple to complex strategies. McGlone and Aronson (2006) found that priming students with positive aspects of their social identity (e.g., being enrolled in a private university or a member of elite organization) can have positive benefits for overall test performance. However, this result may not always be the case. For example, priming students with information about African American role models, even President Barack Obama himself, will not necessarily improve scores and deflect feelings of stereotype threat (Aronson et al., 2009); other factors must be involved.

Shih et al. (2012) found that positive stereotypes presented to African American students could limit the effects of stereotype threat and even enhance performance through a process...
Another phenomenon, called stereotype lift, is a process in which performance can improve when testers are exposed to the negative stereotypes of other groups. However, stereotype lift is not advised because it focuses on the negative stereotypes of other members or groups (Shih et al., 2011).

Some research has discovered a relationship between implicit theories of intelligence and academic performance (Dweck, 1999). Individuals who follow entity theories believe that intellectual abilities are innate and immutable (unchanging) whereas individuals who follow incremental theories believe intelligence is malleable and can be developed. Research has found that entity theorists are more likely than are incremental theorists to disidentify with their academic studies following negative feedback (Dweck, 1999). Entity theorists are more vulnerable to negative stereotypes because they do not believe their intellectual abilities can change (Dweck, 1999). To alleviate the effects of stereotype threat on stigmatized groups, Martens, Johns, Greenberg, and Schimel (2006) proposed a process known as self-affirmation, which encourages students to think about what they value most before an exam. They also suggested that self-affirmation might serve as a buffer against stigmatization and its threatening effects. Schmader, Forbes, Zhang, and Mendes (2009) found that priming students before a test with self-confidence as opposed to doubt, known as positive reappraisal, to not only reduced the effects of threat, but increased performance. This finding was true for both minority and majority students.

Rydell and Boucher (2010) showed that students with high self-esteem were able to discount threatening notions of their group identity and choose another social identity (e.g., college student). In this respect, high self-esteem could be considered a moderating contingency to alleviate stereotype threat in some individuals. McGee and Martin (2011) conducted a
qualitative study and found that students used a process called *stereotype management* to overcome the negative effects of stereotype threat. The researchers believed that stereotype threat is common and pervasive in the lives of African American engineering students. The findings also revealed that African American students used their encounters with stereotype threat to add extra incentive to perform and be successful. Alter, Aronson, Darley, Rodriguez, and Ruble (2010) reframed a test as a challenge instead of focusing on related stereotypes and found, in this test performance situation, African American high school and college students overcame deficits of stereotype threat. This inexpensive intervention could be useful as a stereotype-management technique by focusing students’ attention on the benefits of success instead of the threatening consequences of failure (Alter et al., 2010).

Other strategies that students use to cope with stereotype threat include withdrawal of effort, engaging in less practice or study time to provide an explanation for their poor performance, denial, and a sense of humor (Rivardo, Rhodes, & Klein, 2008). Steele (1997) suggested the following actions to reduce stereotype threat:

1. Optimistic teacher-student relationships,
2. Challenge over remediation,
3. Stressing the expandability of intelligence,
4. Affirming domain belongingness,
5. Value multiple perspectives,
6. Role models,
7. Nonjudgmental responsiveness,
8. Building self-efficacy and confidence in academic domains. (pp. 624-625)

Steele (2011) also found that stereotype threat could be alleviated by changing the way critical feedback is given, improving the stigmatized group’s critical mass in a given setting, fostering intergroup conversations among people of different races, and allowing minorities to affirm their sense of self. He also suggested helping African American students develop a narrative that
allows them to describe their frustrations while also experiencing positive engagement and success in academic realms.

**Conclusion**

A Special Report (2006) in the *Journal of Engineering Education* focused on five areas of future research to help the profession of engineering and national innovation. One recommendation included the following:

_Area 4—Engineering Diversity and Inclusiveness:_ Research on how diverse human talents contribute solutions to the social and global challenges and relevance of our profession. We need to learn how to measure diversity and its impact in order to understand the role diversity plays in advancing solutions, influencing society, and contributing to innovation, critical thinking, creativity, teamwork, entrepreneurship, leadership, and global competencies. (p. 261)

Any research that seeks to diversify engineering would be beneficial to both women and African Americans in general.

Once students are involved in an engineering program, keeping them on the engineering track is extremely important. Heilbronner (2009) believed that students’ abilities to do well in STEM classes and achieve in this domain are the best predictors of retention. Mau (2003) conducted a longitudinal study that tracked the career aspirations of eighth graders through college and found that achievement and confidence were key factors to persistence in STEM careers. Academic proficiency and math self-efficacy were also predictive variables for persistence in STEM. Additionally, Mau found other variables that were important to identify aspirations were not effective in explaining persistence. These factors included parental expectations and school involvement and the specific academic programs students chose. One
important caveat to this study was that a measure of self-efficacy was not available; therefore, the researcher used locus of control and self-esteem to represent self-efficacy (Mau, 2003).

One possible area of focus for future research may be to expose African American students in engineering programs at PWIs to the same networking opportunities and vicarious role-model experiences that are available to African American engineering students at HBCUs. Researchers need to ask why the retention of STEM students who attend HBCUs is higher than the retention of these students at PWIs. Researchers should also consider how PWIs can simulate the success of HBCUs by forming organizations and small groups to mirror the ethnic diversity found at HBCUs (Rodgers, 2009). In this regard, Perna et al. (2009) asked the following question: “How can institutions with more heterogeneous populations and without a historical institutional commitment to ensuring the academic success of all students develop a peer culture that encourages the attainment of African Americans in STEM fields” (p. 18)?

De Cohen and Deterding (2009) found a discrepancy in the data related to male and female retention and concluded that attrition from engineering is virtually the same for both genders once students are grounded in the program. However, they noted that because women represent a smaller number of the total enrollment, the loss of women has a greater net difference in the percentage of female engineering graduates. De Cohen and Deterding supported the belief that the lack of women and minority engineering students is more of a recruitment problem than it is a retention problem. Therefore, research should be conducted to determine whether persistence between male and female students is significantly different once students are grounded in their engineering programs.

According to the Frehill et al. (2009), there was a slight downward trend in men’s participation in STEM in the early 1970s. Male participation rebounded when the doors were
opened to women in engineering after the adoption of Title IX, which requires equal participation by women in college programs. Of note, it would be interesting to see whether recruitment efforts directed toward women also helped increase participation among men in this field. It appears that the increasing number of female and minority students in STEM careers involves both recruitment (getting students interested) and retention (keeping students in the program and helping them graduate). Therefore, universities should emphasize both recruitment and retention; focusing on only one factor could be detrimental to the success of an engineering program. In other words, without recruiting, a program has no students to retain, and without retention, a program will lose the ones it does have. Additionally, the secondary educational system cannot be solely responsible for recruitment. Colleges need to be proactive in their recruiting processes while secondary schools can help with the process of identifying female and minority students who are academically capable and interested in engineering.

