# ABSTRACT

## STEREOTYPE THREAT: A QUALITATIVE STUDY OF THE CHALLENGES FACING FEMALE UNDERGRADUATE ENGINEERING STUDENTS

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From a sociocultural point of view, this qualitative case study explored how upper-level, female undergraduate engineering students perceived the possibility of or experience with stereotype threat as shaping their experiences. The study also investigated how these students explained their reasons for choosing their engineering major, the challenges they encountered in the major, and their reasons for persevering in spite of those challenges. Using Steele and Aronson's stereotype threat theory as a framework, and considering the documented underrepresentation of females in engineering, the study sought to examine how stereotype threat shaped the experiences of these students and if stereotype threat could be considered a valid reason for the underrepresentation.

The study was conducted at a large, four-year public university. First, students in the College of Engineering and Engineering Technology completed the Participant Screening Survey. Based on responses from the survey, six female engineering students from the college were identified and invited to participate in the study. The participants came from the following majors: Electrical Engineering, Industrial and Systems Engineering, and Mechanical Engineering. After receiving the study consent letter and agreeing to participate, the students

were involved in a 90-minute focus group meeting, a 45-minute one-on-one interview, and a 30-minute follow-up interview.

After conducting the data collection methods, the data were then transcribed, analyzed, and coded for theme development. The themes that emerged coincided with each research question. The themes highlighted the complex interactions and experiences shared by the female engineering majors.

The female students were enveloped in an environment where there existed an increased risk for activating stereotype threat. In addition, the female students described feeling pushed to prove to themselves and to others that the negative stereotype that "females are bad at engineering" was untrue. The findings illustrated the need for systematic changes at the university level. Intervention recommendations were provided. In regards to female underrepresentation in science fields, including engineering, stereotype threat certainly had the potential to cause the female students to question themselves, their abilities, their choice of an academic major, and subsequently remove themselves from a hostile learning or working environment. Thus, educational institutions and workplace organizations are responsible for not only educating themselves regarding stereotype threat but also for taking steps to alleviate the pernicious effects of stereotype threat.

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# STEREOTYPE THREAT: A QUALITATIVE STUDY OF THE CHALLENGES FACING FEMALE UNDERGRADUATE ENGINEERING STUDENTS

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DEDICATION

To my wife and family

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# CHAPTER 1

# INTRODUCTION

Knowledge and skills in science, technology, engineering, and math (STEM) are pivotal for developing an informed citizenry, bolstering the United States' capacity for innovation, and further establishing the means by which the nation can compete in the global marketplace (Beede et al., 2011; Casey, 2012; Science Pioneers, 2014). The U.S. Department of Education (2014) stresses this nation has been a global leader due in part to its scientists, engineers, and innovators. It is a widely held belief that the nation's scientists and engineers are fundamental to technological leadership in the U.S. and that the nation's economic strength, manufacturing services, national defense, and other societal needs depend immensely on the nation's skilled engineering workforce (Sargent, 2014). Yet, the vulnerability of the nation's leadership position partially results from a paucity of skilled workers entering STEM fields (Experis Engineering, 2016; Hill, Corbett, & St. Rose, 2010; National Academy of Sciences, 2007; U.S. Department of Education, 2006; U.S. Government Accountability Office, 2006). Some predict that this lack of skilled STEM workers, especially in science and engineering, will harm American competitiveness in the global marketplace, hinder America's innovative capabilities, and result in unfilled jobs in the future (Beede et al., 2011; Casey, 2012; President's Council of Advisors on Science and Technology, 2012). Compounding the nation's overall issue of lacking enough skilled workers to fill science and engineering jobs is the documented underrepresentation of subgroup populations, specifically women in engineering, advanced-level mathematics, and the

physical sciences (Ceci, Williams, & Barnett, 2009; Moss-Rascusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; National Science Foundation, 2002; Nelson & Rogers, 2004; Parker, Pillai, & Roschelle, 2016; Valian, 2007).

Unfortunately, gender-based stereotypes exist that perpetuate the deleterious belief that women lack math ability. In addition, engineering is often perceived as inappropriate for women (Miller, 2004; Muller, 2003; Villa & Gonzalez y Gonzalez, 2014). Research suggests that because of these negative stereotypes, women may be less likely than men to select an engineering major (Frehill, Ketcham, & Jeser-Cannavale, 2005; National Science Foundation, 2011, 2013; Romkey, 2007; Spencer, Steele, & Quinn, 1999). Furthermore, knowing that they are being judged in light of the stereotype can cause female students to question their identity, specifically whether they belong in the field of engineering (Heyman, Martyna, & Bhatia, 2002; Seymour & Hewitt, 1997; Villa & Gonzalez y Gonzalez, 2014). Researchers also suggest that, as a result of discrimination from peers and professors, women students in engineering have significantly different experiences than their male peers (Garcia Guevara, 2002; Seymour & Hewitt, 1997; Villa & Gonzalez y Gonzalez, 2014). If these negative stereotypes and the experience of stereotype threat, a situation where an individual feels threatened by confirming or fulfilling a negative stereotype about the group for which he or she belongs (Steele & Aronson, 1995), are keeping women from entering the field of engineering, this issue needs to be further examined.

Cobbett (2013) suggests that little qualitative information exists regarding the experiences of female students in school. According to Villa and Gonzalez y Gonzalez (2014), "It is important to understand how gender can shape the experiences of female college students in engineering programs" (p. 1044). Therefore, it is essential to examine the experiences of

upper-level, female, undergraduate engineering students as they persist through this type of educational environment.

## Theoretical Framework

Pervasive stereotypes exist regarding gender, academic skills, competencies, and abilities (Eagly & Wood, 1991; Eccles, Jacobs, & Harold, 1990; Quinn & Spencer, 2001). For instance, one stereotype holds that males are better in the domains of mathematics and science while females are better in the domains of English and reading. A problem often associated with stereotypes such as these is that they have the potential to affect students and the choices they make concerning the books they choose to read, the classes they choose to take, and eventually the careers they choose to pursue (Biernat, 1991; Constantinople, Cornelius, & Gray, 1988; Eccles, 1987; Leinhardt, Seewald, & Engel, 1979; Martin, Wood, & Little, 1990; Meece, Eccles, Kaczala, Goff, & Futterman, 1982; Seymour, 2000). What is more, stereotypes can create a threatening environment for groups of students about whom a negative stereotype exists and therefore affect their academic performance. Steele and Aronson (1995) refer to this as stereotype threat.

Generally speaking, stereotype threat can negatively impact the members of any group for whom a negative stereotype exists (Steele, 1997). When engaging in an intellectual task in a specific domain, stereotype threat theory asserts that for a group of people in that domain about whom a negative stereotype exists, this group faces the threat of confirming and subsequently being judged by the negative stereotype (Schmader, Johns, & Forbes, 2008; Shapiro, 2011; Shapiro & Neuberg, 2007; Steele & Aronson, 1995). When students are informed about gender differences or ability differences on tests and told certain subgroups perform better than others,

thereby making the stereotype and gender or ability differences salient, the subgroups for whom a negative stereotype exists perform significantly worse than the subgroups for whom no negative stereotype exists (Danaher & Crandall, 2008; Huguet & Regner, 2007; Keller & Dauenheimer, 2003; Neuville & Croizet, 2007; Pavlova, Weber, Simoes, & Sokolov, 2014). For instance, in their study of stereotype threat effects on the intellectual test performance of African Americans, Steele and Aronson (1995) found that African American students who were informed that a verbal test was ability diagnostic performed significantly worse than their equally skilled White participants and the African American participants in the control group who were not informed that the test showed ability differences.

Stereotype threat has been shown to cause performance decrements, especially regarding the performance of stereotyped groups on standardized tests (Ambady, Shih, Kim, & Pittinsky, 2001; McKown & Weinstein, 2003; Pavlova et al., 2014; Spencer et al., 1999; Steele & Aronson, 1995). Studies have demonstrated that the activation or acknowledgement of negative stereotypes concerning an individual's group membership significantly impedes performance (Ambady et al., 2001; Aronson, Quinn, & Spencer, 1998; McKown & Weinstein, 2003; Spencer et al., 1999; Steele & Aronson, 1995; Steele, 1997). For instance, Spencer et al. (1999) found that when women were given math tests and told that the tests were known to show gender differences, these women performed substantially worse than equally skilled men.

Research has shown that stereotype threat negatively impacts a student's grade point average (Aronson & Jones, 1992), visual-spatial reasoning skills (McGlone & Aronson, 2006; McKown & Weinstein, 2003; Schmader & Johns, 2003), cognitive assessment performance (Aronson, Fried, & Good, 2002; McKay, Doverspike, Bowen-Hilton, & Martin, 2002), future career choice (Davies, Spencer, Quinn, & Gerhardstein, 2002; Davies, Spencer, & Steele, 2005),

and working memory (McKay, Doverspike, Bowen-Hilton, & McKay, 2003). Also alarming, researchers have found that simply being in the minority, which many upper-level, female, undergraduate engineering students are, can induce stereotype threat effects (Inslicht & Ben-Zeev, 2003). Based on studies such as these, it may be suggested that stereotype threat need not be primed to perniciously impact the educational experiences of upper-level, female undergraduate engineering students. These students live these problematic experiences. According to Cobbett (2013), fitting in at school is very different for female students than it is for male students.

It is important to note the distinction between stereotype threat and the act of stereotyping. Stereotype threat is a psychological phenomenon that supposes during academic tasks those for whom a negative stereotype exists are burdened with an extra cognitive load as they exert effort to disprove said stereotype. On the other hand, according to Vescio and Weaver (2013), stereotypes are cognitive representations or beliefs about a group that include how people of that group might look, what their abilities might be like, and how they might behave. Interestingly, although one may not subscribe to or endorse a certain stereotype, simply being aware of the stereotype could affect one's behavior and judgment. One engages in the act of stereotyping when he or she attempts to create shortcuts for defining or understanding a group of people in a complex world. Vescio and Weaver further state:

> Using these mental shortcuts when making decisions about other individuals can have serious negative ramifications. The horrible mistreatment of particular groups of people in recent history, such as that of Jews, African Americans, women, and homosexuals, has been the major impetus for the study of prejudice and stereotyping… people who reject prejudice and stereotyping can still unwittingly internalize stereotypic representations. (p. 1)

For this study, the link between stereotyping and stereotype threat becomes apparent when individuals engage in stereotyping, whether consciously or unconsciously, and create a threatening intellectual environment where people for whom a negative stereotype exists feel the added pressure to disprove said stereotype.

Stereotype threat theory offers a lens for the further exploration of the experiences of upper-level, female, undergraduate engineering students. This theory, along with a more detailed explanation of stereotypes, will be further elucidated in Chapter 2.

## Problem and Purpose

The number of available jobs in STEM fields will increase in the United States in the coming years (Marra, Shen, Rodgers, & Bogue, 2012). STEM jobs in the U.S. are predicted to increase by 17% from 2008 to 2018 (Committee on STEM Education, 2012; Langdon, McKittrick, Beede, Khan, & Doms, 2011). Furthermore, between 2010 and 2020, the Bureau of Labor Statistics (BLS) predicts that the number of engineering jobs in the U.S. will grow by 252,800, or 10.4%. To meet this growth demand and replace the engineers expected to exit engineering occupations, the BLS projects that over 1.7 million engineers will be needed (Lockard & Wolf, 2012). There is concern that the U.S. is currently experiencing a dearth of skilled domestic workers in engineering and will not be able to meet these projected demands (Beede et al., 2011; Sargent, 2014). The President's Council of Advisors on Science and Technology (2012) predicts that at the current rate there will be a deficit of one million workers necessary to meet workforce demands in STEM fields. The underrepresentation of certain subgroups within the fields of science and engineering makes this an even more pressing concern. By analyzing the underlying issues causing underrepresentation, educators and

policymakers cannot only equalize the playing field but can also help to meet the growing demand of the job market.

Women constitute the majority of college enrollments in the United States. Female students make up 56% of the total undergraduate enrollment (National Center for Education Statistics, 2015). However, the underrepresentation of women in engineering, the physical sciences, and upper-level mathematics remains persistent (National Science Board, 2003; National Science Foundation, 2002, 2013). According to the National Science Foundation (2013), "Overall, more women than men graduate from college with a bachelor's degree; however, men earn a higher proportion of degrees in many science and engineering fields" (p. 4). What is more, the participation of women in computer science and engineering remains below 30%. While women's participation in computer science has increased at the doctoral level, it has actually declined at the bachelor's level (National Science Foundation, 2013). Interestingly, while women comprise the majority of college enrollments in the United States at 56% (National Center for Education Statistics, 2015), their representation in undergraduate fields such as engineering is disproportionately low when compared to males (Bae, Choy, Geddes, Sable, & Snyder, 2000; Halpern et al., 2007). This underrepresentation demonstrates an issue of not maximizing the potential of this nation's young minds. According to Hill and her colleagues (2010):

> Attracting and retaining more women in the STEM workforce will maximize innovation, creativity, and competitiveness… When women are not involved… needs and desires unique to women may be overlooked… With a more diverse workforce, scientific and technological products, services, and solutions are likely to be better designed and more likely to represent all users. (p. 3)

Researchers suggest that forces such as stereotype threat impact women's cognitive functioning in math-related subjects, which subsequently leads to underachievement and their

overall decision to avoid math-related careers (Eccles et al., 1990; Jacobs & Eccles,1985; Spencer et al., 1999). The grand majority of this research regarding stereotype threat has been conducted in laboratory settings using quantitative methods to analyze stereotype threat activation and its effects (Ambady et al., 2001; Appel, Kronberger, & Aronson, 2011; Aronson & Inzlicht, 2004; Danaher & Crandall, 2008; Inzlicht & Ben-Zeev, 2003; Neuville & Croizet, 2007; Shapiro & Williams, 2012; Spencer, et al., 1999; Steele & Aronson, 1995; Steele & Ambady, 2006). It is important to note that stereotype threat does not impact performance. Stereotype threat impairs an individual's cognitive functioning, subsequently impacting performance. Essentially, one way to better identify what, within students, is actually impacted by stereotype threat is to deeply explore the experiences of members of a stereotyped group who participate in a domain in which a negative stereotype exists (Doan, 2008). Few qualitative studies examine the stereotype threat experiences of upper-level, female, undergraduate engineering students (Cox & Fisher, 2008; Romkey, 2007; Sayman, 2013; Villa & Gonzalez y Gonzalez, 2014). As females are often excluded in engineering and beliefs held by the dominant male culture in engineering reinforce gender divisions (Miller, 2004), it is quite possible that these issues stem from sociocultural factors such as stereotype threat. What is more, the majority of qualitative studies on stereotype threat have been conducted outside the United States (i.e., Canada, the Caribbean, and Mexico). Qualitative exploration into stereotype threat and the experiences of female students in engineering will help further current research on this topic. Thus, the purpose of this study was to examine how stereotype threat shaped the experiences of upper-level, female, undergraduate, engineering students from a sociocultural perspective and to explore how these students explained their reasons for pursuing a degree in engineering.

## Research Questions

The following research questions guided this study:

1. How do upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences?
2. 2a.) How do upper-level, female, undergraduate, engineering students explain their reasons for choosing their major, 2b.) the challenges they have encountered in the major, and 2c.) their reasons for persevering in spite of those challenges?

## Significance of the Study

Understanding how stereotype threat impacts the experiences of stereotyped groups may help guide the development of initiatives or interventions that support the unhindered and equitable access to education for all students (Doan, 2008). The results of this study may also illuminate how the experiences of upper-level, female, undergraduate, engineering students who experience instances of stereotype threat contribute to gender underrepresentation in the field of engineering.

The grand majority of past and current research has been conducted in laboratory settings and focuses primarily on situational factors that may prime stereotype threat, thereby inducing performance decrements in stereotyped groups while they perform some type of intellectual task. The gap in existing research emphasizes the need for qualitative studies conducted in the United States that investigate how stereotype threat may not just be a situational dilemma but may be something that stereotyped groups are constantly surrounded by and experience throughout their educational endeavors.

A qualitative study of the experiences of upper-level, female, undergraduate, engineering students provided the opportunity to explore how stereotype threat shaped and impacted the experiences of these female students in an engineering program. Although some may argue that stereotype threat is not a mechanism impacting the gender gap in fields such as math and engineering (Stoet & Geary, 2012), its effects cannot be ignored. This study provided insight into how upper-level, female, undergraduate, engineering students persisted through instances of stereotype threat, steps educational institutions can take to encourage female students to remain in engineering once they have chosen it as their major, and how stereotype threat instances may be alleviated to encourage more females to enter the field of engineering.

## Definition of Terms

The following terms have been succinctly defined to provide clarity regarding the distinction that exists between the two concepts:

Stereotype threat theory: Stereotype threat theory posits that people in a group for whom a negative stereotype exists face the threat of confirming and then being judged by the negative stereotype (Schmader et al., 2008; Shapiro, 2011; Shapiro & Neuberg, 2007; Steele & Aronson, 1995).

Stereotyping: "Stereotypes have traditionally been defined as specific beliefs about a group, such as descriptions of what members of a particular group look like, how they behave, or their abilities… people can be aware of cultural stereotypes and have cognitive representations of those beliefs without personally endorsing such stereotypes… the product of adaptive processes that simplify an otherwise complex world so that people can devote more cognitive resources to other tasks" (Vescio & Weaver, 2013, p. 1).

## Delimitations

The study was limited to a focus group meeting with six upper-level, female, undergraduate engineering students and one-on-one interviews and follow-up interviews with those six participants in the engineering college at one large, four-year residential university in Illinois. The small sample size allowed for deep and detailed data collection. What is more, the truncated duration of the study was a delimitation.

## Methodology

I employed a qualitative case study approach to explore the experiences of upper-level, female, engineering students in the College of Engineering and Engineering Technology at one large, four-year, public university in Illinois. The pseudonym "Pleasantdale College" was used to refer to the university. I utilized a focus group meeting and one-on-one interviews. Conducting the focus group meeting first allowed me to obtain insight regarding the social intricacies and interactions of the participants in light of the topic under study, provided context for the interactions, and helped establish trust when moving forward with one-on-one interviews (Merriam, 2009; Mertens, 2015). Semi-structured participant interviews provided the deep, rich experiential data (Mertens, 2015; Seidman, 2013). After data analysis, I reread and analyzed all collected data. Then I conducted open, axial, and analytical coding to categorize emergent themes from the data (Maxwell, 2013). Member checks and peer debriefing were also conducted to ensure validity and reliability (Creswell, 2007; Merriam, 2009; Mertens, 2015).

## Limitations

The small sample size utilized during this study could be considered a limitation. In addition, another limitation was the fact that this study was conducted at a single public university in Illinois. What is more, only three departments within the College of Engineering and Engineering Technology were analyzed: Electrical Engineering, Industrial and Systems Engineering, and Mechanical Engineering.

## Organization of Study

This study is organized into five chapters. This first chapter provides the reader with foundational information regarding the importance of the study. It includes the problem statement and purpose of the study as well as an overview of the framework chosen for the study. The second chapter covers a review of the literature on information related to the problem and the theoretical framework for the study. The third chapter elucidates the methodology that was utilized to complete the study. The fourth chapter presents the findings from the data collected. Last, Chapter 5 includes a discussion of the findings, recommendations for practice, and suggestions for future research.