Tolley (2003) suggested a historical look at the underrepresentation of women and minorities in STEM fields. She believed that researchers should look at how these different groups (i.e., African Americans, Hispanics, and Asians) have been educated in science and how the educational perspectives of minorities have changed throughout the years. Research should also focus on role models of the past (especially women) who have worked hard in the sciences, but have been largely unrecognized (Tolley, 2003). In particular, Steele (2011) found that an abundance of minority professors were helpful in relieving identity-related pressures. Further, role models should be made available to women and minorities in hopes of increasing their production in the sciences. This process is cyclical and serves to prove itself as the number of underrepresented groups in science and engineering increases.
Once members of the stereotyped group feel that they are no longer judged in the light of stereotypes, they will know that the learning environment is safe. This sense of safety could lead to more African American and female students entering STEM fields because students are willing to remain in situations where they feel safe to disprove stereotypes. Students may also be more likely to avoid stereotype-relevant situations when they become aware that they are stereotype safe. This domino effect could lead more minorities into STEM fields because of the presence of students who have learned to deal with stereotype threat (Logel et al., 2012). Minority students who can overcome the effects of stereotype threat will have a greater chance of success and increased self-awareness. Crisp and Turner (2011) this process as follows:

Diversity must be experienced in a way that challenges stereotypical expectations.

Individuals must be motivated and able to engage with resolving the stereotypical inconsistencies. When these preconditions are met, the experience will have cognitive consequences that will resonate across multiple domains. (p. 242)

Caution must be taken when applying stereotype threat research to all situations. Additionally, researchers must be careful when priming participants with stereotype information and not be too explicit in their explanations. Nguyen and Ryan (2008) found that explicit stereotype threat removal strategies sometimes led to more stereotype effects for minorities and were, subsequently, not as effective in moderating test scores. This effect possibly occurs because the intervention backfires and makes the stereotype more salient to the test taker. Some have criticized the applicability of stereotype threat to the real world (see Wax, 2009) because it has mostly occurred in a laboratory-type setting. However, as Aronson and Dee noted (2012), the experiments conducted that point to the effects of stereotype threat in a lab setting are very important, even though they are somewhat limited when used to predict the behaviors of a
complex sociological process such as stereotype threat in the real world. Nonetheless, the experiments conducted over the last 12-15 years related to this phenomenon are considered a type of field experiment because they have dealt with the exact population under consideration and can be extremely useful as a predictive tool (Aronson & Dee, 2012).
Chapter 3

METHOD OF PROCEDURE

The purpose of this research was to determine the differences in stereotype vulnerability at three different classifications of university, Predominantly White Institutions (PWIs), ethnically diverse universities, and Historically Black Colleges and Universities (HBCUs). This study quantitatively compared the scores between African American engineering students who were enrolled in universities in Texas, Louisiana, and Arkansas. Male and female students participated and ranged from freshmen to seniors. Although the sample size was small (N = 48), some patterns emerged that will benefit Science, Technology, Engineering, and Mathematics (STEM) researchers. This chapter discusses the research questions and hypothesis, and provides a detailed description of the process used to collect and analyze the data related to stereotype threat.

Research Questions

The following research questions formed the basis for this investigation:

1. What are the perceptions of stereotype threat of African American engineering students enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

2. Do differences exist in the perception of stereotype threat of African American students between or among those enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

3. Do relationships exist between the percentages of African American students and their perceptions of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?
4. Do gender differences exist in the perception of stereotype threat within the African American engineering student population across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

**Hypotheses**

The following hypotheses were explored to address the research questions:

**Hypothesis 1**

**Ho** sub 1 **.** No differences exist in the perception of stereotype threat of African American students between or among those enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Ha** sub 1. Differences exist in the perception of stereotype threat of African American students between or among those enrolled 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Hypothesis 2**

**Ho** sub 2. No relationships exist between the percentage of African American students and the perception of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Ha** sub 2. Relationships exist between the percentage of African American students and the perception of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Hypothesis 3**

**Ho** sub 3. No gender differences exist in the perception of stereotype threat among African American engineering students across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.
**Ha3.** Gender differences exist in the perception of stereotype threat among African American engineering students across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs.

**Design of the Study**

Although there has been much research on African American students at HBCUs and PWIs (Aronson et al., 2002; Brown et al., 2005; Fries-Britt & Griffin, 2007; Hendricks, 1996), few studies have examined a third school designation, ethnically diverse. For the purposes of this research, ethnically diverse institutions were defined as those with an African American population of between 11% and 20%, PWIs included universities with an African American population of 10% or less, and HBCUs included universities with an African American population of over 80%. The selected universities were chosen because they fit these characteristics based on university data reported by the Education Trust (2009). The selected universities included two PWIs (Texas and Arkansas), one HBCU (Louisiana), and two ethnically diverse universities (Arkansas and Louisiana). All universities were considered public 4-year degree granting institutions.

After receiving IRB approval from Texas A&M University-Commerce, the researchers sent an initial inquiry letter to the engineering departments of all five universities requesting that the online surveys be distributed to their African American engineering students. Approval was granted at the five universities after each university’s IRB reviewed the request. The online surveys were distributed in the spring and fall of 2012. The survey instrument was provided online through Free Online Surveys to accommodate the busy lives of the students and for rapid collection of data.
The survey included a short demographics section (see Appendix B) and the SVS (see Appendix A). Surveys were filled out completely online with a link provided to the students in the email correspondence distributed by the universities. After reading and agreeing to the Informed Consent (see Appendix C), students were directed to a link for the survey. After completing the survey, students were thanked for their participation. All results were compiled and data were stored in a database on the survey website.

Instrumentation

This study was designated as a quantitative investigation. To measure the perception of stereotype threat, a modified SVS was administered (Spencer et al., 1999). Barnard et al. (2008) used the SVS and found an overall internal consistency of $\alpha = .60$; when administered with a specific domain (i.e., mathematics), the SVS revealed an internal consistency of $\alpha = .82$. Although Barnard et al. did not specifically use the SVS for African American students to test the validity of the instrument; however, they did use a group of minority students. The instrument was also used in a study to test for stereotype threat among the female population, which was relevant to the current study (Spencer, 1993). Spencer (1993) and Steele, James, and Barrett (2002) found good internal consistency of the SVS. The SVS includes eight items that are rated using a Likert scale that ranges from 1 = strongly disagree to 7 = strongly agree. For this study, the items were separated into two dimensions for scoring purposes. Dimension 1 included items 1, 4, 6, and 8, which were related to negative personal experiences. Dimension 2 included items 2, 5, and 7, which focused on racial group characteristics. Item 3 was not included in this analysis because it did not align with the other two categories (Dodson-Sims, 2005).
Each student also filled out a standard demographic form that requested data such as age, sex, and university classification (private vs. public). Also included on the form were questions related to type of high school (rural or urban), transfer student (yes or no), percentage of financial support received, whether they were always an engineering major, and a self-rating of mathematics abilities (1 = poor and 5 = excellent).

Sample Selection

The survey was offered to the entire population of African American engineering students enrolled at the five campuses selected. The selected universities included two PWIs, two ethnically diverse universities, and one HBCU. Because the overall population of African American male and female engineers is small, a convenience sample of as many students as possible was used from the entire population of male and female African American engineering students at the selected universities. Selection included any African American engineering student who was willing to take the time to fill out the survey. Of the students who were contacted, 48 returned the completed survey (38 male and 10 female). A total of 17 students were from the PWIs, 20 from ethnically diverse universities, and 11 from HBCUs. Demographic analysis showed that the average age of respondents was 21 years. Additionally, respondents included 13% freshmen, 27% sophomores, 33% juniors, and 27% seniors. All of the universities were designated as public universities. The percentage of African American students at the tested universities averaged 4.0% at the PWIs, 18% at the ethnically diverse universities, and 96.8% at the HBCU.

Data Gathering

The data from the survey were compiled and collected from Free Online Surveys and stored in a Microsoft Excel database until the deadline for participation passed. A short round of
surveys was offered to one PWI and one HBCU in April 2012 with limited results. The process of seeking colleges that were willing to participate continued through the spring and summer of 2012. An additional PWI was recruited in September 2012, along with two ethnically diverse universities, for total to five participating universities. The researcher obtained IRB approval and site authorization letters from each university, which allowed the researcher to recruit participants on each campus. An unsuccessful attempt was made to include a second HBCU in the sample. After sending a number of reminder emails to university contacts, a deadline of December 21, 2012 was established. The last round of data was collected at that time, and the survey instrument link was disabled. In late December of 2012, the formal analysis phase of the data began using SPSS.

**Treatment of Data**

For the quantitative portion of the study, a statistical analysis was conducted to test the first hypotheses for significance between the levels of stereotype vulnerability of students at the three types of universities. The hypothesis that no significant difference exists between African American engineering students at the universities in the area of stereotype threat was tested using a 3X2 MANOVA protocol in SPSS (Trochim, 2006). A similar analysis was conducted to determine whether there were gender differences across the three universities on the SVS. Finally, a Pearson’s one-tailed bivariate correlational analysis was performed to compare the scores on the survey instrument to the percentage of African American students at PWIs, ethnically diverse universities, and HBCUs. The SVS uses a Likert scale scoring distribution; therefore, data were classified as ordinal numbers. Although there is some discussion of the applicability of using ordinal data for MANOVA analysis, it was justified in this case for the purposes of comparison because the scores were not considered equally important or rigid in
their scale values (Velleman & Wilkinson, 1993). Finally, the researcher analyzed each question
to determine variation between and among university type, and between male and female
students as a whole. The next chapter reports results of the statistical analysis.
Chapter 4

PRESENTATION OF FINDINGS

Research Questions

The following four research questions were analyzed:

1. What are the perceptions of stereotype threat of African American engineering students enrolled in 4-year degree granting Predominantly White Institutions (PWIs), ethnically diverse institutions, and Historically Black Colleges and Universities (HBCUs)?

2. Do differences exist in the perception of stereotype threat of African American students between or among those enrolled in 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

3. Do relationships exist between the percentages of African American students and their perceptions of stereotype threat at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

4. Do gender differences exist in the perception of stereotype threat within the African American engineering student population across a group of students at 4-year degree granting PWIs, ethnically diverse institutions, and HBCUs?

Demographic Data

Participants completed both the demographic questionnaire and the SVS. The average age of participants was 21 years. Respondents included 13% freshmen, 27% sophomores, 33% juniors, and 27% seniors. In total of 83% of the students were enrolled at the same university their entire academic career, and 17% transferred from other universities or community colleges. Similarly, 83% of the participants were engineering majors their entire college career, and 17%
had different academic majors before transferring to engineering. Additionally, 30% of the female, and 13% of the male students had transferred from other universities.

Concerning the classification of their high schools, 65% reported having attended an urban high school and 35% attended a rural high school. As a whole, 65% of participants’ educational costs were funded by grants, scholarships, and other financial aid (non-loan assistance). The average self-rating for mathematics skills was 3.98. The average self-rating of mathematics skill for was 4.1 for females and 3.95 for males (see Table 1).

Table 1

<table>
<thead>
<tr>
<th>Demographic Information for Male and Female Engineering Students</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Item</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Age</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Percentage of Rural Students</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>Percentage of Urban Students</td>
<td>70</td>
<td>63</td>
</tr>
<tr>
<td>Percentage of tuition paid by loans, grants, and financial aid</td>
<td>80</td>
<td>61</td>
</tr>
<tr>
<td>Self-Report of math Self-Efficacy</td>
<td>4.1</td>
<td>3.95</td>
</tr>
<tr>
<td>Percentage of Freshman</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Percentage of Sophomores</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>Percentage of Juniors</td>
<td>40</td>
<td>32</td>
</tr>
<tr>
<td>Percentage of Seniors</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Percentage of Transfer Students</td>
<td>30</td>
<td>13</td>
</tr>
</tbody>
</table>
Analysis of Research Questions

Findings for Research Question 1

To determine the perceptions of stereotype threat among African American students, the SVS was administered and included eight items rated on a Likert scale ranging from $1 = \text{strongly disagree}$ to $7 = \text{strongly agree}$. The items were separated into two dimensions for scoring purposes. Dimension 1 was related to negative personal experiences. Higher scores on these items equated to more stereotype vulnerability. The items on Dimension 1 included the following:

- Item 1: “Professors expect me to do poorly in class because of my race.”
- Item 4: “Some people feel I have less academic success because of my race.”
- Item 6: “In the academic setting, people of my race often face biased evaluations from others.”
- Item 8: “In the academic setting, I often feel that others look down on me because of my race.”

Dimension 2 focused on racial group characteristics and included the following items:

- Item 2: “My academic success may have been easier for people of my race.”
- Item 5: “People of my race rarely face unfair evaluations in academic classes.”
- Item 7: “My race does not affect people’s perception of my academic achievement.”

Lower scores equated to more stereotype vulnerability. Item 3 was not included in this analysis because it did not align with the other two dimensions (Dodson-Sims, 2005).

A 3X2 MANOVA, conducted in SPSS, was used to examine differences between the survey responses and institution type. Dimension 1 was tabulated together using institution type.
as the fixed variable and the responses to the survey items as the dependent variable. HBCUs were coded as 1, ethnically diverse universities coded as 2, and PWIs coded as 3. Next, a Pearson’s one-tailed bivariate correlational analysis was conducted to compare the percentages of African American students at each type of university to the average scores on each survey item. This analysis was conducted on a question-by-question basis. Finally, data from the 38 male and 10 female participants across the three campus types were entered into a 2-factor MANOVA comparison using Dimension 1 (items 1, 4, 6, and 8) and Dimension 2 (items 2, 5, and 7) in separate tests. Males were coded as 1 and females were coded as 2.