# CHAPTER 2

# LITERATURE REVIEW

Women comprise the majority of college enrollments in the United States. Specifically, women currently make up 56% of college enrollments in the U.S. (National Center for Education Statistics, 2015), and every year since 1982, American women have earned more college degrees than men. Yearly, this divide continues to widen in favor of females (Bae et al., 2000; Halpern et al., 2007). However, the advancement of women in regard to degrees received has not been even across all disciplines. Fewer women than men continue to pursue degrees in the physical sciences, engineering, and upper-level mathematics. The underrepresentation of women in the physical sciences, engineering, and upper-level mathematics remains prevalent (National Science Foundation, 2002, 2013; Nelson & Rogers, 2004; Valian, 2007).

Researchers, governmental and educational organizations, and other entities have warned that without a pool of highly trained mathematicians, scientists, innovators, and engineers, the United States faces significant issues that have the potential to impact the economy and America's leadership status among developed nations (Committee on STEM Education, 2012; Langdon et al., 2011; Moss-Racusin et al., 2012; National Science Board, 2003). However, a deeper issue residing within that initial problem must be considered. The underrepresentation of females in fields such as science and engineering represents a wasted opportunity to gain knowledge and resources from potential mathematicians, scientists, innovators, and engineers (Moss-Racusin et al., 2012).

Advocating for more equal representation of females in science and engineering could help address present and future workforce shortages (Halpern et al., 2007; Moss-Racusin et al., 2012). In addition, including broad and diverse perspectives would most certainly improve technological, scientific, and engineering developments. Seeing obstacles and their solutions from multiple angles will help researchers better understand and solve problems facing humankind (Blickenstaff, 2005). Addressing the issue of female underrepresentation from an informed perspective will require more details regarding the experiences of females in science and engineering education.

Chapter 2 explores how science, technology, engineering, and math – or the concept of STEM – is defined, its importance, and the role of females in STEM education and careers. The chapter also examines the underrepresentation of females in STEM education and careers and how females leak from the pipeline that leads from academic institutions and organizations to jobs and employment. In addition, the chapter illustrates three potential reasons for the underrepresentation of females in STEM: 1) supposed gender cognitive factors; 2) discrimination; and 3) the impact of sociocultural forces such as environmental factors, gender bias, and stereotyping. What is more, the chapter provides information about what actually happens when a person experiences stereotype threat and the effects of stereotype threat on performance, thinking, and learning. The chapter concludes with an exploration of current and seminal quantitative and qualitative studies conducted on stereotype threat.

## Science, Technology, Engineering, and Math

STEM is an acronym rather particular in nature. The acronym refers to the fields of science, technology, engineering, and math. However, there is much debate regarding what

exactly constitutes a STEM job or a STEM field (Beede et al., 2011). Clearly, one would presume that a job consisting of science, technology, engineering, and math would represent a STEM occupation. Yet, disagreement concerning the inclusion of exact fields and subfields is pervasive (Casey, 2012). For instance, there is developing debate around the inclusion of such fields as healthcare professionals, educators, technicians, managers, and social scientists. The U.S. Department of Commerce, Economics and Statistics Administration (ESA) elucidates that the inclusion of professional and technical support occupations in the fields of mathematics, the life and physical sciences, computer science, and engineering all constitute STEM jobs (2011).

## Importance of STEM

New science, technology, engineering, and math (STEM) education initiatives reach from small rural, suburban, and urban school districts all the way to the United States Department of Education and the White House. For instance, many school districts have developed or purchased STEM curricula. In addition, President Obama, along with the Department of Education, has emphasized the importance of STEM education through initiatives such as the Educate to Innovate initiative and the Committee on STEM Education (CoSTEM). The Educate to Innovate initiative seeks to improve the international standing of American students from the middle to the top of the pack regarding science and math achievement through efforts by the federal government and partnerships with leading organizations and foundations. The CoSTEM initiative, which is comprised of multiple partner agencies, is a national strategy to repurpose funds and reorganize STEM education programs from preschool to postsecondary education (Co STEM, 2013; White House, 2013). Thus, a firm pledge to provide STEM education to all students in the United States is fundamental to fostering an informed citizenry, strengthening the

country's innovative capacity, and further developing the means by which the nation can compete in a global marketplace (Beede et al., 2011; Casey, 2012; Science Pioneers, 2014).

Even though STEM jobs are expected to increase by 17% from 2008 to 2018, employers in the United States from certain economic sectors have reported it difficult to find job applicants with the necessary STEM knowledge and STEM problem-solving skills (CoSTEM, 2012; Langdon et al., 2011). Researchers have determined that, out of 109 countries studied, the United States ranks 29th in regard to the percentage of 24-year-olds who possess a postsecondary degree in science or mathematics (Atkinson, Hugo, Lundgren, Shapiro, & Thomas, 2007). Additionally alarming is the underrepresentation of gender populations in STEM education and careers. Reports have found that women continue to be underrepresented in STEM careers and STEM undergraduate programs (Beede et al., 2011; Ceci et al., 2009). For instance, while women constitute a substantial majority of many college enrollments in the United States, their underrepresentation in engineering, physical sciences, and upper-level mathematics remains constant (National Science Board, 2003; National Science Foundation, 2002, 2013).

## Females in STEM

Women have made advancements in the fields of science and engineering, and participation of women in advanced mathematics courses and studies has increased over the past decades (Halpern et al., 2007; Hyde, Lindberg, Linn, Ellis, & Williams, 2008). For instance, by 2001, women were earning 48% of bachelor's degrees and 29% of PhD degrees in mathematics. These findings alone reveal an exceptional increase over the last 30 years (Ceci et al., 2009; Hill & Johnson, 2004). Also the proportion of women in the field of engineering, mostly at the master's and doctoral levels, has increased significantly since 1991. Encouragingly,

participation of women at the doctoral level in the field of computer science has also increased considerably (National Science Foundation, 2013). Furthermore, data from large-scale assessments in the United States suggest the disappearance of gender differences in mathematics performance (Hyde et al., 2008; Hyde & Mertz, 2009). When considering women in STEM careers, the gender wage gap is smaller in STEM jobs than in non-STEM jobs. For instance, women earn 33% more in STEM jobs than women with comparable credentials in non-STEM jobs, which is actually higher than the STEM premium for men (Beede et al., 2011).

Yet the increase of women entering certain science fields does not indicate that they are no longer underrepresented. Interestingly, at 58%, more women graduate from college with a bachelor's degree than men (National Center for Education Statistics, 2015). However, in the fields of science and engineering, men earn a higher proportion of degrees. What is more, the participation of women in computer science and engineering remains below 30%. Since the early 2000s, while women's participation in computer science has increased at the doctoral level, it has actually declined at the bachelor's level (National Science Foundation, 2013). That underrepresentation is often attributed to the result of gender cognitive differences between males and females, discriminatory policies and practices, or sociocultural factors (Moss-Racusin et al., 2012).

## Underrepresentation of Females in STEM Education

In mathematics and the sciences, although the gender gap has narrowed over the past several decades, women pursue science at lesser rates than men at nearly all levels of education (Else-Quest, Hyde, & Linn, 2010; Hyde & Mertz, 2009). In high school, the National Center for Education Statistics (2005) shows low numbers of female students in STEM concentrations. For

instance, high-school-aged female students made up only 15% of engineering technology students, 8.5% of manufacturing students, 14.5% in computer and information sciences, and 9.6% in construction and architecture.

In regard to postsecondary fields, women continue to represent the minority, except in biology, where they earn nearly half of doctoral degrees and approximately 60% of undergraduate degrees (Lane, Goh, & Driver-Linn, 2012; National Science Foundation, 2008; Snyder, Dillow, & Hoffman, 2009). Women comprise a disproportionately low number of STEM undergraduate degrees, especially in engineering. When looking at two-year colleges, female students made up 58% of enrollment in 2007. Yet during the 2006-2007 school year, females received only 15% of the associate degrees in engineering technologies (Milgram, 2011).

## Underrepresentation of Females in STEM Careers

The underrepresentation of women in STEM educational fields and majors is a trend that follows women into STEM careers as well. In STEM careers, when compared to their male counterparts, even women who hold a STEM degree are less likely to work in a STEM career (Beede et al., 2011; Ceci et al., 2009). Despite the findings that females achieve higher grades or grades equal to that of their male counterparts in middle school and high school science courses, the gender gap follows women into the realm of employment (Britner & Pajares, 2001; Schmidt, Strati, & Kackar, 2010).

Also, in STEM careers, even though women fill nearly half of all jobs in the U.S. economy, they hold less than 25% of STEM jobs. Particularly, women make up nearly 48% of the U.S. workforce, but only 24% of STEM field workers. If the proportion of women in STEM

professions mirrored that of the workforce, one would expect there to be many more women employed in STEM fields. As the proportion of college-educated women in the U.S. workforce has increased, this discrepancy has persisted throughout the past decade (Beede et al., 2011). From 2000 to 2009, Beede et al. state that while the proportion of college-educated female workers increased from 46% to 49%, the trend was not seen in the STEM workforce, as the proportion of college-educated female workers in STEM careers remained at 24%. In regard to particular STEM jobs, the representation of women has varied over time. Although female representation has declined in areas such as computer and math jobs, female representation in life science jobs has increased (Beede et al., 2011). Additionally, many women who do enter STEM jobs eventually leave those jobs at twice the rate compared to men. Reasons for this exodus include but are not limited to the overbearing, male-dominated culture and the unaccommodating job expectations for women who would like to have a family (Belkin, 2008).

## Leaky Pipeline

The pipeline, sometimes called the "educational pipeline" or the "STEM pipeline," refers to the idea that having an ample number of students or graduates for the workforce will require the initial introduction of students and the subsequent retention of those students through the completion of their academic programming (Ewell, Jones, & Kelly, 2003). Like an actual pipeline, the metaphor helps paint a picture of a seamless pathway through all aspects of the K-16 education system and a smooth transition into the workforce. However, the education pipeline is not as seamless as it would sound.

The gender gap in math abilities and scores has continued to narrow while female students have continued to earn better grades in math than boys (Halpern, 2004). Yet significant

gender differences concerning female career choices in the areas of science and engineering remain (Jacobs, 2005). Boys are more likely to choose math or science courses or careers when compared to females whose grades in math are equal to or higher than those of boys. Also women are less likely than men to choose fields such as engineering, technology, or physics (National Science Foundation, 2008). One cannot help but cogitate on what motivates one sex to enter science or math fields over the other. Even with recent gains made in diversifying the fields of science and engineering, women still "leak" from the aforementioned pipeline (Jacobs, 2005).

Unfortunately, those leaking out of the pipeline, in this case the STEM pipeline, often tend to be females. But why does this matter? What if females are simply not interested in these fields? What if females are happy going into other fields? Jacobs (2005) states that the decision not to enroll in science and technology courses may be a result of personal beliefs regarding ability and perceptions concerning possible barriers in the actual fields themselves.

## Reasons for the Underrepresentation of Females in STEM

The existing gender disparity across differing fields is a quite complex social issue. Reasons for female underrepresentation include, but are not limited to, 1) supposed gender cognitive factors (Benbow & Stanley, 1980, 1983; Halpern et al., 2007); 2) discrimination (Chen & Moons, 2014; Moss-Racusin et al., 2012); and 3) the impact of more subtle or covert sociocultural forces such as environmental factors, gender bias, and stereotyping (Eccles et al., 1990; Jacobs & Eccles,1985; Spencer et al., 1999). These points require further elucidation.

## Female Representation in STEM Mediated by Gender Cognitive Factors

In 2005, Lawrence Summers, who was the president of Harvard University, ignited debate when he publicly commented that the paucity of females at the upper end of advanced mathematical achievement and ability tests may be a result of behavioral genetics and innate differences among males and females. Summers also mentioned discriminatory work policies and sex-related differences regarding socialization. However, his central assertion highlighted findings that there is an underrepresentation of females at the upper end of advanced mathematical achievement and ability tests when compared to males (Gallagher & De Lisi, 1994; Gallagher, Levin, & Cahalan, 2002; Geary, 1996; Halpern et al., 2007; Hyde, Fennema, & Lamon, 1990; Voyer, Voyer, & Bryden, 1995) and that the dearth of females with extraordinary mathematical talent is the reason for discordant proportions of females in engineering, the natural sciences, and mathematics.

Other research findings support Summers's assertion. For instance, Benbow and Stanley (1980) acknowledge that it may be difficult to remove the influences of societal expectations and attitudes on mathematical reasoning ability; however, based on the large sex differences observed in mathematical aptitude of male students and female students who have had nearly identical formal educational experiences, the researchers do prefer the hypothesis that sex differences concerning attitude toward and achievement in mathematics may be a result of superior male mathematical ability.

In addition, Halpern et al. (2007) conclude that an evolutionary explanation of sex differences in science and mathematics could indirectly influence or be accounted for by differences in specific brain and cognitive systems. Researchers explain that females are more

innately predisposed toward tasks that require verbal abilities, which apply to all aspects and components of language usage and would include skills such as grammar, spelling, reading, word fluency, verbal analogies, language comprehension, and vocabulary (Bae et al., 2000; Halpern et al., 2007; Hedges & Nowell, 1995; Mullis, Martin, Gonzalez, & Kennedy, 2003; Strand, Deary, & Smith, 2006).

Some researchers purport results that suggest males may be more innately predisposed toward tasks that require visuospatial abilities, which include the retrieval of information from long-term memory; the interplay of verbal, pictorial, and spatial mental imagery; and the production, preservation, alteration, and scanning of representations (Levine, Huttenlocher, Taylor, & Langrock, 1999; Masters & Sanders, 1993; McLeod & Ross, 1983; Nordvik & Amponash, 1998; Voyer et al., 1995). Some believe these findings suggest that males outperform females on many measures of visuospatial abilities, which may contribute to sex differences on mathematics and science standardized exams (Halpern et al., 2007). Similar results have been found for males and quantitative abilities (Geary, 1996; Hyde et al., 1990; Robinson, Abbott, Berninger, & Busse, 1996).

Furthermore, researchers suggest there is a link between visuospatial abilities and math abilities and that visuospatial sex differences may contribute to observable sex differences in certain forms of mathematical performance (Casey, Nuttall, Pezaris, & Benbow, 1995; Halpern et al., 2007). For instance, researchers point to considerable sex differences present among male students and female students who take the mathematics portion of the Scholastic Aptitude Test (SAT-M) to explain the male advantage in visuospatial and quantitative abilities. Specifically, male students tend to be more variable in visuospatial and quantitative abilities, resulting in disproportionately large numbers of male students at both the highest end of the distribution and

the lowest end of the distribution (Feingold, 1992; Halpern et al., 2007; Hedges & Friedman, 1993; Hedges & Nowell, 1995; Strand et al., 2006). In addition, Hedges and Nowell (1995) found this variance has been observed longitudinally over a 32-year interval.

Sex differences found in spatial and mathematical reasoning do not necessarily need to emanate from biological or cognitive differences. It should be noted that the disparity between the average male and female in math ability is narrowing (Ceci, Ginther, Kahn, & Williams, 2014). Interestingly, Sorby, Casey, Veurink, and Dulaney (2013) conclude that spatial skills among engineering students are malleable. For students majoring in STEM fields, especially engineering, proper interventions and spatial training can considerably improve performance. Sorby et al. found that for engineering students who failed a spatial skills test at the commencement of their freshman year, spatial skills interventions did increase spatial skills. Furthermore, the researchers found that improved grades in an introductory calculus course were also a result of improvement in spatial skills through spatial skills training.

What is more, because there have been no major changes in the gene pool, this may suggest that environmental factors, as opposed to biological or cognitive differences, have had a strong impact. In addition, the variation of sex differences regarding math ability at the right tail or high end of the bell curve over time and across nationalities, ethnicities, and gender may indicate that the proportion of males to females does change (Ceci et al., 2014). Also differences in population variance could result in the overrepresentation or underrepresentation of one sex over the other at both extremes (Halpern et al., 2007).

Some biologically founded gender differences may exist. However, most of the roles and stereotypic attributes linked to gender take form more as a result of cultural design than from any abilities attributed to biological endowment (Bandura, 1986; Beall & Sternberg, 1993; Bussey &

Bandura, 1999; Epstein, 1997). Overall, the effects of biological factors or constraints, coupled with early experiences, cultural context, and educational policy systematically interact in convoluted ways (Halpern et al., 2007). It would be difficult to dismiss the complex, systematic interaction of factors, including non-biological factors, that have the potential to influence the findings reported in this section.

## Female Representation in STEM Mediated by Discrimination

Existing research predominantly falls into two highly differing categories regarding the mediating effects of discrimination on females in STEM. The first category is comprised of researchers who assert that active discrimination, although subtle or implicit, still hinders women's representation in STEM fields and careers (Handelsman et al., 2005; Moss-Racusin et al., 2012; National Science Foundation, 2013). The other claim supported by some researchers is that gender disparity in STEM fields and careers is not caused by discrimination but by women's preferences and choices (Ceci et al., 2009). This divide represents an area ripe for further research.

Research suggests that the advancement of women in STEM, especially with regard to the promotion and advancement of females in academic science, may be actively hindered (Handelsman et al., 2005; Moss-Racusin et al., 2012; National Science Foundation, 2013). For instance, there is some experimental evidence to suggest that evaluators report liking women more than men (Eagly & Mladinic, 1994); however, at the same time, they may judge men as more competent than women even when their backgrounds are identical (Foschi, 2000; Moss-Racusin et al., 2012). When Moss-Rascusin and her colleagues (2012) conducted their study regarding the subtle biases of science faculty members and how these biases could affect the

treatment of male and female students who applied to work in the faculty participants' laboratories, they found that faculty participants viewed female students as less competent than male students with identical backgrounds. Also, after comparing aspects such as career mentoring and starting salary, Moss-Rascusin and her colleagues found that these faculty participants were likely to offer male students more career mentoring and a higher starting salary when compared to female students.

Interestingly, faculty gender had no effect on bias exhibited toward the male or female student. Female faculty participants did not rate the female student as either more hireable or more competent. The female faculty participants also did not offer a higher starting salary or more career mentoring to the female student. Furthermore, even though faculty participants expressed warmth toward the female student, the faculty participants may be affected by enduring cultural factors such as stereotypes that hold women as lacking competence in science domains. Based on the present findings, Moss-Rascusin and her colleagues (2012) concluded that gender bias must be addressed because it could translate into real-world discriminatory disadvantages concerning the judgment and treatment of female students in science.

On the other hand, Ceci, Williams, and Barnett (2009) contend that female underrepresentation in science domains is not caused by discrimination. Ceci et al. postulate that women's choices regarding disproportionate responsibilities concerning child and family care coupled with their preference for non-science fields and careers may be the causes of the gender disparity in science. Ceci et al. conclude:

> Institutional barriers and stereotypes, both of which are real, do not appear likely to account for most of the sex differences, nor does outright discrimination against women in hiring and remuneration. To the extent that such barriers and biases operate to decrease the entry and retention of women in math-intensive fields, there is no compelling evidence that removal of these barriers would result in equalization of sex

> ratios, given the evidence that women's lifestyle choices, societal expectations associated with child rearing, and career preferences tilt toward other careers, such as medicine, teaching, law, and veterinary medicine, over engineering and physics. (p. 247)

This claim may lead some to conclude that gender discrimination no longer exists nor plays a part in gender disparity in STEM fields or careers. Although Ceci and his colleagues assert that the removal of these barriers will not result in the equalization of sex ratios, it is highly likely that, if unchecked, discrimination and stereotypes will remain exactly what they referred to them as: barriers. It is essential to consider any and all barriers that may prevent a stigmatized group such as women from entering and remaining in a certain field or profession. Negative experiences at the college level and beyond may impact a female student's decisions about persisting in the field.