**Finding for Research Question 2**

A 3X2 MANOVA analysis was conducted to address research question 2. The findings revealed no significant differences between the SVS and the three colleges for Dimensions 1 and 2 (see Table 2). The results for Dimension 1 were as follows: item 1: $F(2, 84.00) = .004, p = .958$; item 4: $F(2, 84.00) = .235, p = .800$; item 6: $F(2, 84.00) = .063, p = .951$; and item 8: $F(2, 84.00) = 1.120, p = .374$. Because the threshold of $\alpha = .05$ for the significance scores was not met, a Tukey post-hoc analysis was not needed. The result of the Box’s Test of Equality of Covariance Matrices was .291, which demonstrates homogeneity between the institutions on Dimension 1. Additionally, the Wilk’s Lambda = .915, $F(8, 84.00) = X, p = .195$ and further solidified the evidence that no significant differences existed between institutions. Item 8 showed some potential for a significant difference between the three types of institutions. Levene’s Test of Equality of Error Variances = .046, $F(2, 45) = 3.297, p = .046$ for item 8, which demonstrates differences between HBCUs and PWIs as shown by a standard deviation of 2.292 for HBCUs compared to a standard deviation of 1.495 of PWIs.
Table 2

**MANOVA Significance Test of Three Types of Institutions on the SVS Instrument**

<table>
<thead>
<tr>
<th>Survey Item</th>
<th><strong>HBCU</strong></th>
<th></th>
<th><strong>Ethnically Diverse</strong></th>
<th></th>
<th><strong>PWI</strong></th>
<th></th>
<th>Sig.</th>
<th></th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.36</td>
<td>2.01</td>
<td></td>
<td>2.40</td>
<td>1.50</td>
<td></td>
<td>2.53</td>
<td>1.51</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.82</td>
<td>1.08</td>
<td></td>
<td>2.35</td>
<td>1.39</td>
<td></td>
<td>2.06</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>3.18</td>
<td>2.09</td>
<td></td>
<td>2.95</td>
<td>1.61</td>
<td></td>
<td>3.35</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>3.27</td>
<td>2.20</td>
<td></td>
<td>3.85</td>
<td>1.90</td>
<td></td>
<td>3.12</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3.91</td>
<td>2.17</td>
<td></td>
<td>3.75</td>
<td>1.62</td>
<td></td>
<td>3.94</td>
<td>1.56</td>
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<td>7</td>
<td>4.00</td>
<td>2.41</td>
<td></td>
<td>4.40</td>
<td>1.85</td>
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<td>2.88</td>
<td>1.62</td>
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<tr>
<td>8</td>
<td>3.64</td>
<td>2.30</td>
<td></td>
<td>3.20</td>
<td>1.88</td>
<td></td>
<td>4.12</td>
<td>1.50</td>
<td></td>
</tr>
</tbody>
</table>

Results for Dimension 2 were as follows: item 2: \( F(2, 86.00) = .604, p = .550 \); item 5: \( F(2, 86.00) = .832, p = .832 \); and item 7: \( F(2, 86.00) = 2.996, p = .060 \). Because these results were not significant, a Tukey post-hoc analysis was not needed. For Dimension 2, the Box’s Test of Equality of Covariance Matrices was .683, which indicates homogeneity between the institutions. Additionally, the Wilk’s Lambda = .311, \( F(6, 86.00) = 1.203, p = .068 \), which demonstrates no significant differences between the institutions. Overall, these results show that no significant differences existed between participants enrolled in the different institutions. However, in an analysis of each question, differences were revealed, specifically for items 5 and 7. The Levene’s Test of Equality of Error Variances = .047, \( F(2, 45) = 3.279, p = .47 \), which demonstrates variance in the standard deviation between HBCUs and PWIs on that item. Item 7 showed a significance of .060, which is close to meeting the level of \( \alpha = .05 \). The item also
yielded an $F$ statistic of 2.996; combined with the low significance, the results of item 7 can be further discussed.

**Finding for Research Question 3**

A Pearson’s one-tailed bivariate correlation was conducted to compare the percentages of African American students at each type of university to the average scores on each survey item. The percentage of African American students at the tested universities averaged 4.0% at PWIs, 18% at ethnically diverse universities, and 96.8% at the HBCUs. The correlational analysis was conducted on a question-by-question basis. Table 3 summarizes the Pearson’s correlation scores and significance for each item. Of the seven items tested, five showed no relationship between the scores on the SVS and the percentage of African American students at the three types of universities. However, some conflicting results were observed.

Item 1 yielded a Pearson’s correlation of -.778, which reflects a negative relationship between the percentage of African American students at each campus and the perception of stereotype vulnerability. Because the test met the threshold of $r^2 > 0.49$, there does appear to be a correlation between stereotype threat and the percentage of African American students at the three types of campus for item 1. This finding shows higher levels of stereotype threat at PWIs for item 1. Item 7 yielded a Pearson’s correlation of .396, which appears to suggest a slightly positive relationship between the percentage of African American students and the scores of the SVS. However, the result did not meet the threshold of $r^2 > 0.49$; therefore, the results are not statistically strong enough to show a correlation.

Item 2 yielded a Pearson’s correlation of -.753, which denotes a negative relationship between type of institution and average scores on this item. These results conflict with those for item 1 because a lower score denotes more stereotype threat. In this instance, HBCU students
showed a higher level of stereotype threat. Because five of the seven items yielded no correlation and the results for items 1 and 2 conflict, the overall results showed a weak relationship between the percentage of African American students and scores on the SVS.

Table 3

Pearson’s One-Tailed Correlation: SVS Scores and Percentage of AA Students

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>$r^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-.778</td>
<td>.216</td>
</tr>
<tr>
<td>2</td>
<td>-.753</td>
<td>.229</td>
</tr>
<tr>
<td>4</td>
<td>-.054</td>
<td>.483</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>6</td>
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<td>.425</td>
</tr>
<tr>
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<td>.370</td>
</tr>
<tr>
<td>8</td>
<td>-.165</td>
<td>.447</td>
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</table>

Finding for Research Question 4

A 2-factor MANOVA was conducted to test the differences between male and female respondents on the SVS. Sex was used as the fixed factor and the average scores on each item were used as the dependent variable. The results are summarized in Table 4. The table also includes the means and standard deviations for each item. Post-hoc analysis was not necessary because only two factors were compared. Five of the seven items showed no significant differences between the average scores of males and females: item 1: $F(2, 84.00) = 3.004, p = .090$, item 2: $F(2, 86.00) = .040, p = .842$, item 4: $F(2, 84.00) = .013, p = .911$, item 5: $F(2, 86.00) = 1.720, p = .196$, and item 6: $F(2, 84.00) = 3.275, p = .077$. Box’s Test of Equality of Covariance Matrices yielded significance value .820 on Dimension 1 and .997 on Dimension 2, which
demonstrates homogeneity of the results between the sexes. Although the scores on Wilk’s Lambda Effect analysis for both Dimension 1 \((p = .195)\) and Dimension 2 \((p = .068)\) were low, they did not meet the threshold of \(p \leq .05\) that was needed to demonstrate significant differences in male and female scores on the SVS. Results for items 7 and 8 were the most pronounced. Specifically, item 7 \((F(2, 86.00) = 7.898, p = .007)\) and item 8 \((F(2, 84.00) = 5.502, p = .023)\) yielded significant differences between the scores of male and female students.

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>Male M</th>
<th>Male SD</th>
<th>Female M</th>
<th>Female SD</th>
<th>Sig.</th>
<th>F</th>
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<td>3.20</td>
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<td>3.004</td>
</tr>
<tr>
<td>2</td>
<td>2.11</td>
<td>1.33</td>
<td>2.20</td>
<td>1.32</td>
<td>.842</td>
<td>.040</td>
</tr>
<tr>
<td>4</td>
<td>3.13</td>
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<td>3.20</td>
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<td>8</td>
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<td>1.86</td>
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<td>5.502</td>
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Chapter 5

SUMMARY OF THE STUDY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

The purpose of this research was to understand factors that lead to the success of African American students in engineering programs by identifying how students cope with adversity as they approach graduation. The second purpose was to distinguish the similarities and differences in coping strategies of African American engineering students by analyzing their perceptions of stereotype threat at three academic institution types, Predominantly White Institutions (PWIs), ethnically diverse, and Historically Black Colleges and Universities (HBCUs). Participants were selected from three types of universities and were administered a demographic questionnaire and the SVS online to see determine whether significant differences existed between scores on the SVS and institution type.

The results of this study could help researchers determine differences in the achievement of minorities in different college environments. The results are helpful to determine whether males and females respond differently to stereotype threat. Finally, the results increase educators’ understanding African American students’ needs at campuses with varying levels of minority students. However, the most important goal is retention in engineering programs and progress toward graduation in a timely manner; in this study, these concepts were studies in light of stereotype threat and type of university. This chapter summarizes the findings, draws conclusions for the data and implications for colleges and policymakers, and recommends future areas of study related to college student retention, African Americans and females in Science, Technology, Engineering, and Mathematics (STEM) majors, and stereotype threat.
Summary of Study

A significant shortage of engineers exists in America. Frehill et al. (2009) indicated that the current number of new engineers annually is 65,000-75,000; however, this number needs to be 115,000-125,000 to fuel the U.S. economy. Although some schools and industries may be tempted to recruit science and engineering students from other countries, the United States has a potential storehouse of scientists in its public school system. This crop of future workers includes female and minority students and needs only to be cultivated (Chubin et al., 2005). Because of the anticipated changing demographics of the United States over the next 20 years, substantial increases in Hispanic and African American students entering engineering fields will be needed to keep up with the proportions and ethnic diversity of the total population (Trenor et al., 2008). The success and retention of African American students in engineering programs may be dependent on the climate to which they are exposed (Aronson et al., 2002; Brown et al., 2005; Fries-Britt & Griffin, 2007; Hendricks, 1996) and their abilities to withstand the stresses of being an underrepresented minority in a STEM field (Steele, 2011).

African American students face negative stereotypes every day that they attend college, which could be connected to low graduation rates and low achievement compared to their white peers (Steele & Aronson, 1995; Walton & Spencer, 2009). Rodgers and Summers (2008) found that African American students at PWIs reported lower academic self-concept and lower achievement than did students at HBCUs and ethnically diverse universities. Additionally, research on African American students who attend HBCUs has found that these students have an edge in GPA, perception of campus climate, academic self-efficacy, and self-concept compared to African American students at PWIs (Cokley, 2000; May & Chubin, 2003). African American students who attend HBCUs also report less social isolation, alienation, personal dissatisfaction,
and overt racism than do their counterparts who attend PWIs (Harper et al., 2004). Even though a number of studies point to less stereotype threat at HBCUs (e.g., Cokley, 2000; Harper et al., 2004; May & Chubin, 2003), more research is needed to determine whether this phenomenon is true.

A number of researchers have examined African American students at HBCUs and PWIs (e.g., Aronson et al., 2002; Brown et al., 2005; Fries-Britt & Griffin, 2007; Hendricks, 1996); however, few studies have look at a third school designation, ethnically diverse. The present study included a comparison of students enrolled in three designations of universities to assess whether differences in students’ perceptions of stereotype threat truly exist and if the type of university has any connection to those differences.

The purpose of this study was to identify how African American engineering students cope with adversity as they approach graduation. The findings may increase educators’ understanding of strategies to retain quality minority students. The research was also conducted to distinguish similarities and differences in African American students who were enrolled in PWIs, ethnically diverse institutions, and HBCUs with a specific focus on how they respond to stereotype threat. Participants were administered an online survey in which they filled out a demographic questionnaire and the SVS. The first analysis was conducted to determine whether significant differences existed in the scores on the SVS between students enrolled at different types of universities. The second analysis was conducted to determine whether a significant relationship existed between scores on the SVS and the percentage of African American students at each type of campus. A third analysis was conducted to determine whether significant differences existed between the scores of male and female students across the campuses.
Discussion of Results

The comparison of the 48 students (38 male and 10 female) showed subtle differences in their perception of stereotype threat. The results of all three tests failed to reject the null hypothesis in every case. Dimension 1 (negative experiences) yielded mostly high significance scores on items 1, 4, and 6 \( (p = .957, p = .800, \text{ and } p = .939, \text{ respectively}) \), which indicates that there is no significance differences between students in their perceptions of negative stereotype experiences. Item 8 yielded a significance value of \( p = .335 \), which denotes a slight difference between the types of universities. Although it did not meet the threshold of \( \alpha = .05 \), this score was lower than were those of the other items. Item 8 was, “In the academic setting, I often feel that others look down on me because of my race.” While other items denoted people of their race, item 8 used “look down on me,” which may have elicited feelings that the item was more personal. Students at PWIs scored an average of 4.12 on item 8 compared to 3.64 for students at HBCUs and 3.2 for students at ethnically diverse universities. There data point to higher feelings of stereotype threat at least for item 8.

Dimension 2 (group racial differences) yielded fairly high significance scores on items 2 and 5 \( (p = .550 \text{ and } p = .832, \text{ respectively}) \). However, item 7 yielded a low significance score \( (p = .060) \) although this result did not meet the threshold to be considered significant. Item 7 was, “My race does not affect people’s perception of my academic achievement.” For this item, it appears that African American students at PWIs felt strongly that their race has an effect on their perceptions of the academic environment. The scores from PWIs on item 8 averaged 4.12 (denoting high stereotype threat), while the scores at the other campuses were fairly similar to each other, HBCUs \( (M = 3.64) \) and ethnically diverse \( (M = 3.20) \). It is possible that an average
of 18% of African American students at the ethnically diverse campus could offer a critical mass of minority students, thereby buffering the effects of stereotype threat (Steele, 2011).

Although there were slight differences on two item (7 and 8), overall there appears to be little difference between the average scores on the SVS across the three types of campuses. Both Box’s Test of Equality of Covariance Matrices and Wilk’s Lambda Effect analyses yielded nonsignificant results for Dimensions 1 and 2, which indicate similarity between the institutions. The possible reasons for this lack of significant difference could include adequate institutional support, organizational support from the NSBE or similar clubs, and offering study groups to students in a nonthreatening atmosphere. Other unknown mitigating factors may also reduce the stereotype threat felt by African American students.