## Female Representation in STEM Mediated by Sociocultural Factors

As biology has not changed over the past 30 years (Hill & Johnson, 2004), the recent increase in women's participation in STEM fields and careers may be evidence of the strength of social, contextual, and cultural factors such as cultural beliefs, familial desires and responsibilities, discrimination, and stereotypes (Ceci et al., 2009). Ceci et al. suggest that broad contextual expectations and factors differentially impact the performance of males and females, thereby possibly inhibiting motivation and interest in certain activities. They state that this inhibition may have an effect on the development of certain abilities, specifically abilities that may assist a student in being successful in STEM subjects. In regard to biological sex differences and subsequent brain development and mathematical ability, they state that this effect would not result in such variability among male and female students. The researchers concur with Guiso, Monte, Sapienza, and Zingales (2008) that there would be no explanation for why

two countries with similar gene pools would show differing patterns of sex differences if the cause of sex differences in math was indeed biological. To be sure, the observance of male dominance in mathematical ability at the right tail varies around the world. A number of countries have shown the exact opposite, where females are superior and more represented in the right tail (Ceci et al., 2009).

It is important to mention the life choices of men versus women. According to a number of surveys, men devote more time to their careers than women with children because the women with children feel they are expected to devote more time than men to familial responsibilities. For instance, survey results suggest that even educated women with high math ability tend to choose non-STEM fields more often than men, drop out of STEM fields such as math and physical science at higher rates than men, and favor home-centered lifestyles where work is adapted to fit around the family and the home (Hakim, 2006; Strenta, Elliot, Adair, Matier, & Scott, 1994). What is more, Ceci et al. (2009) postulate that STEM-related careers are not the only professions impacted by women's career choices. For instance, the researchers assert that women are also underrepresented in the top positions in time-intensive fields such as medicine, law, biology, psychology, dentistry, and veterinary science.

Ceci and his colleagues (2009) concluded that cultural expectations have an effect on the brain, which in turn affects motivation, interests, and abilities. However, they state that this connection is currently unclear. The researchers provide the following example: if a woman was predisposed as more home centered and innately more interested in the maternal role of raising children, then biological sex would impact brain development and functioning, thereby affecting motivation and further interest development, which would ultimately lead to life choices impacting career status. Again the links and connections, coupled with women's decision

making regarding career selections, are quite complex. For women, reasons for choosing non-STEM fields may have been freely decided upon or coerced. These choices are influenced by biological and sociocultural factors. Furthermore, the researchers state that women's choices do not always follow these connections or pathways.

What is more, factors such as stereotypes and stereotype threat must be accounted for when considering the underrepresentation of stereotyped groups in any field (Steele & Aronson, 1995). Negative stereotypes and stereotype threat, such as the stereotype concerning women's science and mathematical abilities when compared to men, have a negative impact (Davies et al., 2002; Davies et al., 2005). This impact may be significant enough to alter the decisions of female students to enter STEM fields, thereby changing the trajectory of their future career and life choices.

## Stereotypes and Stereotype Threat Theory

### Stereotypes

According to Stagnor and Schaller (1996), stereotypes are universally accepted societal expectations, beliefs, or generalizations often utilized in the viewing of individuals who may experience common characteristics of a social group, including, but not limited to, gender and race. Bargh (1994) and Smith (1994) posit that social psychologists and researchers in social cognition have determined that social behaviors such as stereotyping are often automatic or unintentional. In regard to stereotypes, it has been discovered that attitudes or prejudices are automatically activated by the sheer presence of the attitude object and then exert their influence over thought and behavior (Bargh, Chaiken, Govender, & Pratto, 1992; Bargh, Chaiken, Raymond, & Hymes, 1996). Researchers have found that physical features associated with

stereotyped groups can automatically activate stereotyping and categorizing behavior (Carlston & Skowronski, 1994; Devine, 1989; Perdue & Gurtman, 1990; Pratto & Bargh, 1991; Winter & Uleman, 1984).

Along with physical features, varying stimuli such as appearance or vocabulary can also activate stereotypically held beliefs (Wheeler & Petty, 2001). However, researchers do believe that, although these perceptions and feelings may be produced automatically, the ultimate decisions to act on said behaviors as a result of the automated perceptions or feelings are made consciously. For instance, Devine's (1989) two-stage model of prejudice asserts that the perceptual phase may be automatic, where a stereotyped person's features may activate the stereotype. Then in phase two, acting on the perceptual phase is a matter of conscious choice.

For the stereotyped or stigmatized group, stereotypes are often widely acknowledged. Devine (1989) found that in a sample of participants who had varying prejudice toward African Americans, all knew about stereotypes regarding this group. Even among people who did not accept a stereotype, knowledge of the stereotype throughout the society is widely disseminated. This suggests that people who are the victims of stereotypes are fully aware of the stereotypes as well. In addition, social stereotyping does not consist solely of the dominant group imposing its view and belief system on others. The social sharing and reinforcement of stereotypes can occur even among the targets of stereotypes (Jost & Banaji, 1994).

In addition, rejecting stereotypes – for example, the stereotype that men are better equipped for science and engineering fields than women – does not inhibit the internalization of said beliefs at a less conscious level or implicit social cognition, where a person may be unaware or unable to control certain thoughts or feelings (Nosek et al., 2007). Researchers have found that even implicit stereotypes can predict the academic performance and behavior of stigmatized

individuals. In their study, Nosek, Banaji, and Greenwald (2002) found that while measuring implicit stereotypes of adults, respondents demonstrated strong associations of male with science and female with liberal arts.

This type of implicit stereotypic association for academic self-concepts has been observed in American elementary school children as well. Fredericks and Eccles (2002) observed that in math, female students tended to rate their own ability as lower than male students. More recent research has also found that women were less engaged in science and perceived themselves as less capable in math if they held strong implicit stereotypes and associated science with males (Nosek & Smyth, 2011). Culturally communicated messages about the association between male students and math may contribute to female students' weaker identification with the math domain (Dweck, 2007; Eccles, 2007; Guiso et al., 2008; National Science Foundation, 2003; Steele, 2003). These culturally communicated messages, whether in the form of television shows that represent males as scientists or more toys for males being associated with science, may help build and perpetuate the stereotype that female students are not associated with STEM fields or careers.

## Stereotype Threat Theory

Researchers posit that stereotype threat exists when an individual is at risk of confirming or fulfilling a negative stereotype about his or her group. These individuals face the burden of abrogating stereotypes among their peers or associates. In addition, these individuals are susceptible to internalizing the negative stereotypes about their group even when they do not believe the stereotype themselves (Milner & Hoy, 2003; Niemann, 1999; Steele, 1997; Steele & Aronson, 1995). It must be noted that the threat can be experienced by members of any group

for whom a negative stereotype exists and that this pressure not to confirm said negative stereotype is part of the students' normal experiences (Steele, 1997, 2010). Steele (2010) further asserts that internalizing negative stereotypes about one's group and then fearing the confirmation and subsequent judgment of that stereotype action fulfillment happens to all people, probably several times a day. What is more, an individual does not need to identify with a stereotype-relevant domain to fear his or her peers' stereotype-based treatment and judgment (Shapiro & Neuberg, 2007). Furthermore, Inzlicht and Ben-Zeev (2003) found that simply being in the minority can induce stereotype threat effects.

The deleterious consequences often associated with stereotype threat effects include underperformance in stereotype-relevant domains (Schmader & Johns, 2003; Steele & Aronson, 1995), a reduction in self-efficacy beliefs (Aronson & Inzlicht, 2004), negative health consequences (Blascovich, Spencer, Quinn, & Steele, 2001), and a reduced interest in stereotype-relevant careers (Davies et al., 2002). Niemann (1999) concludes that the effects of stereotype threat can be physically, psychologically, or professionally detrimental. Although academic performance is often considered when measuring stereotype threat and its effects, other consequences such as disengagement, avoidance, and disidentification with stereotyped domains can have long-term consequences (Davies et al., 2002; Davies et al., 2005; Major & Schmader, 1998; Major, Spencer, Schmader, Wolfe, & Crocker, 1998; Osborne, 1995; Shapiro & Neuberg, 2007). Widening the range of stereotype threat's potential impact would require researchers to move beyond achievement tests and consider negative stereotypes and the entire population. After all, not all groups are stereotyped in academic domains.

## What Actually Happens When Individuals Experience Stereotype Threat

Essentially, stereotype threat can be considered a source of stress or anxiety (Allison, 1998; Clark, Anderson, Clark, & Williams, 1999; Pascoe & Richman, 2009; Steele, 2010). Experiencing stereotype threat could result in a variety of emotional, behavioral, cognitive, or physiological reactions (Major & O'Brien, 2005; Miller & Kaiser, 2001). When one acknowledges the possibility of confirming or fulfilling a negative stereotype concerning his or her group, multiple involuntary stress responses may be activated, such as increased arousal (Ben-Zeev, Fein, & Inzlicht, 2005; Blascovich et al., 2001; O'Brien & Crandall, 2003) and distracting thoughts (Cadinu, Maass, Rosabianca, & Kiesner, 2005) that deplete the limited working memory (Beilock, Rydell, & McConnell, 2007; Schmader & Johns, 2003). Regarding an intellectual task such as an academic assessment, individuals for whom a negative stereotype exists go to great lengths and expend immense effort to do well (Jamieson & Harkins, 2007). While these individuals expend immense effort to perform well and disprove the negative stereotype, they may also attempt to stifle and overcome any distressing thoughts or emotions (Johns, Inzlicht, & Schmader, 2008; Logel, Iserman, Davies, Quinn, & Spencer, 2009). Through their integrated model of recognized stereotype threat mechanisms and effects, Schmader, Johns, and Forbes (2008) propose that the more executive control is depleted, the less executive control remains to complete the necessary task. Inzlicht and Kang (2010) concluded:

> Regardless of whether stereotype threat leads to performance deficits, it will lead people to exert more effort than if stereotypes were not in the air. It is this extra compensatory effort, we suggest, that is draining and can leave people depleted for subsequent tasks - especially tasks that require effortful self-control. (p. 468)

## Effects of Stereotype Threat on Performance, Thinking, and Learning

Multiple studies have analyzed the effects of stereotype threat on performance, especially regarding how stereotyped groups perform on standardized tests (Ambady et al., 2001; McKown & Weinstein, 2003; Spencer et al., 1999; Steele & Aronson, 1995). Researchers have found that the activation or acknowledgement of negative stereotypes concerning an individual's group membership may significantly impede performance (Ambady et al., 2001; Aronson et al., 1998; McKown & Weinstein, 2003; Spencer et al., 1999; Steele & Aronson, 1995; Steele, 1997). Steele and Aronson (1995) found that when asked to report their race before taking a demanding GRE-like test, African American students underperformed relative to their ability. In addition, they also found that when the test was referred to as diagnostic of intellectual ability, African American students again underperformed relative to their ability. Similarly, when men and women were randomly assigned to learn that a test had either shown gender differences in the past or not, Spencer, Steele, and Quinn (1999) discovered that female participants who were told the test had shown gender differences performed significantly worse when compared to equally skilled male participants. Danaher and Crandall (2008) also found that when female AP Calculus students were asked to report their gender before completing the AP Calculus exam, which the researchers determined made gender salient prior to the test, their performance suffered. Particularly, their performance was lessened by 33% when compared to female students who reported their gender after the test.

"A mind trying to defeat a stereotype leaves little mental capacity free for anything else" (Steele, 2010, p. 123). Stereotype threat has the potential to also directly affect thinking. Being under the pressure of confirming a stereotype causes rumination, takes up mental capacity, raises

self-doubt, and ultimately distracts individuals from a certain task. The "racing mind at work," as a result of being placed under stereotype threat, negatively affects working memory capacity (Steele, 2010). Steele (2010) clarifies:

> Stereotype and identity threat… increase vigilance toward possible threat and bad consequences in the social environment, which diverts attention and mental capacity away from the task at hand, which worsens performance and general functioning, all of which further exacerbates anxiety, which further intensifies the vigilance for threat and the diversion of attention. A full-scale vicious cycle ensues, with great cost to performance and general functioning. (p. 126)

In regard to the effect of stereotype threat on learning, Appel, Kronberger, and Aronson (2011) focused their study on the effects of stereotype threat on learning tasks and essential components of the learning process. Appel and his colleagues determined that learning would constitute situations in which students prepared and revised notes for test taking. These situations included note taking and assessing the quality of notes. The researchers found that stereotype threat conditions did indeed hinder the quality of test preparation. Appel and his colleagues concluded:

> If stereotype threat also impairs learning activities (at least among those who are domain identified) then, over time, targets not only will demonstrate impaired test performance but will actually learn content in less efficient ways as well. Gradually, the knowledge gaps between targets and nontargets will widen. The present studies thus add to the evidence that stereotype threat not only is a phenomenon that impacts on ability measurement but also impedes the acquirement of ability and knowledge. (p. 911)

If this threat persists over time, students who experience negative stereotypes regarding their group and also experience the pressure associated with attempting to disconfirm these stereotypes may actively and protectively disidentify with specific domains, or even school (Steele & Aronson, 1995). Steele and Aronson clarify that this persistent threat has the potential to pressure an individual to the point at which he or she refuses to acknowledge school achievement as a basis for personal identity or self-evaluation.

## Self-Control and Other Coping Strategies

Some researchers postulate that stereotyped individuals under stereotype threat have the potential to perform equally as well as non-stereotyped individuals. However, the stereotyped individuals under stereotype threat would need to exhaust more energy, effort, and resources to perform equally as well as non-stereotyped individuals. These researchers posit that performance decrements occur when stereotyped individuals cannot cope with the stereotype threat situation and cannot compensate for the stereotype threat-induced effects by expending more effort and working harder (Eysenck & Calvo, 1992; Inzlicht, Aronson, Good, & McKay, 2006).

Self-control, a type of mental energy expended to override urges and emotions and ignore temptations, is not a limitless resource. In fact, self-control is very easily depleted (Baumeister & Heatherton, 1996; Muraven & Baumeister, 2000). Either through minimal self-control capacity or decreased motivation to activate self-control, expending control in one task often diminishes performance in another task (Robinson, Schmeichel, & Inzlicht, 2010). As a result of an individual's attempts at coping, stress can also be responsible for self-control failure. In response to stressful situations, coping responses that demand cognitive resources often include thought suppression, distraction, emotion regulation, sensation blocking, denial, and avoidance (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Because coping with stress requires regulatory functioning, one could see how these coping mechanisms would interfere with self-control and, subsequently, possibly impact performance on an academic measure or daily functioning. Inzlicht and Kang (2010) state:

> Given that self-control is limited and that stereotype threat taxes it, we propose that stereotype threat will leave people with fewer volitional resources to perform - even on

> nonstereotyped tasks… coping with the stress of stereotype threat can have aftereffects by hurting performance on any task that requires self-control… coping with stereotype and social identity threat can spill over and lead to a host of maladaptive behaviors and responses. (p. 468)

Thus, even when an individual attempts to cope with stereotype threat by employing self-control, he or she will experience elevated levels of stress that could negatively impact performance or lead to other issues. The next sections will explore studies using quantitative and qualitative methodologies to analyze stereotype threat.

## Quantitative Studies Conducted in Laboratory Settings

The grand majority of research regarding stereotype threat has been conducted in laboratory settings in a manner that replicates Steele and Aronson's (1995) seminal study. In their study of the effects of stereotype threat on the test performance of African American college students, Steele and Aronson found that in situations and scenarios in which a negative stereotype may be applicable, one is at risk of confirming the negative stereotype about his or her group. For instance, they found performance decrements when African American participants were informed that a test would measure ability. When African American participants were not told that ability would be measured by the test, these African American participants matched the performance of White participants.

Spencer et al. (1999) analyzed stereotype threat and its effects on women's math performance. When they informed one group of participants that a test yielded gender differences, women severely underperformed compared to equally skilled men. However, when there was no mention of gender differences on the test, women performed as well as the equally skilled men. They concluded that societally held or established stereotypes, especially the

stereotype regarding women's math underperformance when compared to men, threatened the math performance of women, most notably in advanced math settings.

Correspondingly, Schmader and Johns (2003) found that priming self-relevant negative stereotypes before taking a standardized mathematics and word trial assessment reduces the working memory capacity of women. To prime the specific stereotype concerning women's math ability, the stereotype threat group was told that gender differences in math performance may potentially be the result of underlying gender differences in mathematical capacity. The stereotype threat group showed decreased cognitive capacity when compared to the non-stereotype threat group and equally skilled males. The results of this experiment helped substantiate the researchers' hypothesis that making stereotype threat salient in a stereotype-relevant situation involving academic tasks will lead to a significant decrease in cognitive resources.

Similar results have been found with children as well. McKown and Weinstein (2003) hypothesized that stereotype threat would adversely impact the cognitive task performance of ethnically diverse children, ages six to ten, who were aware of broadly held stereotypes. The researchers used a letter-writing task that relied immensely on concentration and working memory. Their results confirmed their hypothesis and demonstrated that knowledge regarding broadly held stereotypes has the potential to negatively impact the performance of stereotyped children, as these children will be concerned about being judged according to the negative stereotype.

Inzlicht and Ben-Zeev (2003) conducted a quantitative analysis to examine whether stereotypes can threaten individuals in private settings. After students took the Mathematics Identification Questionnaire (MIQ) and submitted results from the Scholastic Aptitude Test

(SAT), the researchers selected female undergraduate students who highly identified in the mathematics domain. The female students were then randomly assigned to either the same-gender or minority conditions and either the public or private conditions. The researchers knew that in a public environment, where other class members could judge or evaluate a person's performance, performance decrements had been observed. The researchers were mostly concerned with what happened in the private environment. They wanted to know if stereotype threat in a private environment would still lead to intellectual underperformance. The researchers found that, in both public and private environments, minority students performed worse than same-gender students. In both public and private evaluation settings, being a member of the minority may have the potential to create a threatening intellectual environment for stereotyped groups. Inzlicht and Ben-Zeev posit that their results demonstrate how pervasive the effects of stereotype threat can be.

Researchers have also used quantitative methods to determine if there are ways to reduce the effects of stereotype threat. Aronson and his colleagues (2002) were concerned by the trend showing that, even after entering college with equivalent test scores, African American college students often received lower grades than their White peers. The researchers considered past research that suggested that negative stereotypes undermine and contribute to the academic underperformance of Black students. In their study, they conducted an experiment to determine if there was a way to help students resist the effects of stereotype threat. Students in the experimental group were instructed to have a growth mindset or to see intelligence as malleable rather than fixed. The researchers predicted that this mindset would help students see their performance as less vulnerable to stereotype threat and, subsequently, help them maintain academic and psychological engagement to boost their grades. The results of the experiment

confirmed the researchers' predictions. Black students in the experimental group who viewed intelligence as malleable and held a growth mindset reported higher enjoyment in the academic process, received higher grade point averages, and reported higher academic engagement when compared to their peers in the control groups.