Similar conclusions can be drawn from the Pearson’s correlational analysis. This portion of the study compared the average scores on the SVS at the three types of campuses to the percentage of African American students at these universities. The percentage of African American students at the selected universities averaged 4.0% at the PWIs, 18% at the ethnically diverse universities, and 96.8% at the HBCUs. The majority of the items did not show a relationship between the two variables (5 out of 7 items). Item 1 (“Professors expect me to do poorly in class because of my race.”) showed a correlation of -.778, which indicates a strong negative relationship between the scores (level of stereotype threat) on the SVS and the percentage of African American students on campus. This finding points to more problems with stereotype vulnerability at PWIs. Item 7 (“My race does not affect people’s perception of my academic achievement.”) showed a positive correlation ($r = .396$), which could point to more stereotype threat at PWIs. Of note, item 7 deals with the personal perceptions of others and may
also describe the personal nature of feelings reported in the African American population. However, the result for item 7 was not significant; thus, the null hypothesis could not be rejected.

Finally, there is a discrepancy with the results of one of the items as it relates to stereotype threat and the percentage of African American students. Most of the questions showed no relationship between minority presence and stereotype threat. However, item 2 showed \( r = -.773 \) a complete opposite pattern of item 1 \( r = -.778 \). Item 2 states: “My academic success may have been easier for people of my race.” A lower score on this item denotes a stronger perception of stereotype threat. The mean score on item 2 at HBCUs was 1.82 in contrast to ethnically diverse universities (M = 2.35) and PWIs (M = 2.06). This finding could relate to the way the question is phrased. This item does not reflect the institution where students are enrolled; rather reflects the personal feelings they have that academic success is not easy, regardless of where they attend college. To students at HBCUs, race is salient, even though they are surrounded by a majority of African American engineering students. While, these students do not feel threatened, they are cognizant of their race and society’s view of their race. Overall, the correlational study showed a weak relationship between the percentage of African American students and their scores on the SVS instrument (excluding items 1 and 2). Therefore, these results also failed to reject the null hypothesis that no relationship exists.

The comparison of male and female students using a 2-factor MANOVA analysis yielded near significant differences in 5 out of the 7 questions. With the exception of items 2 \( p = .842 \) and 4 \( p = .911 \), the majority of the items showed slight differences between the average scores of males and females: item 1 \( p = .090 \), item 5 \( p = .196 \), and item 6 \( p = .077 \). However, because the threshold of \( \alpha = .05 \) was not met, the scores cannot be considered statistically significant. Item 7 \( p = .007 \) and item 8 \( p = .023 \) yielded significant differences between the
scores of male and female students. Overall, this analysis showed slight differences in the sexes and their perceptions of stereotype threat.

At first glance, these data seem to reject the third null hypothesis that no significant differences exist between male and female participants on the SVS. However, strictly based on the statistics and overall significance levels, this hypothesis cannot be rejected. Although the scores on Wilk’s Lambda Effect analysis for both Dimensions 1 ($p = .195$) and 2 ($p = .068$) were fairly low, they did not meet the threshold of $\alpha = .05$ that was needed to demonstrate significance differences between male and female scores. Of the three hypotheses, this one came closest to showing significant differences, mostly from the results of items 7 and 8.

Before drawing conclusions about the results of this study, a number of areas for possible error must be discussed. First, the small number of total participants ($N = 48$) and, specifically, the small number of female students surveyed ($N = 10$) is troubling. However, considering small number of minority engineering majors at each campus, it does appear to be a fair and representative sample of students. Second, there is debate on conducting MANOVA when data are ordinal in nature. Velleman and Wilkinson (1993) believed that this test is justified for the purposes of comparison as long as the scores are not considered equally important or rigid in their scale values. In this regard, it is possible that the actual scores are not important. The current data reflect differences in the feelings and perceptions of African American students; researchers should only these data as points of reference and comparison, not as concrete measures. While the actual scores are not important, the feelings and perceptions of the students are and these are reflected in their SVS scores. Finally, participants may have misunderstood some of the survey items. Specifically, terms such as unfair evaluations and academic setting may have been confusing. Participants may have wondered if evaluations referred to formal
tests, written tests, semester exams, or daily grades. Participants may also not have known whether *evaluations* referred to objective testing or subjective evaluations of the students themselves by their professors and peers. Finally, participants may not have known whether *academic setting* referred to their institution, study groups, classes, or a combination of the three.

**Conclusions and Implications**

Overall, there appears to be very small differences among the perceptions of stereotype threat of the three types of institutions, PWIs, ethnically diverse institutions, and HBCUs. This lack of difference could be due partly to the small sample size and partly to the ambiguity of some survey items. However, upon closer analysis of the data, slight differences emerged. Items that reflect personal feelings seemed to show some significance across the three groups (specifically, items 7 and 8). Differences emerged when participants were pushed to judge their personal feelings of stereotype threat.

Although not part of the original study design, an additional 2-factor MANOVA was conducted in SPSS to compare participants’ scores on the SVS at HBCUs and ethnically diverse institutions. This analysis yielded little differences between the two types of institutions (see Table 5). Item 2 yielded a slight differences \( p = .281 \) although not significant; the remaining items yielded significance levels or .450 or higher. These findings demonstrate that participants’ perceptions of stereotype threat at the two institutions were similar. One could question whether this finding reflects the percentage of African American students at both institutions. Although 18% African Americans at the ethnically diverse campuses seems low, it is possible that this critical mass of minorities mitigates the negative stereotypes perceived by some engineering students (Steele, 2011).
Table 5

2-Factor MANOVA Comparing HBCUs and Ethnically Diverse Colleges

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>HBCU M</th>
<th>HBCU SD</th>
<th>Ethnically Diverse M</th>
<th>Ethnically Diverse SD</th>
<th>Sig</th>
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</tr>
<tr>
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<td>1.605</td>
<td>.732</td>
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<td>1.899</td>
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</tr>
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</tr>
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<td>3.64</td>
<td>2.292</td>
<td>3.20</td>
<td>1.881</td>
<td>.572</td>
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</table>

Concerning the correlational study, 5 of the 7 items showed no significant differences when comparing SVS scores to the percentage of African American students on each campus. Item 1 showed a higher level of stereotype threat at the PWIs and item 2 showed a stronger sense of stereotype threat among students at the HBCU. When analyzing these items, one can see that participants might be considering their race as a whole and not necessarily linking their experiences to institutional factors. Further, participants’ salience, or awareness, of their race is evident at the HBCU and a sense of unity and solidarity with their fellow African American students makes that sense even stronger.

Of the three hypotheses, hypothesis 4, regarding differences between male and female students was the most significant, yet failed to statistically show differences and reject the null hypotheses. Four items (2, 4, 5, and 6) showed a significance of .090 or lower and two items (7 and 8) showed significance levels below .050. An analysis of the reasons behind these
differences is difficult because the SVS instrument does not consider gender or ask any questions related to gender.