## Qualitative Studies Conducted in Naturalistic Settings

The overwhelming majority of studies regarding stereotype threat have utilized quantitative methods similar to the methods used by seminal researchers Steele and Aronson (1995). Some researchers have attempted to manipulate certain conditions to differentiate their studies. However, overall, most quantitative studies concerning stereotype threat have focused on the effects of stereotype threat or reducing stereotype threat effects in a laboratory setting (Aronson et al., 2002; Inzlicht & Ben-Zeev, 2003; McKown & Weinstein, 2003; Schmader & Johns, 2003; Steele, 1997; Steele & Aronson, 1995). Criticism exists regarding the lack of measurement or exploration of stereotype threat in naturalistic settings (Doan, 2008). Although their studies are not necessarily guided by the stereotype threat theory framework, some researchers encourage more qualitative exploration of stereotyped groups and their experiences (Cobbett, 2013; Cox & Fisher, 2008; Doan, 2008; Loshbaugh & Claar, 2007; Miller, 2004; Romkey, 2007; Sayman, 2013; Villa & Gonzalez y Gonzalez, 2014).

Using Butler's notion of gender as performed as opposed to linked to the sex body, Cobbett (2013) conducted her study in Antiguan schools and focused on identity and the consequences associated with that identity within the school setting. Specifically, Cobbett examined how female students can position themselves in their school context and the types of consequences linked to that positioning. Cobbett utilized classroom observations and narrative

interviews to discuss the stories of six Black African Antiguan female students in Antiguan secondary schools and to classify three types of gender performances or identities: beauties, geeks, and men-john. The researcher interviewed each female student twice, once at the beginning of the school year and once halfway through the school year. The interviews were conducted in single-sex groups consisting of three female students who were either friends with each other or had similar academic achievement levels as perceived by their teachers. Cobbett also observed classes for three days. Cobbett found that there were costs and rewards associated with adopting different identity positions within the school context. The students who identified as beauties enjoyed the pleasure of high-status femininity by using their looks to get what they wanted. The female students who positioned themselves as geeks and men-johns did not engage in traditional female behavior. For these female students, school was a painful and isolated experience. Though painful, the female students did freely choose to diverge from the traditional norm. Ultimately, Cobbett notes that all three identity positions and performances involved bullying to some degree, whether it was sexual harassment, ridicule, or ultimate exclusion. Cobbett concluded that these Antiguan female students were not only disadvantaged when they left school but also within it. One cannot help but wonder how these female students navigated such a complex terrain of acceptance and freedom to make their own choices. The social costs of divergence can be overwhelming.

As foundational catalyst for their study, Cox and Fisher (2008) utilized past research that suggests single-sex educational environments provide benefits to women's learning. In regard to information technology disciplines, Cox and Fisher claim that the underrepresentation and problematic retention of women in these fields is a well-known problem and that single-sex environments have the potential to positively impact women's enrollment and retention in these

fields. The researchers hypothesize that, through methods such as single-sex environments, more positive experiences on the part of these female students may lead to increased retention of female students in the information technology fields. At the university level, the researchers devised a single-sex environment during a third-year software engineering course. They integrated single-sex activities into a mixed-sex classroom environment. Female students completed a voluntary survey at the culmination of the term. The survey sought to gauge their experiences with their single-sex group when compared to their experiences with mixed-sex groups in other courses. The researchers found that, when compared to their experiences in mixed-sex groups, the female students enjoyed the experience in their single-sex groups, as it allowed them to comfortably develop confidence in their abilities. As a result of this heightened sense of comfort within the single-sex groups, the female students described higher levels of cooperation and felt that they were more willing to take risks and attempt new tasks. Although the study had small sample size, this experiential information from female students in a single-sex grouping method holds promise for decreasing underrepresentation and increasing female enrollment.

In her study, Doan (2008) denounced the overuse of quantitative methods to identify stereotype threat activation and its effects on performance through a priming situation. Therefore rather than examining performance outcomes, she utilized a phenomenological qualitative research design to determine whether stereotype threat can be identified through a retrospective analysis. After administering the Mathematics Stereotype Threat Experience Survey (MSTES) to 235 male and female mathematics students, Doan chose 18 female student participants based on their responses to the survey. These participants engaged in semi-structured interviews over multiple sessions. Through the phenomenological qualitative research

design, she identified six themes: achievement, stereotype investment, motivation, implicit beliefs regarding intelligence, experience, emotion/affect, and social comparison. Also Doan applied grounded theory that helped identify causal relations between frustration, anxiety/nervousness, and outcomes on emotion. At the culmination of her study, Doan suggested that stereotype threat in real life may exist on a continuum, where stereotype threat susceptibility increases when multiple factors become relevant to the individual. She also posited that the retrospective analysis allowed participants to provide a richer experience regarding how their educational history may have been impacted by stereotype threat. Doan's research helped lay the groundwork for the current study. For example, this researcher utilized a modified version of Doan's screening survey to identify participants for the study.

Miller's (2004) study qualitatively explored the experiences of female engineers in the oil industry in Alberta, Canada. Miller found that the masculinity of the oil industry was structured by three distinct and primary processes. First, she found that the everyday interactions in the oil industry often exclude women. Second, she found that a specific set of values and beliefs regarding the dominant occupation of engineering within the industry reinforces divisions by gender. Finally, she found that the female engineers were bombarded by symbols of the frontier myth and the "cowboy" hero. Miller concluded the female engineers developed strategies to both survive and thrive in this environment. However, these strategies were problematic because they resulted in short-term individual gains but long-term failure to change the masculine system. Also, in some instances, the strategies that the female engineers employed actually reinforced the masculine system.

While analyzing qualitative, semi-structured interview data from 10 female engineering students and recent graduates from an engineering school in Canada, Romkey (2007) sought to

understand if females would enjoy an engineering course of study more if the subject were placed within a social, environmental, or human context. The researcher examined an engineering program that utilized a science, technology, society, and the environment (STSE) approach. An STSE approach emphasizes the need for science education to include a plethora of varying perspectives on science. Philosophical, political, ethical, and cultural perspectives are included in an STSE approach. In addition, the STSE educational approach also consists of an understanding concerning the quality of life in the face of environmental threats, the analysis of the imperfect nature of science, the consideration of values and personal opinions, and a multi-cultural aspect of science. Through the theoretical lens of Gilligan's (1982) theories on females and the care orientation of moral development, Romkey suggests her results illustrate that these female students and graduates responded well to this STSE approach regarding engineering education because the moral development included in an STSE approach to studying engineering could positively impact a woman's choice to pursue a career in engineering or the physical sciences. She concludes by stating that to alter how people often view science and engineering as male dominated or male oriented, an STSE approach could help recruit more female students in both high school and college.

Through the theoretical lens of Chicana feminist theory, Sayman's (2013) qualitative analysis, which focused on exploring the experiences of Latinas in residential state STEM schools, aimed to uncover experiential factors such as retention of these female students in the STEM school, initial decisions for enrolling, and barriers and supports they may have encountered. Ten young women, ages 16-19, who self-identified as Latina were recruited from four different STEM schools in both rural and urban locations. The researcher conducted individual semi-structured interviews, focus group interviews, and direct observation of classes.

Sayman found that these young women struggled with agency and identity issues, were continually bombarded by stereotypes concerning females in STEM classes, and had difficulty maneuvering the ineffective or effective teacher pedagogies. In regard to identity, Sayman found that all of the young women experienced difficulty discovering and articulating their ethnicity in mainstream American society. In addition, traditional Latino family expectations, along with the societal pressures associated with gendered stereotypes concerning females in STEM, may have erected perceived barriers for the female students. What is more, in regard to teacher pedagogy, the female students felt better when the teacher's approach was welcoming. Sayman concluded that researchers must better understand how to create opportunities for underrepresented populations. Understanding the complex factors that can contribute to the underrepresentation in the first place may lead to the development of interventions that could encourage more diversity in STEM schools.

Villa and Gonzalez y Gonzalez (2014) thought it essential to understand how gender has the potential to shape the experiences of female college students in engineering programs. Ten female engineering students from private universities and 10 female engineering students from public universities were individually interviewed. The researchers conducted semi-structured interviews to explore the beliefs, thoughts, and experiences of the female students in engineering colleges in Mexico. The researchers also investigated how these female students survived the male-oriented engineering environment. The researchers found that female students were burdened with the possibility that their performance might confirm the negative stereotype concerning female inferiority in math and science and the stereotype that females in science and engineering are unfeminine or unattractive. In addition, these female students feared that they would be judged according to that stereotype. Also the researchers found that these female

engineering students faced challenges such as a demanding academic curriculum and navigating an environment that perpetuates competition. Furthermore, Villa and Gonzalez y Gonzalez found that some female engineering students found their professors as sources of support that helped them remain in the engineering program.

In summation, the aforementioned qualitative studies have shown that females were disadvantaged in schools, as they felt forced to adhere to particular norms of certain social identities. Also female engineers in the oil industry were often excluded as a result of the values and beliefs of the dominant male culture, which reinforced gender divisions. In addition, female students from minority groups, such as Latinas, were forced to navigate a precarious terrain when they were confronted with traditional Latino family expectations and gender-based stereotypes about females in STEM. This could have served as a barrier and led to increased levels of underrepresentation. What is more, female students were constantly burdened with the possibility their performance would confirm gender-based stereotypes and an environment that perpetuated competition. These issues should be taken seriously as potential barriers and reasons for female underrepresentation in STEM, specifically engineering. Only four of these qualitative studies focused on female engineering students. Of those four studies, only two were conducted in the United States, thus revealing a need for further exploration of the experiences of collegiate-level female students in the U.S.

## Conclusion

In postsecondary classrooms, stereotype threat may be activated both covertly and consistently (Steele, 1997). Indeed, Inzlicht and Ben-Zeev (2003) found that simply being in the minority can induce stereotype threat effects. In engineering classes, where females are most

always in the minority, are these female students being constantly impacted by stereotype threat? One would presume it to be very difficult to learn in an environment in which a student constantly stands the chance of confirming or fulfilling a negative stereotype about his or her group. Time and time again, quantitative researchers have found that the effects of stereotype threat negatively impact the performance of stereotyped groups on intellectual tasks (Inzlicht & Ben-Zeev, 2003; McKown & Weinstein, 2003; Schmader & Johns, 2003; Spencer et al., 1999; Steele & Aronson, 1995). Qualitative studies also suggest some intriguing and bewildering trends (Cobbett, 2013; Cox & Fisher, 2008; Doan, 2008; Loshbaugh & Claar, 2007; Miller, 2004; Romkey, 2007; Sayman, 2013; Villa & Gonzalez y Gonzalez, 2014).

Similar to previous qualitative research focused on female students in STEM-related domains, the current qualitative case study strived to unearth information regarding the ways stereotype threat shaped the experiences of upper-level, female, undergraduate, engineering students. To extend the qualitative research that presently exists and differentiate this study from previous studies, I conducted the study in the United States, focused specifically on upper-level, female, undergraduate engineering students, and used stereotype threat theory as the theoretical framework. In addition, the researcher analyzed the challenges that faced the female engineering students from a sociocultural perspective where society and culture interacted to influence personal development (Vygotsky, 1980). I was concerned with how social relations and environmental contexts influenced development and personal choices. The sociocultural point of view will be further detailed in the Research Design section of Chapter 3.

# CHAPTER 3

# METHODOLOGY

The purpose of this study was to examine how stereotype threat shaped the experiences of upper-level, female, undergraduate engineering students and how these students explained their reasoning for pursuing a degree in engineering. This chapter addresses the study's research questions, research design, the case/university background/participant selection, data collection procedures, data analysis procedures, and limitations.

## Research Questions

Two research questions guided this study:

1. How do upper-level, female, undergraduate engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences?
2. 2a) How do upper-level, female, undergraduate engineering students explain their reasons for choosing their major, 2b) the challenges they have encountered in the major, and 2c) their reasons for persevering in spite of those challenges?

## Research Design

Within the qualitative framework, researchers often employ a case study as the essential format of their study. Yin (2009) suggests, "Case studies are the preferred method when (a) 'how' or 'why' questions are being posed, (b) the investigator has little control over events, and

(c) the focus is on a contemporary phenomenon within a real-life context" (p. 2). This study most certainly adhered to these suggestions.

Merriam (2009) clarifies, "A case study is an in-depth description and analysis of a bounded system… could be a single person who is a case example of some phenomenon, a program, a group, an institution, a community, or a specific policy" (p. 40). Merriam describes various special features of case studies, such as how case studies are particularistic, descriptive, and heuristic. Case studies are particularistic because they focus on a single particular event, program, situation, or phenomenon. Descriptively speaking, case studies are rich, "thick" descriptions of the case, situation, or phenomenon under study. "Thick description is a term from anthropology and means the complete, literal description of the incident or entity being investigated" (Merriam, 2009, p. 43). The case in this study was the College of Engineering and Engineering Technology at Pleasantdale College, a large, four-year, public college. This study was designed to explore the experiences of upper-level, female, undergraduate engineering students and their perceptions of stereotype threat. Leong (2012) stresses that a qualitative approach is essential in the field of minority psychology. In addition, Bailey (2012) and Olesen (2011), who are concerned with the history of feminist research, affirm that qualitative approaches to research help illuminate issues of relevance to women such as educational disparities and inequalities. What is more, this approach assists in shedding light on and supporting social change.

Again the grand majority of research regarding stereotype threat has been conducted in laboratory settings using quantitative methods to analyze stereotype threat activation (Ambady et al., 2001; Appel et al., 2011; Aronson & Inzlicht, 2004; Danaher & Crandall, 2008; Inzlicht & Ben-Zeev, 2003; Neuville & Croizet, 2007; Shapiro & Williams, 2012; Spencer et al., 1999;

Steele & Aronson, 1995; Steele & Ambady, 2006). Although this research is extremely important, one must note that stereotype threat does not impact performance. Cognitive functioning is hindered when an individual experiences stereotype threat. This hindrance affects performance.

For this study, the researcher decided to analyze stereotype threat and the subsequent challenges facing the female students from a sociocultural perspective. As previously stated, stereotype threat impacts cognitive functioning. However, the researcher wanted to look at this issue from the point of view that society and culture interact and simultaneously influence personal development (Vygotsky, 1980). From this perspective, the researcher was able to see how social relations and environmental contexts influenced personal choices and development. For instance, although the participants experienced challenges related to a gender-specific stereotype while immersed in their engineering majors, subsequently creating a threatening intellectual environment, all of the female students made the conscious decision to persist. Of course, it is likely that, even from a sociocultural perspective, these challenges have impacted their cognitive performance. However, the researcher could not overlook the challenging social relations and environmental contexts that shaped the experiences of the female engineering students.

As opposed to replicating the aforementioned quantitative laboratory methods that the majority of researchers employ while studying stereotype threat (Ambady et al., 2001; Appel et al., 2011; Aronson & Inzlicht, 2004; Danaher & Crandall, 2008; Inzlicht & Ben-Zeev, 2003; Neuville & Croizet, 2007; Shapiro & Williams, 2012; Spencer et al., 1999; Steele & Aronson, 1995; Steele & Ambady, 2006), I sought to qualitatively study the experiences of members of a stereotyped group in a domain in which a negative stereotype exists. This avenue of inquiry

investigated and attempted to illuminate the types of experiences that upper-level, female, undergraduate engineering students lived through while seeking their degrees and how these experiences related to the sociocultural issue of stereotype threat.

## Case

### University Background

The participants in this study, upper-level, female, undergraduate engineering students, were selected from a public university in Illinois. Pleasantdale College is a large, four-year, public university and was utilized in part because of its undergraduate gender composition. The university's demographic information showed that the gender make-up of the college was fairly equal. For instance, in 2014, 7,606 (49%) of the university's undergraduate population was female, while 7,829 (51%) of the university's undergraduate population was male, comprising a total population of 15,435 undergraduate students ([redacted], 2014). In 2013, the university had a total of 958 students enrolled in its undergraduate engineering programs, of which 91.5% were male and 67% reported as Caucasian ([redacted], 2013).

The university was also utilized because of the number of undergraduate engineering programs available. The university offered undergraduate degrees in engineering fields such as electrical engineering, industrial and systems engineering, and mechanical engineering ([redacted], 2015). By offering these engineering majors, the university had made a commitment to providing students with the technical knowledge and skills necessary to succeed in the field of engineering.

## Participant Selection: Gaining Access and Consent

After receiving Institutional Review Board (IRB) approval, the researcher sought a purposive sample from the university's College of Engineering and Engineering Technology. Creswell (2007) elucidates, "The inquirer selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study" (p. 125). To obtain a purposive sample from the College of Engineering and Engineering Technology (CEET), I contacted the dean of the CEET through email (see Appendix A) and asked permission to conduct research. Once permission was granted by the dean and I was introduced to the department chairs (see Appendix B) of the electrical engineering, industrial and systems engineering, and mechanical engineering departments, I asked the dean and the department chairs to send the Participant Screening Survey (see Appendix C) link to all female students. The dean recommended that I also enlist the assistance of the Society of Women Engineers (SWE) from Pleasantdale College. Therefore, I contacted the president and vice president of Pleasantdale College's SWE through email and asked that they also distribute the Participant Screening Survey link to all female students (see Appendix D). The Participant Screening Survey identified those who fit the following criteria:

1. Student must identify as female and be enrolled as a full-time student at the university.
2. The female must be an undergraduate student.
3. The female undergraduate student must declare as an engineering major.

4. The female undergraduate student must identify the engineering program in which she is enrolled: electrical engineering, industrial and systems engineering, or mechanical engineering.
5. As of Spring 2016, the female undergraduate engineering major must be a junior or senior upperclassman.
6. The upper-level, female, undergraduate, engineering student must be enrolled in an engineering course (as part of her degree pursuit) while the study was conducted.

Those students who met the aforementioned criteria were invited to participate and the Research Study Consent Letter was sent to them (see Appendix E).

## Data Collection Procedures

This qualitative case study utilized four data collection strategies: a) the Participant Screening Survey, b) focus group meeting, c) one-on-one interviews, and d) follow-up data collection strategies. The data collection process took place during the 2016 summer semester.

### Participant Screening Survey

The Participant Screening Survey (see Appendix C) served three purposes: 1) identified participants who met the necessary study criteria, 2) identified participants who believed a stereotype exists regarding people of their sex and their abilities in engineering, and 3) identified participants who may have experienced stereotype threatening situations in the past.

The Participant Screening Survey was adapted from Doan's (2008) Mathematics Stereotype Threat Experience Survey (MSTES). Similar to the way Doan (2008) explains that the MSTES screened participants in relation to the stereotype concerning women in

mathematics, the Participant Screening Survey was designed to screen participants specific to a stereotype regarding women in engineering. Like Doan, the researcher identified participants based on a response pattern that indicated the participant had possibly experienced a stereotype threatening situation. In this way, I was able to identify participants who answered in the affirmative regarding Questions 2, Is there a stereotype that women are not good at engineering and, 3: Have you ever felt that your performance has been impacted because you identify as a woman and women are thought to be bad at engineering. A panel of three professionals with qualitative research experience vetted the wording of the survey in advance. These professionals assessed the survey for face and content validity.

Six participants were selected using the screening survey. The six participants from the CEET were invited to participate in the focus group meeting. The participants came from the following departments within the college: Electrical Engineering, Industrial and Systems Engineering, and Mechanical Engineering. The researcher did not have any participants from the Technology Department.

Thirteen females from the CEET responded to my request and completed the Participant Screening Survey. Since more than six participants qualified according to the response pattern from the Participant Screening Survey, I considered participants who answered all questions in the affirmative. Of the 13 students who completed the survey, only six answered all questions in the affirmative. This response pattern indicated that the participant had experienced stereotype threat priming, was aware of the stereotype, and that she felt her performance was affected by it in the past. Thus, these six participants were invited to be a part of the study.

## Focus Group Meeting

Focus groups are group interviews usually made up of six to ten participants and use a question-and-answer format to solicit group interaction (Krueger & Casey, 2009; Patton, 2002). The group interaction among participants elicits more information regarding the participants' points of view (Mertens, 2015). Mertens further elucidates that focus groups provide information for the researcher concerning how individuals develop and explain their perspective of a problem. I agree with Patton (2002), who states that "the object is to get high-quality data in a social context where people can consider their own views in the context of the views of others" (p. 386). I felt that socially constructed responses from participants who were surrounded by participants similar to them would help illuminate aspects of the study's research questions, especially aspects that were not too personal or invasive.

Based on responses from the Participant Screening Survey, I invited the six participants to the focus group meeting (see Appendix F). To accommodate the participants, I coordinated the focus group meeting at a convenient location on campus. For this study, the single focus group meeting lasted 90 minutes. To help facilitate the focus group meeting, an assistant moderator was present. Responsibilities of the assistant moderator included distributing the necessary equipment, supplies, and refreshments; arranging the room; setting up the equipment; welcoming participants; taking notes regarding profound quotes and nonverbal activity; and monitoring the recording equipment. The assistant moderator did not participate in the focus group meeting discussion (Krueger & Casey, 2009). I utilized the Focus Group Meeting Introduction (see Appendix G) and the Focus Group Meeting Protocol (see Appendix H) to conduct the focus group meeting.

The same panel of three individuals with qualitative research experience who vetted the screening survey also vetted the Focus Group Meeting Protocol. This panel reviewed the protocol and checked for face and content validity.

## One-on-One Interviews

Seidman (2013) asserts that if the researcher's goal is to understand how people make meaning of their experiences, interviewing is a necessary avenue of inquiry. "At the root of in-depth interviewing is an interest in understanding the lived experiences of other people and the meaning they make of that experience… At the heart of interviewing research is an interest in other individuals' stories…" (Seidman, 2013, p. 9). Because thoughts, feelings, or intentions cannot be observed, interviews are an important method for discovery. Interviewing allows the researcher to enter into another person's perspective (Patton, 2002).

To further investigate information revealed during the focus group meeting, I conducted one-on-one interviews with all six participants. I saw the one-on-one interviews as an opportunity to gather further details and more personal information from participants. I believed that the purposive selection for one-on-one interviews helped facilitate the sharing and collection of rich details and depictions.

The one-on-one interviews were semi-structured and continued for approximately 45 minutes. The semi-structured interview design lends itself to a more flexible interview and allows the researcher to respond to the emerging perspective of the respondent (Merriam, 2009; Mertens, 2015; Patton, 2002; Seidman, 2013). I also conducted a 30-minute follow-up interview with the six participants. This allowed me to further clarify questions and answers from the initial one-on-one interview. To accommodate the participants, both the initial interviews were

held on campus in a library study area, a living hall, the student center, or an unused classroom. For the purposes of this study, the One-on-One Interview Protocol (see Appendix G) focused on questions that strove to further understand how upper-level, female, undergraduate, engineering students perceived stereotype threat as shaping their experiences. For instance, I asked questions such as, "When do you believe was your first encounter with the stereotype that women are not good at engineering?" "Do you think this stereotype, or experiencing this stereotype, has shaped your experiences in your classes?" and "Would you consider the pressure to disconfirm a negative stereotype a part of your normal experience in your major?"

Similar to the Participant Screening Survey and Focus Group Meeting Protocol, a pre-arranged panel of three individuals with qualitative research experience vetted the One-on-One Interview Protocol. This panel reviewed the protocol and checked for face and content validity.

## Follow-up Interviews

The follow-up interviews were conducted over the phone and lasted approximately 30 minutes (see Appendix I). Follow-up interviews were semi-structured and were comprised of questions that sought to clarify or dig deeper regarding the perspectives and points that had emerged during the focus group meeting and the one-on-one interviews (Merriam, 2009, 2015; Patton, 2002; Seidman, 2013).

## Phases in Conducting the Study

The phases used to carry out the study are described in Table 1.

Table 1

Phases of the Study

| Phases | Purpose/Objective |
|---|---|
| Phase 1<br>April 2016 | The researcher contacted the dean of the College of Engineering and Engineering Technology through email asking for permission to conduct research. |
| Phase 2<br>May 2016 | Once permission was granted by the dean and the researcher was introduced to the department chairs of the Electrical Engineering, Industrial and Systems Engineering, and Mechanical Engineering Departments, the researcher requested that the dean and the department chairs send the Participant Screening Survey link to all students. |
| Phase 3<br>May 2016 | Based on the results of the Participant Screening Survey, the researcher identified students who met the necessary study criteria. |
| Phase 4<br>May 2016 | The students who met the necessary criteria were invited to participate and were sent the Research Study Consent Letter. |
| Phase 5<br>June 2016 | The researcher conducted a 90-minute focus group meeting with the six participants. |
| Phase 6<br>July 2016 | The researcher conducted 45-minute one-on-one interviews with each participant from the focus group meeting. |
| Phase 7<br>August 2016 | After the one-on-one interviews, the researcher conducted separate, 30-minute follow-up interviews with each participant. |

## Data Analysis Procedures

I audiotaped and transcribed the information gathered through the focus group meeting and interviews. I utilized a digital voice recorder to capture the audio. This recorder allowed me to slow the speed of the audio recording to focus on transcription. The data obtained through the focus group meeting and one-on-one interviews were analyzed to identify common themes regarding the experiences of upper-level, female, undergraduate engineering students.

I used the following approach to analyze all transcribed data:

1. I thoroughly read all transcriptions and reviewed any notes collected or recorded during the data collection process. Also the research questions were used to help guide the emergence of themes.
2. After all responses were reviewed, I began open coding to develop major categories that seemed most important (Creswell, 2007; Maxwell, 2013). Once I was satisfied with the preliminary set of categories that emerged during open coding, I narrowed the focus to completely solidify and finalize the categories (Merriam, 2009). Then I returned to the data to further develop themes for each category (Creswell, 2007).
3. Once themes were specifically delineated, I highlighted areas of the text based on emergent themes and information from the open and focused coding. This process was repeated until category finalization and theme identification were exhausted.
4. Then I ensured that the theme information directly corresponded to one of the determined categories and that the categories and themes directly related to one of the research questions.

5. A critical friend whose role was to provide feedback, pose provocative questions, and assess the validity and quality of a project analyzed and critiqued the categories and themes derived from these data. This cross checking with a critical friend, who is a doctoral student familiar with qualitative research, helped to facilitate the progress of the research by encouraging honest reflection that enhanced the reliability and validity of these data (Costa & Kallick, 1993; Kember et al., 1997).

The transcription documents were saved on a computer and on a flash drive. In addition, three copies of the transcription documents were utilized as follows:

- One copy was given to interviewees for the purpose of member checking (Merriam, 2009; Mertens, 2015).
- The researcher used one copy for coding.

## Validity

I conducted member checks and peer debriefing to ensure validity (Villa & Gonzalez y Gonzalez, 2014).

### Member Checking

To help ensure validity, I conducted member checks after one-on-one interviews. Through email, I provided the participants with the written transcripts of their interviews (see Appendix K). This way, by not having the researcher present during the member check, the participants had more cognitive space to vet the transcripts. By revisiting the collected and interpreted facts, experiences, and feelings of respondents, these member checks helped me attain advanced levels of accuracy and consensus (Cho & Trent, 2006). Participants then judged

the accuracy and credibility of the data and made additions and corrections (Creswell, 2007). All of the female students indicated that the transcripts from their interviews were accurate. However, Melissa diligently combed through her entire transcript, fixing grammatical errors and ensuring clarity so that I obtained exactly what she had stated.

## Peer Debriefing

According to Creswell (2007), an external check of the research process must be conducted. Lincoln and Guba (1985) refer to the peer reviewer as the individual who assists in keeping the researcher honest. This reviewer is concerned with questions of methodology, meanings, and interpretations. In this study, the reviewer posed hard questions to me. The reviewer was very concerned with the honest representation of the study participants' experiences. For example, the reviewer asked that I be sure to capture and display the true raw emotion so bravely expressed by the female engineering students. The reviewer was a doctoral-level colleague who had also completed the data collection process.

## Limitations

Although case studies are often considered one of the best ways to obtain and produce insightful and illuminating information regarding real-life situations, issues concerning transferability are present (Merriam, 2009). If the case study's focus is too narrow, it may not be transferable to the population. What is more, as the researcher is the primary investigator and instrument of data collection and data analysis, questions of researcher sensitivity, integrity, and researcher bias are inherent with case study research (Maxwell, 2013; Merriam, 2009; Mertens, 2015). The use of member checks and peer debriefing helped counteract issues of bias. Another

limitation was that the researcher only studied three departments within one college from the university.

## Conclusion

This study utilized a qualitative case study methodology to examine how stereotype threat shapes the experiences of upper-level, female, undergraduate engineering students. The research design, participants, data collection procedures, data analysis procedures, and the study's limitations were explained. Chapter 4 will include the findings of the study, including extensive narrative and authentic comments made by the women.

# CHAPTER 4

# FINDINGS

Chapter 4 presents the findings of this research study. In particular, this chapter includes an overview of the participants and a summary of the data that were collected, coded, and organized into themes. The findings are presented as they coincide with the study's research questions:

1. How do upper-level, female, undergraduate engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences?
2. 2a) How do upper-level, female, undergraduate engineering students explain their reasons for choosing their major, 2b) the challenges they have encountered in the major, 2c) and their reasons for persevering in spite of those challenges?

The data are aggregated and represent the participants' responses to questions from the Participant Screening Survey, responses given during the focus group meeting, responses to questions from one-on-one interviews, and responses to follow-up interview questions. To provide clarity, the data are organized by theme and presented as they pertain to each of the research questions.

## Participants

The researcher sought a purposive sample from Pleasantdale's College of Engineering and Engineering Technology. The Participant Screening Survey identified upper-level, female,

undergraduate engineering students who met the criteria noted in Chapter 3. Table 2 represents demographic information about the participants. Pseudonyms have been used to identify participants to preserve their confidentiality.

Table 2

Participants, Their Majors, and Their Year in School

| **Participant Name** | **Academic Major/Field of Study** | **Year in School** | **Age** | **Race** |
|---|---|---|---|---|
| Amanda | Electrical Engineering | Junior | 19 | White |
| Gaby | Electrical Engineering | Junior | 27 | White |
| Melissa | Electrical Engineering | Senior | 20 | White |
| Lisa | Industrial and Systems Engineering | Junior | 23 | Hispanic |
| Nancy | Industrial and Systems Engineering | Senior | 22 | Asian/White |
| Anna | Mechanical Engineering | Senior | 21 | White |

Research Question 1

How do upper-level, female, undergraduate engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences?

For Research Question 1, data were collected, coded, and analyzed from the focus group meeting, one-on-one interviews, and follow-up interviews. The following themes emerged from the data: 1) Explicit and Implicit Experiences with Stereotype Threat, 2) Conformity, and 3) Increased Motivation. Only the second theme – Conformity – was divided into two subthemes: Modifying Language/Volume and Dress Attire. Table 3 illustrates the themes that coincide with Research Question 1 and the number of data points for each that were collectively made by the female engineering students during the focus group and interviews.

Table 3

Themes and Number of References from Research Question 1

| Theme | Subtheme | Total Number of References from All Participants | Total Number of Participants Who Evoked Each Theme |
|---|---|---|---|
| Explicit and Implicit Experiences with the Stereotype | | 15 | Explicit: 2<br>Implicit: 3 |
| Conformity | Modifying<br>Language & Volume<br>Dress Attire | 26<br>13<br>13 | Conformity: 6<br>Language & Volume: 5<br>Dress Attire: 4 |
| Increased Motivation | | 11 | Increased Motivation: 5 |

Appendix L contains significant comments made by the participants that were extrapolated and coded from the data to support the themes and subthemes.

## Theme 1: Explicit and Implicit Experiences with Stereotype Threat

All participants were cognizant of stereotypes in the field of engineering. Of the female engineering students, two could cite specific and explicit instances when they felt the negative stereotype was made salient. In addition, three of the female students had more subtle experiences with the stereotype that "females are bad at engineering." Also, participants were keenly aware of stereotypes regarding females in math and science. They acknowledged that stereotypes exist that suggest females lack ability in math and science. The female engineering majors felt that those stereotypes bleed into engineering. Gaby summarized it best when she said, "When it comes to engineering, people think that we're just not good enough because of

math and science stereotypes... engineering is a degree of math and science… They [negative perceptions] completely spread over in engineering" (One-on-one Interview, July 17, 2016). Whether their experiences with this negative stereotype were explicit or implicit, five of the six female engineering students agreed that they did experience situations involving this negative label.

Explicit Experiences with Stereotype Threat

Two of the six participants agreed that they had explicit experiences with the negative stereotype that "females are bad at engineering." Explicit experience with stereotype threat was considered when a participant recalled an experience when a person made an overt comment or remark concerning her gender and engineering skill set, which created a threatening environment for the participant. Nancy described the pressure associated with that negative stereotype and asserted that being explicitly reminded of their gender in engineering led some of her classmates to change their majors. Nancy believed that explicit statements made by her peers brought unnecessary attention to her and her classmates' gender and that the negative stereotype was too much for some students. For example, Nancy stated,

> That is why a lot of women change their majors. Like the Society of Women Engineers. We get a lot of incoming freshmen. We recruit really hard, but they fall off because… you know, the emotional abuse of people just constantly reminding them, 'Hey, you're a woman'... I think it's really hard for them, because then they take it as a sign of weakness. (Focus Group Meeting, June 25, 2016)

Nancy felt that explicit reminders of gender, which she believed correlated with the stereotype "females are bad at engineering," constituted emotional abuse and led female students to change their field of study.

Furthermore, as a result of explicit negative experiences related to gender and ability,

Nancy said she experienced "impostor syndrome" in which she asked herself, "What am I doing here?" The feeling of not belonging because of a negative gender-based stereotype led her to question her status as an engineering student. According to Nancy, "Impostor syndrome is a real thing. You're looking around and you're like, 'What am I doing here?" (Focus Group Meeting, June 25, 2016). Nancy further explained, "Impostor syndrome doesn't go away" (One-on-one Interview, July 7, 2016).

Like Nancy, Gaby mentioned that she also felt like an impostor in her engineering major as a result of explicit experiences with the stereotype:

> I guess that I'm just nervous that I don't know enough and I guess I get that impostor syndrome sometimes. Where I know that I know some things, but I don't feel like I belong. I don't know how I got here! (Focus Group Meeting, June 25, 2016)

In light of her experiences, Gaby also asked herself, "What am I doing here?" The impostor syndrome these participants experienced caused confusion regarding their statuses as engineering majors. The other female engineering students had more subtle experiences with stereotype threat.

Implicit Experiences with Stereotype Threat

Implicit experience with stereotype threat was considered when a participant could not recall an experience where a comment about gender and engineering was made explicit. However, peer reactions and the participants' minority status in their engineering majors caused them to question their identity as engineers, ponder the negative stereotype about female ability to be engineers, and experience a threatening environment. Three of the six female engineering students agreed that they had implicit experiences with the stereotype.

Amanda said she always knew the stereotype was there, even if it was never mentioned

explicitly. Amanda described it this way: "It was always in the back of my mind… Nobody said anything, but you could definitely feel that… I feel like there's an unwritten stereotype" (One-on-one Interview, July 5, 2016). During the focus group meeting, Amanda described one situation to illustrate how others perceived her abilities as a female engineering major and how this reaction implicitly suggested a negative stereotype. Amanda explained,

> I'll explain that I'm coming to school at [Pleasantdale College], so they'll ask you specifically, 'What are you doing?' And I'll say, 'Engineering.' And then they will want to know what kind of engineering or whatever. So that's when I'll specify I'm in bio-medical engineering, and they'll kind of go, 'Oh, you must be really smart…' They sound surprised. (Focus Group Meeting, June 25, 2016)

The incident was implicit because the responses of the individuals speaking with Amanda suggested that they were surprised by her decision to major in engineering. Their reactions caused Amanda to feel that her peers questioned her choice. These surprised reactions from her peers suggested a belief that she was not capable of meeting the requirements of her engineering major. As a result of the surprised reaction from her peers, Amanda did not question or doubt that a possible link between gender and her ability in engineering could have existed. However, because of these surprised reactions from her male peers, the potential for this type of questioning and doubt did exist.

Comparatively, Anna also mentioned that no one ever explicitly mentioned the stereotype to her. However, as one of the only females in her engineering major, being in the minority played a part in her implicit experience with stereotype threat. Similar to Amanda, Anna explained that knowledge about the stereotype that "females are bad at engineering" lingered in the back of her head. Anna described that feeling in this way:

> I was the only girl in almost all of my classes… I didn't have any female teachers in the math and science program here… I wasn't exposed to any female engineers until my last semester… It was kind of like, 'Where are they?'... I just didn't really ever see them… I think it's something that gets thought in the back of our heads, 'Oh, they're not around.' (One-on-one Interview, July 5, 2016)

As part of the minority in her engineering major, Anna was left wondering and searching for female peers or instructors. Because minority status has the potential to activate a negative stereotype, simply being in the minority was enough to create a threatening intellectual environment.

Together with Amanda and Anna, Melissa also mentioned the lingering stereotype. She explained that she does not think about it unless someone explicitly mentions it. Melissa said, "It's not something I think about until someone else brings it up" (One-on-one Interview, July 10, 2016). Melissa has never heard anyone talk negatively about females or their abilities in engineering. However, in her experience, one of the ways classmates or teachers implicitly perpetuate the stereotype is when they redirect her attention and interests to other areas. For example, Melissa explicated,

> I don't know if I've ever had someone tell me, 'Oh, women aren't meant to be engineers.' It's more so just directing you somewhere else. So, if you're in math or something, they're like, 'Why don't you go into English?' It's not like telling you you can't do it. It's just directing you to something that is more widely accepted. (One-on-one Interview, July 10, 2016).

Melissa also felt that males did not have to deal with the threatening intellectual environment created by stereotype threat. She stated, "This wouldn't be a problem if I was a straight male in this field" (Focus Group Meeting, June 25, 2016).

These experiences illustrate the strenuous terrain the female engineering majors were forced to navigate. The female engineering students' explicit and implicit experiences with stereotype threat created a threatening intellectual environment in which students in the minority

have been shown to underperform and experience pressure to prove to themselves that the negative stereotype is untrue. This threatening engineering environment could also force the female engineering students to question their identity as engineering majors. This environment and the pressure to prove to themselves that the negative stereotype is untrue were in addition to the normal pressure associated with obtaining a difficult degree like engineering. In this threatening intellectual environment, students for whom a negative stereotype exists consistently perform below their potential and feel pressure to prove to themselves and others that the negative stereotype is untrue. This was part of the female engineering students' everyday experiences. Unfortunately, as Nancy stated, the environment and the pressure were often too much for some students. The female engineering majors felt they were often left with only two choices: conform to distract from their gender and subsequently dissociate themselves with the negative stereotype that "females are bad at engineering" or leave their major.

## Theme 2: Conformity

In the context of this study, conformity refers to when the female engineering students took steps to assimilate into their engineering major. While conforming, all of the participants knowingly diverged from their normal behavior to better fit in or to help themselves accomplish a task with their fellow peers. Mostly, the female students described tactics related to the way they used language or to their attire. Lisa, a junior industrial and systems engineering major, explained it rather directly. She stated, "I think that it's [conforming to perceived standards and conventions of the engineering major] a part of the normal college experience if you're a female and in STEM or just engineering" (One-on-one Interview, July 25, 2016). That is, conforming is an expectation.