Because African American females are a small subgroup of the overall engineering population, they may perceive their double consciousness or double jeopardy status reflected in the fact that they are both female and African American (Logel et al., 2011). In fact, Ong (2005) proposed a triple threat for African American females that reflects their status as a female, a minority, and a student pursuing a nontraditional STEM career. Of the categories compared, sex showed the highest level of difference even though the findings were not significant.

Since the development of the theory of stereotype threat in the 1990s (Steele, 1997; Steele & Aronson, 1995), there has been much research related to its effects on achievement in the African American population (Steele & Aronson, 1995; Strayhorn, 2010; Walton & Cohen, 2007; Whiting, 2009). Many studies have also looked at the different levels of stereotype threat at PWIs and HBCUs (Aronson et al., 2002; Brown et al, 2005; Fries-Britt & Griffin, 2007; Hendricks, 1996). However, few have looked at the role of the third category of universities, ethnically diverse. Ethnically diverse universities are comprised of between 11% and 20% of African American students. The ethnically diverse universities in this study averaged 18%. It is possible that this critical mass of African American students is beneficial to other minority students, by giving them a greater number of role models, study group relationships, and greater minority class composition. Trenor et al. (2008) found that an ethnically diverse learning environment could be very beneficial for female engineering students as evidenced in their success in helping minority students build social supports and realize higher achievement. When comparing the average scores of the SVS of HBCUs to ethnically diverse campuses, no significant differences were found in the level of stereotype vulnerability.
If HBCUs and ethnically diverse institutions are successful in helping students overcome feelings of stereotype threat, the question remains, “Is there any possibility that PWIs can effectively serve their African American students?” At first glance, it seems the odds are stacked against these institutions. However, there a few reasons for hope. First, it appears the difference between the institutions on the level of perceived stereotype in this study was minimal. Except for a few survey items, the average measure of stereotype vulnerability was not substantially different between the three institution types. It is possible that the universities chosen for this study has adequate institutional support, collegial study groups with high minority participation, and strong support from organizations such the NSBE that help mitigate the effects of stereotype threat. At least one of the PWIs used NSBE membership and the organization’s student president in recruiting students to participate in this study. At this university, students who agreed to participate appeared to be highly invested in the program and confident in their abilities.

**Recommendations for Future Research**

This study answered some questions; however, opened up numerous possibilities for future research and expansion of the current project. The research did not clearly find a relationship between stereotype threat and university composition. For clearer results, two improvements should be made to the current study. The first recommendation is to expand the number of participants at the current universities to determine whether the conclusions derived from the current study still hold true. For better balance of institutions, a second HBCU should be added. The second recommendation is to solicit more female participants at the three universities. The current study analyzed 10 female students and compared their stereotype vulnerability to 38 males across the three institution types. The current study analyzed collective
gender scores for all participants. Therefore, it would be worthwhile to compare the scores of female students across institution types as well as the scores of male and female students across institutions types. For this of analysis to occur, a larger female sample size is needed.

Related studies could also be developed to test similar hypotheses. A number of universities in different parts of the country could be assessed and compared to the current results. Research questions of interest may include the following:

- Does geographical location of a university have any connection to stereotype threat among its students?
- Does the total population of a university affect stereotype threat?

Similar studies could also look at the amount of stereotype threat at private and Ivy League universities such as Harvard. Additionally, researchers could examine schools that have a substantial population of African American engineering students and compare university level (freshman, sophomore, junior, and senior) to level of stereotype threat. Considering this variable, researchers could determine whether students’ vulnerability to stereotype threats increase or decrease as they progress toward graduation. This type of research could be accomplished using a longitudinal study that follows a group of African American engineering students from their freshman year until graduation and periodically assess their perceptions of stereotype threat.

Because the students who chose to participate in this study seemed to take interest in their success and the success of their peers, the results of the current project are quite optimistic and reflect students with a strong chance of completing their degrees. However, it is important to assess students who drop out of these programs. A quantitative analysis of scores on the SVS among students who drop out could be revealing and help researchers understand whether
students drop out because of stereotype threat. Such a study should be combined with qualitative methods in which students are interviewed to shed more light on their reasons for dropping out or changing majors.

Future studies could also focus on African American engineering students who recently graduated as well as those in engineering careers to see how their level of stereotype threat compares to that of undergraduate students and non-finishers. Schmader and Croft (2011) said, “We might learn a great deal from specifically studying those individuals who attain great success despite frequent exposure to stereotype threat clues. Perhaps in success stories, we can backward engineer the recipe for advancement and resilience” (p. 802).

Future research could also focus on the differences between male and female minority students. The results of the current study show that females perceive stereotype threat more so compared to their male counterparts. The reasons for these differences are unknown; however, could relate to the double pressures they face because of their status as both a minority and a female in a STEM career. The major problem with the current research was the small overall population of female engineering students. Combining more quantitative studies of female engineers with qualitative studies could offer a clearer understanding of the pressures that females, especially African American females, face in the field of engineering. Research could also be developed to examine differences between females of other nonminority races and African American females as they relate to stereotype threats they all seem to face.

One problem that must be resolved is the development of an instrument that delineates the source of stereotype threat experienced by females separate from their minority status. The differences seen between male and female students in the current study could relate to females’ minority status, their status as a female only, or both. The SVS does not include items related to
gender, but that also was not the original intent of the instrument (Spencer, 1993). Thus, research should be conducted with females at different types of institutions (i.e., HBCUs, PWIs, private universities, elite universities, and female-only universities).

Finally, research is needed to determine the similarities and differences at HBCUs, ethnically diverse universities, and PWIs as they relate to student development, institutional support, and academic achievement. Future research could take a deeper look at ethnically diverse universities to see if these institutions could serve as a model for other institutions in the area of institutional development and minority services (Trenor et al., 2008). Researchers might ask the following question: How do the different institutions help their students withstand the pressures of stereotype threat? Steele (2010) believed that stereotype threat is pervasive and salient to all African American students; it is not a matter of whether they feel the threat, it is related more so to how they face the threat and how it affects their success. The current survey instrument only measured stereotype vulnerability, which means that it measured how much students were aware of their perceptions of the threats around them. How participants responded to the survey is a different story entirely. This difference is why a focus on engineering graduates and professionals is so important; students who overcome negative influences and finish their programs could serve as role models to the larger population of African American students.

**Summary of Study**

This study examined a small sample population of African American engineering students at PWIs, ethnically diverse universities, and HBCUs. Findings revealed little differences between scores on the SVS. A few areas indicated that HBCUs and ethnically diverse universities are doing a similar job in addressing perceptions faced by their African
American engineering students. The findings also revealed no correlation between the percentage of African American students and scores on the SVS. Of note, slight correlations were found on questions that relate to the personal feelings students have about their race. One question even showed that students at HBCUs were aware of these stereotypes and were highly aware of their minority status. The strongest findings related to the differences in male and female students across universities. African American female engineering students appeared to perceive more stereotype threat than did their male counterparts.