Subtheme: Modifying Language and Volume

The female engineering majors made attempts to adjust their language and voice to conform better with males in their engineering majors. The participants attempted to conform to socially acceptable standards or conventions. In the case of language and volume, the female students felt that talking loudly, being less shy, and being assertive helped them conform. Table 4 provides a sample of the participants' statements regarding their attempts to conform by modifying their language and volume.

Table 4

Participants' Experiences with Language and Volume Conformity

| **Name<br>Year<br>Major** | **Participant's Experiences with Language Conformity** |
|---|---|
| Gaby<br>Junior<br>Electrical Engineering | ● You get really uncomfortable with a whole bunch of guys around and they make inappropriate comments. It just gets uncomfortable sometimes and I feel like **I have to be really forceful, stubborn, and loud just to get heard, and not to be pushed around.** Kind of pushed around and told what to do. (Focus Group Meeting, June 25, 2016)<br>● **I find myself talking more like the other guys and just mimicking their behaviors**. (Follow-up Interview, August 24, 2016)<br>● **The volume and the tonal quality becomes a bit more gruff. I tend to lower my voice** a little bit instead of having a more natural, higher pitched voice **just to sound similar to fit in.** (Follow-up Interview, August 24, 2016) |
| Melissa<br>Senior<br>Electrical Engineering | ● When I was a freshman here, I didn't swear. I was right out of Catholic school… I was like, 'Oh my God, I'm just gonna be sweet as pie and all these guys are gonna make friends quickly.' **I now swear like a sailor because that's the only way that guys will respect me. I have to be loud**. I have to swear. And as much as possible. **I swear more than the guys to the point that they are shocked at what words I know.** (Focus Group Meeting, June 25, 2016)<br>● I **swear a lot more.** I didn't swear at all when I first came to college, and then when I went into the engineering program, I learned how to cuss like a sailor because that's **the only way they would take me seriously.** (Follow-up Interview, August 17, 2016)<br>● **I did end up talking a lot louder just to be heard**… Otherwise, they forget that I'm there… Like, if I'm not speaking louder, they almost like don't hear what I'm saying. (Follow-up Interview, August 17, 2016) |

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| | |
|---|---|
| Lisa<br>Junior<br>Industrial and Systems Engineering | • **You've got to struggle to get your voice heard. You have to be louder and you kind of have to put yourself out there more to make your voice heard with them.** (Focus Group Meeting, June 25, 2016)<br>• If I do feel confident in that particular subject, then **I have to put on this persona where I'm loud and commanding for them to hear me out.** (One-on-one Interview, July 25, 2016)<br>• **I do assimilate. I do talk louder. I guess I am little more aggressive** in how I approach group work and whatnot. (Follow-up Interview, August 9, 2016) |
| Anna<br>Senior<br>Mechanical Engineering | • I'm usually a pretty patient, quiet person, but mechanical [engineering] has the least percentage of women, so a lot of times, I can be, or there is one or two women in the group… Sometimes, **I have to get angry and raise my voice**… I don't like to do that, but it's almost like **you have to prove yourself**. Even the teachers, I've had that and it's not… It shouldn't be that way. (Focus Group Meeting, June 25, 2016)<br>• **The way I act,** I guess, maybe less shy for sure… **assertiveness… to be taken seriously**… have no mercy. It's like, have more confidence. (Follow-up Interview, August 11, 2016) |
| Amanda<br>Junior<br>Electrical Engineering | • With that TLC group, I really **wanted to make sure that I was one of the guys.** Some of the conversations they would have, like just leisure conversations, usually is stuff guys wouldn't talk about with a girl around. I finally got to the point where it's like, 'Oh, it's just [Amanda]. She's fine. So, I definitely **tried to just be like one of them.** (One-on-one Interview, July 5, 2016) |

As demonstrated in the table, five of the six female engineering students attempted to conform to the perceived standards and conventions of their engineering majors. The participants felt pressure to conform to distract from their gender and subsequently distance themselves from the stereotype that "females are bad at engineering" – a phrase used by the female engineering majors of this study to describe the perceived stereotype they believed existed in their engineering majors. To reinforce their identities as engineering majors, the female engineering students altered and modified their language usage behaviors. They purposefully made these modifications so they would not be ignored or disregarded. In addition, they hoped to divert attention from their gender and dissociate themselves from the inaccurate stereotype that females lack ability to be in engineering.

Subtheme: Dress Attire

Four of the six female engineering majors adjusted their attire to conform to the male culture in their engineering majors. Attire conformity was definitely a part of their normal experiences. Table 5 details the participants' experiences with dress attire conformity.

Table 5

Participants' Experiences with Attire Conformity

| **Name**<br>**Year**<br>**Major** | **Participant's Experiences with Dress Attire Conformity** |
|---|---|
| Nancy<br>Senior<br>Industrial and Systems Engineering | ● **If I wear heels or anything like that, it's just a free for all… You're asking for it at that point** is what it comes down to. So, **I go to work and I have to be very professional and then I usually stop and I change before class**. Because, **if I go to class wearing my professional clothes, you get stares, people comment**… So, **I find myself dressing down, trying to appear as like one of them [male peers].** (Focus Group Meeting, June 25, 2016)<br>● **You have to be careful of your neckline**. (Focus Group meeting, June 25, 2016)<br>● **I find myself dressing down a lot more.** For example, when I go to work, I wear lipstick, makeup, and dress clothes, but when I know I have class, I stop at home and I change. **I take off my makeup. I put on sweats… You draw less attention if you are dressed like a bum.** (Follow-up Interview, August 12, 2016) |
| Melissa<br>Senior<br>Electrical Engineering | ● I totally do that… I mean, **I changed like the clothes I wear so that I mean, like somebody wouldn't be looking down my shirt. I wore makeup more but not like red lipstick, more just like a natural foundation just so… but they wouldn't make comments** about like how my skin looks regularly because then otherwise, like **then you're not a pretty girl that they want to be around.** (Follow-up Interview, August 17, 2016) |
| Amanda<br>Junior<br>Electrical Engineering | ● **I don't want to go back being a blonde because I feel like I'm getting enough grief as it is as a woman**. I feel like honestly, a woman with blonde hair, they just take you like a stereotypical Barbie. **I feel like the brunette gives me a little more power. They [male peers] seem to take me more serious**. (One-on-one Interview, July 5, 2016)<br>● I definitely have… It'll be like different situations where I don't necessarily get all fancy and I'll purposely not wear a dress. **I'll just be in jeans and a t-shirt just to look more functional**. **I can get in there and help the guys more rather than just a preppy, little secretary, supervisor, whatever**… that type of mentality comes across like, 'Oh, you know, we can't get her dirty, or she probably just got her nails done this morning. I can't mess her up.' (Follow-up Interview, August 11, 2016) |

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| | |
|---|---|
| Gaby<br>Junior<br>Electrical<br>Engineering | • Haven't really changed my makeup or the way I dress too much. **I probably wear a little bit more, just a little bit more conservative just to alleviate some of the comments that could be said.** (Follow-up Interview, August 24, 2016) |

Two of the female engineering students felt differently. One student did not conform to the attire standards or conventions of her engineering major because she already "dressed like the guys." Anna stated, "I've always kind of dressed like the guys… I've never really dressed up or wore makeup… so that wasn't assimilation [for me]" (Follow-up Interview, August 11, 2016). Interestingly, Lisa was the only engineering student who did not purposefully conform. Instead, she wanted to stand out by the way she looked. Lisa declared,

> I like to go with full eye shadow because I don't understand why I cannot be feminine and be an engineer… I'm not going to dress down for them… I can be smart, whatever, wearing whatever makeup I want to wear. (Focus Group Meeting, June 25, 2016)

Furthermore, Lisa also proclaimed,

> When it comes to how I look, I kind of try to, what's the word, exaggerate a little bit more… just not hide myself… I apply glittery makeup, gold lips… I like to make engineering a little more fabulous… There's no need for me to dress down… I don't think it affects my grades or anything. (Follow-up Interview, August 9, 2016)

Neither Anna nor Lisa felt the pressure to conform, and Lisa deliberately chose to resist conforming to any perceived standards or conventions in her engineering major.

Again, similar to the pressure participants felt to conform by altering and modifying their language and volume, they also faced pressure to modify their attire to fit the perceived standards and conventions of their engineering majors. Like conformity regarding language and volume, the base desire for participants to conform by modifying their attire was to distract from their gender so that they would be viewed as a student first, as opposed to just an attractive female. By modifying their attire, they also tried distancing themselves from the gender-based stereotype

that "females are bad at engineering," which allowed them to be seen as students similar to their male peers. As evidenced by the comments made by the female engineering students, facing this pressure and subsequently modifying their appearance were parts of their normal experiences in their engineering majors.

In summarizing Theme 2 – conformity – all of the participants adjusted their language by either modifying their normal language usage patterns or adjusting the tonal quality of their voice. Conformity in attire was also expressed by four of the six female engineering majors. Although Anna and Lisa acknowledged that other female engineering students changed how they dressed, Anna said that she did not conform in this way and Lisa actually tried to diverge from that compliance. Instead Lisa exaggerated her features and aspects of clothing or makeup to purposefully send a message. The participants' cognizant decisions to modify their language and/or attire shaped their experiences in a way that made them feel that they needed to conform to be viewed as students first, to distract from their gender, and to dissociate themselves with the stereotype that "females are bad at engineering."

Theme 3: Increased Motivation

The theme of Increased Motivation highlights the ways in which the female engineering students felt pressure to push themselves beyond expectations to disprove the stereotype that "females are bad at engineering." All participants agreed that this stereotype existed within their engineering majors. Interestingly, five of the six participants even felt increased motivation to disprove that stereotype. For instance, Amanda stated that knowledge of the stereotype that "females are bad at engineering" definitely motivated her to do well (One-on-one Interview, July 5, 2016). Similarly, Anna also reported increased motivation in herself. She explained, "I saw

how a lot of other students, including the females, were grasping all of this so much better than me… That kicked me into gear" (One-on-one Interview, July 5, 2016). Also Anna was not simply concerned with getting better grades to disprove the stereotype. She said that she was motivated to actually learn the content. Anna shared,

> I let people know that I want to figure this problem out. I don't want you just to give me an answer… I want you to show me and explain it, and make sure that I understand it. Because this is my future… Just make me a better student. (One-on-one Interview, July 5, 2016)

Like the other female students, Gaby was fully aware of the stereotype that "females are bad at engineering." She believed that the negative engineering stereotype formed because of the negative stereotypes that exist concerning women's abilities in math and science. She felt that the stereotypes were so closely related because, as she put it, "engineering is a degree of math and science" (One-on-one Interview, July 17, 2016). As a result of being aware of the negative stereotype, Gaby stated, "I think it pushes me to perform harder… It definitely pushes me to try harder" all the time (Focus Group Meeting, June 25, 2016). Gaby felt the pressure she put on herself and so was subsequently motivated to try harder to disprove the stereotype as well as prove to others that she belonged in her engineering major.

In addition, Nancy also felt increased motivation; however, her motivation was fueled by her desire to disprove the negative stereotype by "showboating" while making class presentations:

> The stereotype is that women are not good at engineering. So, like I said, I was showboating. I am good at engineering. I know what I'm talking about. It's more of a, I guess, staking a claim. This is where I belong. (One-on-one Interview, July 7, 2016)

Nancy felt strongly that she belonged in her engineering major, and she was motivated to disprove any negative stereotype by making class presentations to show otherwise.

Notably, because of the stereotype, Melissa also felt increased motivation to disprove the

stereotype that females are not good at engineering, yet she expressed anger about feeling the pressure she put on herself that motivated her to try hard to disprove the negative stereotype. She described the dichotomous situation female students face in their engineering majors:

> I think it just aggravates you to the point where you wanna try harder. In most of the cases when girls experience it, I think it's either you're gonna be motivated to try harder or you're gonna be, I don't wanna deal with it, and you leave. And it's not that you don't want to be in engineering. It's just that you don't wanna deal with it. (One-on-one Interview, July 10, 2016)

Although feeling angry could be problematic, for Melissa, feeling anger as an internal motivator was beneficial, as it pushed her to try harder to do well, disprove the stereotype, and persevere in her engineering major.

## Summary of Research Question 1

The female engineering students disclosed information concerning their perceptions about how stereotype threat has shaped their experiences. Stereotype threat, or being at risk of confirming a negative stereotype about one's group, shaped the experiences of these participants in multiple ways. Explicit participant experiences with stereotype threat and implicit participant experiences with stereotype threat served to remind the participants of their gender and their identity. These experiences also reinforced the risk of confirming a negative stereotype and urged them to conform to the perceived standards and conventions of their engineering majors. Unfortunately, even after feeling the need to conform and taking the necessary steps to do so, the female students were not able to completely distance themselves from the negative stereotype. As a result, like victims of stereotype threat who act or perform in a way to disprove the stereotype associated with their group, these experiences motivated these female students to attempt to disprove the inaccurate perception that females are not good at engineering.

In addition, all of the female students felt the pressure to make an effort to conform to the standards and conventions of their engineering major, whether by conforming through purposeful changes in their use of language and volume or modification to their dress attire. For some, their experiences revealed their attempts to be seen as "one of them [the guys]," as Amanda explained. Similarly, these attempts at conformity were the result of a desire to "fit in," like Gaby described. Regardless of the type of conformity, five of the six female students felt they needed to fit in, mimic behaviors, and overall appear more like their male peers. By appearing more like their male peers, they felt they would distract attention from their gender, thereby disassociating and distancing themselves from the stereotype that females are not good at engineering.

What is more, five of six participants experienced increased motivation to disprove the negative stereotype. This increased motivation pushed them to try harder in their engineering majors. From a sociocultural perspective, this pressure to disprove a negative stereotype has been shown to cause negative health consequences (Blascovich, Spencer, Quinn, & Steele, 2001) and a reduced interest in stereotype-relevant careers (Davies et al., 2002; Davies et al., 2005). In this study, social and cultural factors such as social relations and environmental contexts certainly interacted to influence the development and experiences of the female students. Although a sociocultural perspective may be distinct from a cognitive perspective, it is likely that the sociocultural factors had cognitive implications. For example, while battling stereotype threat by attempting to disprove the stereotype that females are bad at engineering, the female students in this study also experienced cognitive issues like increased anxiety and elevated levels of stress.

For these female students, their everyday experiences were certainly impacted by

stereotype threat. The theme of conformity revealed how the female engineering students attempted to distance themselves from the negative stereotype, while the theme of increased motivation showed how the participants attempted to disprove the negative stereotype.

Research Question 2a

How do upper-level, female, undergraduate engineering students explain their reasons for choosing their major?

Data collected for Research Question 2a were obtained from the focus group meeting. The following themes illustrate how upper-level, female, undergraduate engineering students explain their reasons for choosing their engineering major: 1) Familial Connections and Support and 2) Coursework Affinity. Table 6 includes a summary of the themes connected to Research Question 2a and the number of times participants made reference to the themes during the focus group meeting.

Table 6

Themes and Number of References from Research Question 2a

| Theme | Total Number of References from All Participants | Total Number of Participants Who Evoked Each Theme |
|---|---|---|
| Familial Connections and Support | 9 | 5 |
| Coursework Affinity | 8 | 4 |

Theme 1: Familial Connections and Support

The first theme highlights the familial connections and support these females identified as influencing their decisions to major in engineering. Five of the six participants cited familial connections and support as a reason for pursuing an engineering degree.

As an illustration, Nancy, an industrial and systems engineering major, mentioned that she felt that being an ethnic minority was beneficial to her. Nancy explained, "I'm part Asian, so my family pushed that [science] really hard, so that worked in my favor" (Focus Group Meeting, June 25, 2016). It is not completely clear if Nancy bought into the stereotype that Asians excel at math and science. However, it seemed that she saw her ethnic status as a reason her family pushed her into the sciences.

On the other hand, Anna, a mechanical engineering major, felt that she was never pushed into engineering. Instead Anna's father, a civil engineer, spent time with Anna bonding and sharing in interests like building Legos and watching engineering-inspired programming such as the History Channel's *How It's Made*. Anna credits these experiences with her father for influencing her decision to major in engineering. Anna explained,

> My dad works in the civil engineer field, so I don't know if he pushed me so much, but [engineering] was always in the mindset when we played with Legos and we watched the History Channel and *How It's Made* all the time. (Focus Group Meeting, June 25, 2016)

In addition to spending time sharing in similar interests with her father, she often went to him when she needed support with coursework. Equally important, she also described how supportive her family was of her decision to major in engineering. Anna detailed,

> I have three sisters, so I was always kind of the tomboy. I just kinda got into whatever I wanted and my parents were like, 'Good. We'll support you if you want to do it [engineering]'. They're very supportive. My family was a really big backup. (Focus Group Meeting, June 25, 2016)

For Anna, her family was always willing to support her, no matter what she decided to do. The "backup" she received from her family influenced her decision to major in engineering.

Comparatively, for Lisa, an industrial and systems engineering major, her father also influenced her decision to major in engineering. Lisa's brothers also played a role in influencing her decision, too. Lisa explained:

> I have all brothers, so since I was little I was pushed into Legos, helping my dad with the cars and stuff around the house… My senior year, they [brothers/family] pushed me to do this Boy Scouts program with my brother. We went to an engineering company in my hometown, and we got to learn about the different engineers that were working around there. I liked it. (Focus Group Meeting, June 25, 2016)

It seemed that having a strong male presence in her household led her to experience more traditional male experiences. Lisa credited her experiences playing Legos with her brothers, helping her dad with the cars, and participating in a Boy Scouts program for influencing her decision to major in engineering.

In a similar fashion, Gaby credited multiple male family members for influencing her decision to major in engineering. Gaby said, "My brother is an electrical engineer. My uncle is an electrical engineer. My grandfather was an electrical engineer. My dad is a computer programmer. So I figured I would give it a try, and I've loved it so far" (Focus Group Meeting, June 25, 2016). Before giving it a "try" Gaby worked as a high school math teacher and decided to return to school and earn a degree in engineering. Gaby explained how her family fostered an idea that she could do anything she wanted and that they would always be behind her. Gaby described:

> My family just fostered that sense that I could really - no matter what - anything that I really wanted to. If I wanted to open up a computer and play with that, I could do that. If I wanted to build a structure outside, I could go and do that. They were just there and 100% behind me, no matter what I wanted to do. (Focus Group Meeting, June 25, 2016)

Correspondingly, Amanda, an electrical engineering major, gave an in-depth explanation regarding her experiences with her father and how those experiences influenced her decision to major in engineering:

> My dad is a farmer. He does a lot of things himself and when things broke down, he fixed a lot of things himself… I was always out with him, tinkering with stuff and messing with stuff, and oiling… So, I think a lot of it was honestly more me being around my dad… I think being exposed on the farm the way I was honestly - as weird as that sounds - being exposed on the farm was really, and messing with stuff, what

kind of kicked me. (Focus Group Meeting, June 25, 2016)

Clearly, Amanda credited her experiences working with her father on the farm for influencing her decision to major in engineering.

Intriguingly, all five of the female students who cited familial connections and support as a reason for pursuing a degree in engineering mentioned males. The participants did not explicitly describe the males as "role models"; however, whether it was a father or a brother, these males had a significant impact on the female engineering majors.

## Theme 2: Coursework Affinity

Coursework affinity, the second theme to emerge from the data, illustrated the fondness the female students felt toward certain subjects. Four of six female engineering majors expressed a penchant for their coursework that helped influence their decisions to major in engineering. All four described an affection toward the same two subjects: math and science. For these participants, their experiences with their coursework were strong and positive. The affinity that participants felt towards math and science were gateways that led them into their engineering majors.

As an industrial and systems engineering major, Nancy stated that her decision to major in engineering was influenced by the classes she took in high school. Nancy detailed, "I loved biology in high school, and I really loved my drafting classes… I kind of always knew I was going into the sciences" (Focus Group Meeting, June 25, 2016). By the same token, Melissa, an electrical engineering major, first started to feel the urge to major in engineering during her later years in high school. She agreed that she felt an affinity for math and science. Yet she also mentioned that her teachers were a part of her decision to major in engineering:

> I had always had really great teachers, since third grade, who taught math and science… So that always made me closer to them. I would go to their office hours, and we would go chat, and they would show me things, like after school. (Focus Group Meeting, June 25, 2016)

In addition to Melissa's affinity toward math and science, she also credited the relationships she fostered with the teachers of those subject areas for influencing her decision to major in engineering. Like Melissa and Nancy, Lisa, an industrial and systems engineering major, felt an inclination toward math and science in high school as well. She explained, "As I was going to school, in high school and stuff, I was always a little bit better, not good, but better at math and science" (Focus Group Meeting, June 25, 2016). Similar to the previous female engineering students, Amanda agreed that coursework she previously engaged in influenced her decision to major in engineering; however, she felt the affinity for math and science while still in junior high.

### Summary of Research Question 2a

The female engineering majors shared intriguing information regarding how they explained their reasons for choosing their engineering majors. The participants discussed how supportive family members, whether parents or siblings, helped influence their decisions to major in engineering. Notably, all participants who described being influenced by familial connections and support shared experiences involving males in their families. Furthermore, all the female engineering students shared their affinity for the same two subjects: math and science.

### Research Question 2b

How do upper-level, female, undergraduate engineering students explain the challenges they have encountered in their major?

Data were collected from the focus group meeting, one-on-one interviews, and follow-up

interviews to answer this research question. Table 7 includes a summary of the themes connected to Research Question 2b and the number of times participants made reference to the themes.

Table 7

Themes and Number of References About Challenges Encountered

| Theme | Subtheme | Total Number of References from All Participants | Total Number of Participants Who Evoked Each Theme |
|---|---|---|---|
| Male Dominance | | 38 | 6 |
| Harassment | | 26 | 5 |
| | Resulting Anxiety | 7 | 5 |
| Representing My Gender Well | | 13 | 6 |
| Teacher/Professor Comments and Behaviors | | 11 | 4 |

## Theme 1: Male Dominance

Before describing the nature of the first theme, it must be noted that all of the female engineering students expressed that not all male students or professors acted in a way that perpetuated a negative stereotype or engaged in behaviors that made them question their decision to be an engineering major. However, as Nancy put it, "The rest of them are enough to ruin the entire experience. That is why a lot of women change their majors" (Focus Group Meeting, June 25, 2016). All participants in this case study experienced overbearing male dominance. The female students completely acknowledged their minority status in their engineering majors. Yet

they felt that females in the minority were certainly treated differently than their male peers in the majority.

To begin, Gaby felt overwhelmed at times by her male classmates, especially while working in groups. For her, the actions of the males in the majority were oppressive and devaluing:

> They wouldn't value my opinion. I would try to contribute to group projects, and they would just kind of talk over me and shut me down. If I would say one thing, they'd be like, 'No, no, no.' And then a male would say the exact same thing and they're like, 'Oh yeah, that's great!' So I was made to feel that I wasn't good enough, I wasn't smart enough to be in engineering because I was female... I feel like it is so hard to get myself to be heard. I've had people say, 'Oh, she doesn't know what she's talking about.' 'Oh, she's a female. She's gonna get emotional.' I'm called the mother of my group sometimes… I just feel like I'm being insulted, and they don't think I actually know anything, just because I'm a female. (One-on-one Interview, July 17, 2016)

Gaby continued, "I've been the only female in a lot of my courses. The opinions of females are valued less" (One-on-one Interview, July 17, 2016). Lisa affirmed this experience while working in groups:

> You kind of feel like, with their body language, they're just telling you, 'Let the boys talk.' You're just like on the sidelines of the group, and you've got to struggle to get your voice heard. You have to be louder, and you kind of have to put yourself out there more to make your voice heard with the team. (Focus Group Meeting, June 25, 2016)

Amanda concurred with their assertions regarding group participation. Conflicts arise during many group projects. Good groups find ways to dissolve the conflicts of work through the conflicts. According to Amanda, while solving disputes within groups, she stated, "The boys are a little bit more resistant… if two of the guys are arguing, it's resolved a lot quicker than if I'm arguing with one of them" (Focus Group Meeting, June 25, 2016).

In the same fashion, Nancy claimed, "It's always like, out to discredit you sort of thing, anything to take you down a notch and make you seem like less of a person or less of a student compared to them" (Focus Group Meeting, June 25, 2016). Nancy also felt that being one of the

only females in her major created a "spotlight" effect. Nancy mentioned that this caused her to feel uncomfortable. She claimed:

> If you're a girl, you're going to stand out no matter what. So a lot of people know who you are, and you have no idea who they are. And it becomes really uncomfortable when people start acting very friendly towards you, and you have no idea who they are, but they've watched you walk past them every single day for the whole semester so they think that you are friends or something… There's a spotlight, so they know who you are. (One-on-one Interview, July 7, 2016)

Equally important, when it came to finding friends, Anna felt that the males had an easier time than females in her engineering major because of their dominance in the majority. Anna shared,

> So, I think guys have a little bit more of an easy time finding friends and being comfortable talking with people with the same interests and same backgrounds… I remember being, being kind of intimidated by all of them because they would work in groups outside of class, and I really was too scared to ask them to join in. (One-on-one Interview, July 5, 2016)

Other female students stated that while attempting to find friends or become part of a group, there were costs for admission. Nancy said, "It's kind of like an initiation… You're almost earning their respect in a sense" (Focus Group Meeting, June 25, 2016). Melissa agreed and described,

> My friends are like big brothers to me at this point, where they have made all of their jokes and now we've gotten past it sort of thing. Now we can be friends. But like, they have to get it of their system, I feel like, to some degree, before… To be part of that group, you have to get picked on significantly before you can be friends with them. (Focus Group Meeting, June 25, 2016)

What is even more unfortunate about these female engineering students and their experience with male dominance is that adults in their major, such as teachers and teaching assistants (TAs), acknowledge this environment with a defeatist attitude and claim that there is not much that can be done about it, almost as if to say, "It is what it is." For example, Melissa recalled,

> When I went to the teachers or when I went to the TAs, they are like, 'Well, this is what you're going to face in engineering, so you might as well get used to it.' So I was like, 'Okay, I guess I can deal with it.' At the end of the year, I was crying… (Focus Group Meeting, June 25, 2016)

This defeatist attitude or mentality only served to perpetuate this environment full of male dominance. By simply acknowledging that it exists without taking steps to improve it, these faculty members were part of the problem.

## Theme 2: Harassment

In the context of this study, harassment was considered when participants faced comments or behaviors from male peers in their engineering majors that made them feel belittled, devalued, and uncomfortable. Even if one could not draw the conclusion that harassment may lead to underrepresentation issues in the CEET, the denigrating experiences reported by five of the six female engineering students shed light on what upper-level, female, undergraduate engineering students face while in the minority. Table 8 provides an extensive description of their experiences with the second theme, Harassment.

Table 8

Participants' Experiences with Harassment

| Name | Participants' Experiences with Harassment |
|---|---|
| Gaby | • **I was called terrible, terrible names for being the only girl in a group, and just harassed**… Actually, I took an Intro to Engineering class when I started my first degree… **the way that I was treated in that class was the reason why I didn't pursue engineering with my first degree**. **I switched to** [redacted] **because I couldn't handle the way that guys would talk to me, the way the teacher would talk down to me**… I just couldn't do it. (Focus Group Meeting, June 25, 2016)<br>• I'm part of the [redacted] Club on campus… I'm the only female in that… I decided to go be a part of the Election Board, and I ran for treasurer. **They openly made comments in front of me, including ones like, 'Oh, she's only running, she's just tits and ass.' It was extremely sexist and degrading to me,** to be told that in earshot of like 20 people that I don't actually have anything valuable to add to the club. (Focus Group Meeting, June 25, 2016)<br>• They have that idea that they are top dog… **They get intimidated by smart females**. And **if a female is doing better, then obviously she is sleeping with somebody, or she's cheating**. (Focus Group Meeting, June 25, 2016)<br>• During my internship last year, I hadn't actually taken any engineering classes yet, and **my manager called me 'stupid.' And it just made me wonder, 'What am I doing here? I can't do anything he wants me to do. Why am I going into engineering? I can't do this.'** And just having… That made my… **it made me really question myself** last summer. **It made me think about not going back the next semester.** (Focus Group Meeting, June 25, 2016)<br>• I just wanna do well and I don't want people to think I'm stupid, it's not something that I can tolerate… **It makes me uncomfortable being the only female because there is sexual harassment that I have dealt with**. I don't want people saying that the only reason I got a good grade is because I could be potentially sleeping with a professor. (One-on-one Interview, July 17, 2016) |

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|---|---|
| Melissa | • So, I would be working on the car and I would bend over, and they would be like, 'Hey, can you stay there for a second?' And I'm like, 'Sure, I'm just holding a part.' And then **they would all go on the other side of the car and look down my shirt**. So I mean, I stopped wearing… **You have to be careful of your neckline**. (Focus Group Meeting, June 25, 2016)<br>• They're like, **'Are you on your period?'** (Focus Group Meeting, June 25, 2016)<br>• **I've been to the counseling services, and they say I should go take tests in private and all these things. And I refuse to do it because I feel like the guys are gonna notice, and they'll make comments or things like that.** And then, **if I'm right before a test and a guy makes a comment, like one of the guys accused me of flirting with one of his friends right before a test. So, during the whole test, I was furious about it.** I'm like, 'This wouldn't be a problem if I was a straight male in this field.' **Because they'll get on you right before a test, and it gets in your mind.** And then like, maybe it would be better to take it by yourself, but then everyone notices and then you don't want to draw attention to the anxiety of it all. Because as soon as you let them know, that's just something they're gonna play into. (Focus Group Meeting, June 25, 2016)<br><br>• **They still make sexist comments**… I don't know, and then just comments about, **'Oh, are you PMS-ing?' All those little comments make it harder and harder**... **Girls are getting all of these comments, and guys don't have to get those comments**. I mean, **guys oversexualize you to the point where it's uncomfortable, and they make comments that aren't okay to make**. And **it just makes the atmosphere more uncomfortable** than it should be… (One-on-one Interview, July 10, 2016)<br>• I had one girl pull me aside and tell me, 'You don't wanna go on the trip with them.' I was so excited to go on the trip, and she was like, **'Just from me to you, don't go on the trip because bad things happen on those trips. And it's very likely you could end up being raped on that trip**…' It makes you look at your friends in a different light. You feel like you know them. And then it's like if someone else is making these comments, did they have an experience with these people or are they just paranoid? **It makes you a little bit paranoid about your friend group. I have anxiety attacks when I go in there now**, just because of how stressful he [a male peer] would make it for me. (One-on-one Interview, July 10, 2016) |

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|---|---|
| Anna | • I do like to answer questions in class, or if the teacher writes something on the board that I don't think is right, I like just bring that up in class. I had that happen where classmates next to me, I'll correct the teacher, and they're, 'Oh, why are you doing that? Gee, **you're such a big shot**…' **That always gets me a little upset when my classmates react that way. And it happens more often than I wish**… bothers me that it happens. (Follow-up Interview, August 11, 2016)<br>• When I started the [redacted] Club, there wasn't many of us. We were trying to get some research done as a team… I offered to just research something… **But, the president just looked at me, and kind of almost yelled, 'So, are you actually going to do that?'** I don't know why it happened, and I just didn't say anything for the rest of that meeting… **None of the guys would make eye contact with me for a good week or two.** It was really like, **it was stressful**. **I wanted to quit the team**… I don't need this stress. **I don't need to be treated this way.** It really bothered me for the rest of the semester. I remember it was a tough semester… But that whole semester **I had a lot of anxiety**… **stress about being on the team**… It just was, 'When is this going to happen again, or why?' I don't understand. (Follow-up Interview, August 11, 2016) |
| Nancy | • There's a lot of rumors going around… They go around about me too… **We're only in our positions because we're attractive young women**. (One-on-one Interview, July 7, 2016)<br>• If you're a girl, you're going to stand out no matter what. So, a lot of people know who you are, and you have no idea who they are. And **it becomes really uncomfortable when people start acting very friendly towards you, and you have no idea who they are but they've watched you** walk past them every single day for the whole semester so they think that you are friends or something. (One-on-one Interview, July 7, 2016) |
| Amanda | • I definitely have an issue where, because I'm like one, or there's either one, two, three, maybe four women in the class, all the guys know who I am. And I have randomly come up to me and say, 'Hi [Amanda]!' And, I'm like, 'I'm really sorry. I have no idea who you are…' I was talking to one of my friends from Bridge [the university's math bridge program for incoming freshman that helps them improve in math] and he's making not like rude comments or anything. But, he's like, 'Oh, yeah. I remember you were always answering questions in class.' And like, he's just remembering really weird little details… **They really watch you**. And you don't realize it and it's kind of… **It's freaky a little bit!** (Focus Group Meeting, June 25, 2016) |

For these five female students, harassment was a very real issue. Some instances were clearly more explicit than others. For instance, degrading a person by referring to them as "just tits and ass" or in a moment of emotion being told to stop "PMS-ing," these are fairly unambiguous instances of harassment. Interestingly, the female engineering majors also made note of the implicit instances that still made them feel "uncomfortable." Although somewhat covert, three of the six female students battled the uncomfortable feeling that resulted from being watched. Being watched, and subsequently being made to feel uncomfortable, contributed to the creation of a threatening intellectual environment for these female engineering students in their respective departments. What is more, none of these participants ever mentioned harassment coming from other female students within their majors.

Subtheme: Resulting Anxiety

Unfortunately, five of the six female students were faced with anxiety as a result of something they experienced in their engineering major. The female engineering majors were very honest in their responses. For instance, when Nancy talked about her battles with anxiety, she candidly responded, "I smoke a lot of weed for my anxiety" (Focus Group Meeting, June 25, 2016). Similarly, Lisa mentioned, "I was drinking every weekend" (Focus Group Meeting, June 25, 2016).

In a like manner, Gaby has tried therapy because of anxiety resulting from things she has experienced in her engineering major. Gaby explained, "Things that other students have said have made me feel uncomfortable. I feel the need to perform extremely well, and that just adds to anxiety… I've gone to therapy before… to cope with anxiety that was produced… by

engineering" (Follow-up Interview, August 24, 2016). However, dissimilar to Nancy and Lisa, Gaby attempted to offset the anxiety with physical activity. Gaby detailed,

> I incorporate physical exercise and yoga into my everyday schedule to give me like a break. I have to have some sort of physical activity or something for that relief… It helps me process and it helps me just to get all that energy out that might be that anxiety, gets it out and help me process, and cope with those sorts of things. (Follow-up Interview, August 24, 2016)

Comparatively, Anna admitted to developing serious anxiety during her freshman year. Although her anxiety may not have been a direct result of any harassment she faced, there was an aspect of intimidation that caused fear in her case. For example, Anna shared,

> I started getting really bad anxiety my freshman year. Because I didn't understand a lot of the terminology of engineering. I was too scared to ask my teachers too, most of the time either for fear of what my [male] classmates would say. I mean, you know, kind of social anxiety. And so, I just had a lot of anxiety throughout my whole career of being a student… The anxiety is the biggest thing that pulls me back from engineering. (Focus Group Meeting, June 25, 2016)

As part of the minority in her engineering major, Anna felt serious intimidation to the point that she refused to seek help from her teachers for fear of what her male classmates would say.

Furthermore, Melissa was extremely clear that her experiences with harassment and intimidation led to an actual anxiety disorder. Melissa described,

> When I was in [redacted]… and by the third semester I was in it, I had an anxiety disorder because of it. That was extremely stressful, and I get panic attacks when I go to [redacted] Club… This is how much it impacts my life, because of what those guys said and how intimidating they are. That's really stressful, so my grades slipped because of how stressful it was, just being harassed by guys for three semesters. (Focus Group Meeting, June 25, 2016)

Like Gaby, Melissa sought out counseling services through the university. However, Melissa did not feel that her needs were being addressed. Melissa shared,

> I do counseling when I need it… I've been to the counseling services, and they say I should go take tests in private and all these things. And I refuse to do it because I feel like the guys are gonna notice, and they'll make comments or things like that… Maybe it

> would be better to take it by yourself, but then everyone notices and then you don't want to draw attention to the anxiety of it all. (Focus Group Meeting, June 25, 2016)

Melissa felt that most female students will feel anxiety in their engineering major. Melissa claimed, "I think engineering overall, it's a very high-anxiety field… I feel like girls are a little bit more prone to it… just because we have all those other stressors going on" (One-on-one Interview, July 10, 2016).

At the same time, Lisa's experiences were somewhat different. She acknowledged feeling some anxiety; however, as a member of two minority groups, female students in engineering and Latina students in engineering, she felt more anxiety as a result of being a Latina. She stated, "The only anxiety I have is just half because I'm a girl and the other half is because I'm a minority. So, I kind of have to represent both" (Follow-up Interview, August 9, 2016). Clearly, Lisa felt anxiety associated with being both a female in engineering and a female Latina in engineering.

## Theme 3: Representing My Gender Well

The third theme that emerged about challenges they encountered in their major concerned gender representation. All of the female engineering majors faced the burden of representing their gender well while working in a male-dominated environment. Melissa asserted, "So, I guess I don't compare myself to the stereotype, but I'm aware of it. And I wanna represent girls well… I wanna do well so other girls see they can do well" (One-on-one interview, July 10, 2016). Nancy felt the pressure and stated it very matter-of-factly: "Well, there's only a handful of girls, so anything we do is obviously going to be reflected off of the rest of them" (Follow-up Interview, August 12, 2016).

Similarly, Gaby felt this burden and believed that while in the minority in her engineering major, everything she did would represent or reflect on her gender. From the way she described it, this burden seemed almost unavoidable. Gaby elucidated,

> Always. I'm always one of the few female students, so I feel like I have to… show up and not even just physically, but mentally I have to show up and be ready and be on my game, and just show men we make up 50% of the population. And there's such a few that even if a female doesn't think that they're gonna represent the female gender, they do no matter what. (Follow-up Interview, August 24, 2016)

Correspondingly, this pressure even caused Lisa to feel apprehensive about participating in class. Lisa contributed,

> I always feel like even if maybe I don't feel confident in this particular subject, sometimes I feel like maybe I shouldn't open my mouth because I don't want to take a step backwards for all girls… I just keep my mouth shut because I don't want to embarrass girls. (One-on-one Interview, July 25, 2016)

Because of the added pressure the participants felt to represent their gender well, two female students stated that it also caused them to feel disdain for fellow female classmates who were not pulling their weight or possibly perpetuating the stereotype that women are not good at engineering. For instance, Nancy described,

> I had another class… and this group was horrible. I had another girl in it. And I was really excited because it's like, 'Oh, yeah! We're going to be friends. It's going to be great. Another professional, smart, working woman.' Unfortunately, she's not smart and it really upsets me because I feel she actually perpetuates that girls are bad at engineering… I was trying to combat the rest of my group's opinion of this girl by proving that I deserved to be here even if she didn't... It was horrible. (One-on-one Interview, July 7, 2016)

Lisa affirmed Nancy's experience. Although she may have felt guilty about her thoughts at a later date, she still admitted to thinking that a female classmate could potentially perpetuate a negative stereotype or outlook for the rest of the female engineering students. She stated,

> I know I've been guilty of judging other girls. One time, I was in a computer lab, and there was this girl that was a couple of seats down from me. And I know her from my classes. And she was just crying and crying because she didn't get the grade that she

> wanted. I feel bad about it now. But in the moment, I was just judging her hardcore for setting us back, you know, making us look weak… (Follow-up Interview, August 9, 2016)

In a like manner, Amanda felt that her performances, participations, and work ethic would help paint a good picture of the female engineer, but she emphasized that female engineering students should persevere even if engineering is not exactly the right path for them. Amanda felt the pressure and stated, "I feel like it's definitely more pressure that we all succeed, and that the few of us that actually made it in continue to go through even though it may or may not be exactly what we want" (One-on-one Interview, July 5, 2016).