Future research should focus on the following: (1) expanding the number of survey participants at the current universities, (2) adding more HBCUs, (3) running similar experiments in different parts of the country, (4) comparing stereotype threat in private and elite universities, (5) using ethnically diverse universities as a model for minority student development, and (6) using new or improved survey instruments that delineate race and gender stereotype threat as faced by African American female students. The following idea must always be in forefront: How can universities create an environment that drives female and minority students to graduate in the field of engineering? According to Chubin et al. (2003), all universities can be minority serving. The future and prosperity of the United States depends on a strong and diverse base of scientists and engineers of all genders and races.
REFERENCES


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APPENDICES
APPENDIX A

STEREOTYPE VULNERABILITY SCALE
STEREOTYPE VULNERABILITY SCALE

The following questions are about how you feel about being an African American college student, and about how these feelings may affect your perceptions of your academic ability. For some people, their race is a major concern; for others it is less important. We would like you to consider your race and respond to the following statements on the basis of how you feel about your race and ethnicity. There is no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions.

1. Professors expect me to do poorly in class because of my race.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

2. My academic success may have been easier for people of my race.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

3. I doubt that others would think I have less academic success because of my race.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

4. Some people feel I have less academic success because of my race.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

5. People of my race rarely face unfair evaluations in academic classes.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

6. In the academic setting, people of my race often face biased evaluations from others.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

7. My race does not affect people’s perception of my academic achievement.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree

8. In the academic setting I often feel that others look down on me because of my race.
   1  2  3  4  5  6  7
   strongly disagree  strongly agree
APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE
Demographic Questionnaire

Name__________________________________

Research Code: __________________________

Classification (Junior or Senior): _______________________________

Sex: _____ Male       _____ Female

Age: _____ Race: Caucasian     African American     Other:_____________________

Please describe the degree to which you aspire: _________________________________

In what year do you plan to graduate? _________

What year did you begin your freshman year of college? ____ Are you a transfer student? Yes  No

If Yes, name the college or university from which you transferred:____________________

Name of College or University Presently Attending: ______________________________

Classification of college/university: Private _____ Public ___________

Would you describe your high school as rural or urban? ___________________________

Estimate the percentage of your college paid for by grants, scholarships, or financial aid (not including loans)? _______%

On a scale of 1 to 5, place self-rate your mathematics abilities (1 being poor and 5 being excellent):

1  2  3  4  5

Were you always an engineering major? ________Yes       ________No

If no, please list other majors you considered before changing to engineering:

____________________________________________________________________

Email Address _______________________

THANK YOU

Permanent address of your choosing: 904 West 41st Texarkana, Texas 75503
Email:dsparks@leomail.tamuc.edu
APPENDIX C

INFORMED CONSENT LETTER
Coping Strategies of African American Engineering Students

Description of the Study and Your Part in It

David Sparks, a doctoral candidate at Texas A&M University-Commerce under the guidance and supervision of Dr. Rusty Waller invites you to participate in a research study. This study involves research with African American engineering students. The purpose of the study is to determine if African American students at different types of universities (predominantly White, urban ethnically diverse, and Historically Black) have similar perceptions of stereotype threat.

The research method to be used is a quantitative study using a scale that measures perception of stereotype threat. You will be asked to take the surveys and to complete a basic demographic questionnaire. The surveys are found at freeonlinesurveys.com and should take approximately 30 minutes.

Risks and Discomforts

The risks for this study are minimal and will be no more than is expected in daily life. There is the risk that participating in the study may lead to some emotional and cognitive discomfort related to the degree to which one is affected by the issues when discussing the stressors of college life. If you experience any emotional discomfort or distress as a result of your participation in this study you are encouraged to contact the university counseling center for support.

Possible Benefits

The primary benefit of participating in the study may be learning more about themselves and their perception, if any, of the strategies used to cope with stress while pursuing an engineering degree. Another benefit of student participation in the study will be to help universities understand how to help students become more successful by helping them cope with the stresses of academic life.

Incentives

There will be no financial and gift compensation for this study.

Protection of Privacy and Confidentiality

The students’ names will not be used, nor will it be indicated on the questionnaire or the surveys. This consent form will be kept separate from the instrumentation packet to insure confidentiality, and only code numbers will be used to link participants with the completed materials. Once data collection is complete, the consent forms and data will be locked in a secure location. Demographic information and data will be shared with the researcher’s committee, but the committee will not have access to your individual forms.
Choosing to Be in the Study

You do not have to be in this study. Participation is voluntary. You may choose not to take part and you may choose to stop taking part at any time without penalty. You will not be punished in any way if you decide not to be in the study or to stop taking part in the study.

You may choose to stop taking part in this study after today. If you do, we will not collect any more information from you. However, we would keep and use the information we had already collected from you.

Contact Information

If you have questions regarding the study, feel free to contact David M. Sparks at (903) 794-8032 or dsparks@leomail.tamuc.edu. Should a research related injury occur or questions related to the rights of research participants arise, contact committee chairman,

Rusty Waller, Ph.D.
Associate Professor and Interim Department Head
Department of Educational Leadership, Texas A&M University-Commerce
PO Box 3011
Commerce, Texas 75429-3011
(903) 886-5125
rusty.waller@tamuc.edu

If you have any questions or concerns about your rights in this research study, please contact the Texas A&M University-Commerce Office of Sponsored Programs (OSP) at 903-886-5143 or mona.gilley@tamuc.edu. And you may contact the IRB Chair at

Dr. Carmen Salazar
Chair, Institutional Review Board (IRB)
Department of Counseling
Texas A&M University-Commerce
Commerce, TX 75429-3011
(903) 886-5634
carmen.salazar@tamuc.edu

Consent Information

If you agree to participate in the study, a link to the research project on freeonlinesurveys.com will be emailed to you. After reading the Informed Consent document, if you agree to its terms and conditions, click Next and you will be directed to the survey. Continuing to the survey will designate your signed consent, so please read the description carefully before agreeing to participate.
VITA

David Maurice Sparks was born September 19, 1967 in Texarkana, Texas. His parents are Jeanne Sharon Sparks and the late Donald Sparks. He attended school in Texarkana ISD and graduated from Texas High in Texarkana, Texas in 1986. After attending Texarkana College from 1986-1988, he transferred and completed his Bachelor of Science Degree in Scientific Nutrition at Texas A&M University in 1990. In 1992, he began a teaching middle school science in Texarkana, Texas. He was voted Secondary Teacher of the Year in 1995. David taught secondary science and technology for 20 years in school districts in Texarkana, Redwater, Queen City, and McCleod. In 2005, he received his Master of Science in Interdisciplinary Studies from Texas A&M University-Texarkana. In 2008, he began his doctoral studies at Texas A&M University-Commerce and received the Pathways to the Doctorate Fellowship to complete his studies. Mr. Sparks has a daughter, Mauri, and a son, Caleb. In 2012, he began teaching at the Hope Academy of Science and Technology in Hope, Arkansas. He plans to pursue a second career in Higher Education.