In addition to certainly feeling the pressure to represent their gender well, three female engineering students also stated a need or desire to represent according to a standard they previously established for themselves. They acknowledged the pressure of representing their gender; however, they also had a personal standard they wanted to uphold. Anna declared,

> Absolutely… Even though the stereotype of men are better engineers than females, it might not be something that everyone believes in or even that popular of a stereotype within our college. Just being of a minority in the field and saying, 'Oh, I can do this and that' and the fact that I'm a female and I can still go through this program and be successful at the end. It might even be, for me, it's personal too, because everything I start I want to finish, and I want to finish well, at the top, always… (Follow-up Interview, August 11, 2016)

Amanda substantiated Anna's declaration. Amanda stated that she also has a personal standard to uphold:

> I definitely feel the pressure to represent. But, I feel more like I wanna represent myself… I mean, obviously, I am a woman. I represent all women, but I'm more concerned with representing myself. I wanna do well in school. I want a higher GPA. I wanna be able to get my job. I wanna be able to represent myself really well, and say, 'Hey, this is all the stuff I have done,' and I guess I focus more on… me and like what I wanna do in my personal goals rather than, like, women as a whole. (Follow-up Interview, August 11, 2016)

Melissa confirmed Amanda's and Anna's experiences:

> I mean, like, I always want to represent myself well, and I guess because I want to represent myself well, I want to represent my gender well. So, I guess, yes… but it's not like my first thought… I want to do this for me versus I'm gonna represent my gender sort of thing. I'm sure in the back of my mind it's there, but at the forefront, like I'm not trying to make anything about my gender… I think that's my first thought, is to represent myself… (Follow-up Interview, August 17, 2016)

Melissa definitely acknowledged the idea of representing her gender. However, Melissa was also concerned with representing herself. Three of the six female engineering majors felt double the pressure, as they were concerned with representing their gender well and representing themselves well according to their own standards.

## Theme 4: Teacher/Professor Comments and Behaviors

The fourth and final theme to emerge from the data highlighted the comments, actions, and behaviors of teachers and professors. Four of the six female engineering majors described experiencing negative comments or behaviors from teachers or professors. The female students focused on comments from professors that were directed toward them during class, face-to-face meetings, or extracurricular activities. Some participants did not seem to recognize how seriously these statements or actions had the potential to affect an individual. The female students shared their experiences during the focus group meeting, which were then further explained and validated during the one-on-one and follow-up interviews.

During the focus group meeting Anna described one of her first experiences with an engineering faculty member from Pleasantdale College:

> I met the our previous dean… I met him at a community college, 2014, so two years ago now, and that was the first time I had met him. It was just one-on-one because he happened to be there that day. And I said, "Hi, I'm looking into doing mechanical engineering, and I want to go to [Pleasantdale College]." He was like, "Oh, don't you want to go into electrical/industrial? More women are in that." I said, "No! I'm going into mechanical." (Focus Group Meeting, June 25, 2016)

Nancy echoed Anna's experience regarding teacher/professor concerns about female underrepresentation. However, in Nancy's experience, the professor commented further by making an actual statement about the ability of females in upper-level mathematics classes. In addition, the professor made a suggestion to Nancy that could have altered her trajectory in her major and possibly in her life. Nancy shared,

> When I changed from biomedical to biology, the big catalyst was I had failed Calc 1, and the professor… a woman, told me that some people just weren't cut out for this… Which is why I ended up switching to biology, which is the soft math STEM major. I didn't feel like I was good enough. I felt like I was an impostor because I couldn't even get simple calculus. (Focus Group Meeting, June 25, 2016)

Furthermore, Nancy proclaimed, "I was kind of offended and then I did doubt myself heavily because of that… If that professor didn't think you can do it, that's very negative... So when she said that, I was just crushed…." (One-on-one Interview, July 7, 2016). Whether the professor intended her comment to be considered in light of Nancy's gender, Nancy perceived the comment in a way that highlighted both her gender and her ability in math.

Similarly, Melissa perceived some teachers, especially those from a different generation, tended to believe there was a connection between gender and ability. She confirmed, "I've had teachers who get on you really bad about being a girl in engineering. I definitely think some of the teachers, especially the older teachers from a different generation, think they can get away with those comments" (Focus Group Meeting, June 25, 2016). Whether comments were explicit or implicit, Melissa was saddened that teachers in her major would subscribe to a belief regarding gender and ability in engineering.

Correspondingly, Gaby maintained a similar point of view regarding an experience that did alter her area of study trajectory and, in fact, her life and career pursuits. Gaby explained,

> I was getting my first degree back in 2006, and I went into engineering and was made to

> feel uncomfortable by a professor with all the other males in my courses, and I switched to education… It basically changed my entire career path… It took eight years later for me to be able to have the confidence to be able to say, 'This is what I really want to do, and I'm not going to let anybody discourage me from that.' (Focus Group Meeting & One-on-one Interview, June 25, 2016 & July 17, 2016)

Anna had a similar experience. After asking a question, she could not understand why the professor was not willing to help her:

> This one teacher… I think I was the only girl in the class… and I asked him a question. It was kind of similar to other questions that everyone else had been asking before me… He's like, 'We don't ask these kinds of questions.' But he would answer everyone else's. So, I didn't really understand why I wasn't being helped with it, especially because it was something I was struggling with. (One-on-one Interview, July 5, 2016)

After reflecting on the matter, Anna stated that is was "one of those things that kind of… you look at it for that week and it kind of sets you back… A little upsetting" (One-on-one Interview, July 5, 2016). Melissa affirmed Anna's experience concerning questions that were asked of professors. As far as Melissa was concerned, she said that some professors tend to treat male and female students differently. Melissa described,

> I think teachers, as much as they're like, we're equality and everything, I think they'll definitely be different towards the guys, and they'll be more willing to help one-on-one sort of thing… Me and my friend went in to go talk to a teacher, and we asked for a question on homework help. And he was on me about my age, and he goes, 'Well, shouldn't you have learned this in high school? You should know this already…' So, he was picking on me, and he left the guy alone [who was of the same age]. (One-on-one Interview, July 10, 2016)

Melissa had a comparable experience with another professor that occurred during class in front of other students:

> I had one teacher who I have had him twice now and every time I answer a question, he sort of, like, he will pick on you until you get it right. But I'll get it right on the first time, and then he will keep picking on me until I get it wrong. And then he'll either be like, 'Oh, I see. So I guess you didn't know it.' Or if I do know it, he is like, 'Why do you know that? You shouldn't know that.' Like, 'What are you doing?' (Focus Group Meeting, June 25, 2016)

Gaby confirmed Melissa's experience with a professor's differentiated treatment toward male and female students. She summarized her experiences by saying, "Sometimes, professors will value what males have to say more than females" (One-on-one Interview, July 17, 2016).

For the most part, Melissa felt that her engineering teachers and professors were trying. At least, that is what she thought. However, based on her comment, she seemed to imply that changes needed to be made. Melissa concluded:

> I think the teachers we have right now, they're really trying, I mean, I guess they're trying, but I think they don't have that natural way of getting along with students, and then some of them are clearly more, like, guy-driven. It's definitely a thing where they relate a lot more to guys. (Follow-up Interview, August 17, 2016)

Although Amanda and Lisa did not mention any specific instances, they did not have difficulty believing that such instances had occurred.

## Summary of Research Question 2b

In summation, all female engineering majors revealed some rather distressing information regarding the challenges they encountered in their majors. All female students detailed ways in which overbearing male dominance was a challenge for them, leaving some of the female students feeling devalued and belittled. In addition, five of the six females recounted experiences in which they dealt with some sort of harassment from their male peers. Harassment experiences made participants very upset and uncomfortable in their engineering majors. As a result of experiencing harassment, five of the six females also developed anxiety. For some, this anxiety made them want to quit certain teams and extracurricular organizations. All of the female engineering students depicted experiences in which they felt pressure to represent their gender well. Finally, four of six the female engineering students described how teachers or professors within their departments made comments that truly had the potential to alter their

course trajectories. In fact, for one participant, comments from a professor were so uncomfortable that she did change her major and her entire career path. Challenges that caused the participants to feel increased amounts of pressure, elevated levels of anxiety, and reasons for career modification are in line with previous research regarding stereotype threat.

In addition, these findings directly contrast with postfeminist notions that suggest the gendered oppressions that once infested educational institutions have evaporated and that the pursuit for gender equality is no longer necessary, as society is now experiencing an age of equality (McRobbie, 2004, 2009). Postfeminism further proposes that success is readily available to any girl – regardless of her circumstances. What is more, it advocates the idea that there is now a level playing field in school where females have elevated levels of power, which has allowed them to be, do, and have anything they want (Pomerantz & Raby, 2011; Ringrose, 2007). Based on the findings of this study, it would appear that success as measured by the completion of engineering courses and, ultimately, an engineering degree was most certainly hindered by gendered challenges. The female students in this study were not treated equally. They were not on a level playing field with their male peers. Based on these findings, it is inconceivable to agree with these notions set forth by advocates of postfeminism.

### Research Question 2c
### How do upper-level, female, undergraduate engineering students explain their reasons for persevering in spite of those challenges?

For Research Question 2c, data were gathered from the focus group meeting, the one-on-one interviews, and the follow-up interviews. Three themes emerged from the data: 1) Burden of Proof, 2) Support Groups, and 3) the Desire to Help. Table 9 illustrates the themes and one subtheme connected to Research Question 2c, along with the number of times the female

engineering majors made reference to them during the focus group and interviews.

Table 9

Themes and Number of References About Reasons for Persevering in Spite of Challenges

| Theme | Subtheme | Total Number of References from All Participants | Total Number of Participants Who Evoked Each Theme |
|---|---|---|---|
| Burden of Proof | | 20 | 5 |
| Support Groups | | 20 | 6 |
| The Desire to Help | | 14 | 5 |
| | Female Reasons for Persevering vs. Male Reasons for Persevering | 8 | 4 |

## Theme 1: Burden of Proof

After the data were collected, analyzed, and coded, the first theme for Research Question 2c was the participants' concerns with proving themselves in their engineering majors. Five of the six female students experienced issues dealing with the burden of proof. This burden of proof pushed the female students to excel above and beyond the requirements of an assignment or a task and inspired them to persevere in the face of challenges. In addition, because of this burden of proof, the female engineering majors were driven to persevere through challenges to prove to their male peers that they belonged in their engineering majors. Anna pointed out, "I feel like… because I was surrounded by guys, I had to step up and try and be better than them… equal or better than my peers… I think I try a little harder to overcome whatever they say" (One-

on-one Interview, July 5, 2016). By attempting to be better than her peers and overcome any negative comments they might say, Anna persevered to prove to her male peers that she was competent and could be successful in her major.

In a like manner, Nancy detailed her experiences with proving herself, or as she once referred to it – "showboating." She wanted people to know she was good at engineering. Nancy stated, "I really like showing off that I can do it and just kinda be like, 'Up yours!' (Focus Group Meeting, June 25, 2016). She also described,

> I'll go out of my way to use an application like Prezi because it has so much more flash, and obviously I make sure that my work is top quality. So I go out of my way to do things when I present… to go into further details just to show off… I deserve to be here… I'm just trying to be better than everyone else is what it comes down to… So, if I go up and present, I give them a very smooth speech and have a flashy presentation. It just makes me look so much better… I was showboating. I am good at engineering. I know what I'm talking about… This is where I belong. (One-on-one Interview, July 7, 2016)

Nancy worked hard and went out of her way to prove that she belonged in her engineering major. She continued, "Engineering's a lot about just going, 'I can do this.' And you tell yourself that. You don't get to stop telling yourself that" (One-on-one Interview, July 7, 2016). She persevered through challenges to prove that she belonged.

Likewise, Gaby seemed very concerned about proving that she was more than just a female. She seemed very cognizant of her gender while attempting to prove herself in her major. Gaby mentioned, "It pushes me to perform harder because I want to prove that I'm more than just a female… to show everybody that I can do it, and I can do it just by being smart and working hard" (Focus Group Meeting, June 25, 2016). It seemed that she was very concerned with how others viewed her capabilities. Gaby stated, "It definitely pushes me to try harder and to prove everybody wrong… it pushes me to prove everybody wrong" (Focus Group Meeting, June 25, 2016). Also, like Nancy, Gaby talked about being better than others:

> It's made me want to try harder just to prove not only just to myself but prove to others that I'm more than just capable. That makes me wanna be better than people, makes me wanna be better than their opinions. I wanna outperform people because of adversity that I may face from other students and their opinions… it just makes me wanna be even more competitive with grades. (One-on-one Interview, July 17, 2016)

When Gaby described being "more than just a female," she declared, "I always have to prove that I'm not dumb and that I'm actually capable" (One-on-one Interview, July 17, 2016). Like Anna and Nancy, Gaby persevered to prove that she was better than her peers and to battle their negative opinions. Gaby was stressed that her male peers viewed her gender as a reflection of her capabilities in engineering. By persevering through the negative opinions and comments of her male peers, she hoped to prove to her male peers that she was competent and that she belonged in engineering.

Correspondingly, like the other female engineering majors, Lisa seemed concerned about her abilities and if she was perceived as less capable than male students. For instance, Lisa said, "So I just never asked for help and sometimes that kinda hinders me… I'm stuck between a weird place wanting help but not wanting to seem weak" (One-on-one Interview, July 25, 2016). Even while facing the possibility of not understanding something, which could lead to eventual failure, Lisa refused to ask for help so that she would not seem weak. She faced the burden of proving to her classmates that she did not need help. In her opinion, male students in her engineering major do not have to face these types of dilemmas. Lisa addressed this based on her perception of the male perspective. She saw the exact opposite of the burden of proof for male students. Lisa stated,

> I think guys will never question that they're doing the right thing or they'll never feel insecure with their answers in class… They don't have anything to prove, I guess, versus when women, you know, we have to kind of prove that we're not lesser than the guys. (One-on-one Interview, July 25, 2016)

Comparatively, Amanda felt that other female students engage in engineering and

persevere through engineering to prove others wrong. However, Amanda noted that her personal standards were more pressing and relevant. Amanda shared,

> I mean, I know some girls definitely do it to prove others wrong… that proving mentality. I mean, it does definitely give me more motivation… Motivation to do well… I definitely feel like I need to be, if not the smartest one, on the smart end of everything… But I feel like the pressure I have to do well daily is more my personal standards for myself… I feel like my pressure on me to just do better because I've always kind of been, like, an honor student, so it's weird if I'm not getting… seeing the numbers I want to see. (One-on-one Interview, July 5, 2016)

Five of the six participants mentioned feeling this burden of proof. Even for a participant like Amanda, who felt that her personal standards were more of a motivator than the burden of proof, these female students acknowledged this burden to a certain degree. They persevered through challenges such as negative comments or opinions from their male peers while attempting to prove themselves in their engineering majors.

It should be noted, the themes Increased Motivation from Research Question 1 and Burden of Proof from Research Question 2c emphasize the participants' desire to prove themselves. However, the burden of proof is distinct from increased motivation, as the female engineering majors described the burden of proof in the context of perseverance. The burden of proof focused their attention on persevering through the difficult challenges they had as female engineering students. The female students always felt this burden of proof to prove that they belonged. On the other hand, the participants described increased motivation as reactionary responses after experiencing stereotype threat. In this context, the female students felt that they were already stereotyped, experienced stereotype-threatening situations that led to a threatening intellectual environment, and reacted with increased motivation to disprove the stereotype.

## Theme 2: Support Groups

The second theme that emerged from the data emphasized support groups, both inside and outside of engineering, as a reason for persevering despite the challenges they faced in their engineering majors. All six female engineering students felt that support groups were essential while explaining their reasons for persevering in spite of challenges. The quotations in Table 10 demonstrate how the female students explained how support groups helped them to persevere.

Table 10

Participants' Experiences with Support Groups

| **Name** | **Participants' Experiences with Support Groups** |
|---|---|
| Melissa | ● I have one girl outside of engineering and we can go get dinner and vent to each other. **And I think it's really important to have a friend group outside of engineering to talk to**, because when you're in engineering, you're stuck in the same thing… **I think it's important to let go and have quality time outside of engineering**, because you're going to sit there from 9 o'clock until midnight, five days a week. And so it's really important to get outside of the building because that's just like a prison cell in there. (Focus Group Meeting, June 25, 2016) |
| Gaby | ● Support system is really key… sometimes **family**. **I have friends outside engineering**… there's things outside of engineering that are really important. (One-on-one Interview, July 17, 2016) |
| Amanda | ● It's definitely like **the groups outside of engineering**. **Work is kind of an escape** sometimes. I have some **really awesome coworkers**… It's just kind of nice to have other people to talk to about this kind of stuff… **not doing all engineering all the time** definitely helps. **Going to work honestly is kinda therapeutic to me.** (Focus Group Meeting, June 25, 2016) |
| Nancy | ● **Having groups outside of engineering**. If I just had engineering 100% of the time, I would probably go crazy! (Focus Group Meeting, June 25, 2016) |
| Lisa | ● I think, for me at least… just **talking with my parents, with my brothers**. (Focus Group Meeting, June 25, 2016) |
| Anna | ● Probably the largest thing [that has helped me persevere] is… my first thought was always, "What else would I be doing?" I don't know what else I would want to do. And I know I really like this, and I know it's tough. But this is what I see myself doing… And then second would be support from family and friends. I hate to say "second" because it's huge. But it really is. (One-on-one Interview, July 5, 2016) |

All of the female engineering students cited some type of support group (family, friends, and coworkers) that has helped them persevere in spite of the challenges they faced in their engineering majors. Intriguingly, all of the participants focused on the importance of a support group outside of their engineering major. Although they acknowledged having friends in the program, it was the support groups outside of their engineering majors that truly helped them persevere.

## Theme 3: The Desire to Help

The third theme to develop for Research Question 2c was the female engineering students' desire to help. Four of the six of the female engineering majors specifically addressed helping other females, especially future female engineers, while one student was more general and stated that she felt the desire to help others. Five of the six female students stated that feeling the desire to help helped them persevere in their engineering majors.

Melissa felt that many females shared this same desire: "I think most girls are like, 'I wanna help somebody'" (One-on-one Interview, July 10, 2016). In addition, Anna was very adamant about her desire to help others. She declared,

> It's kind of like a fulfillment of what I should be doing, what I think I should be doing with my life. Hopefully, it's something I love doing, and it'll help someone else out in the future. Either with what I do or what I physically do at work, and what products maybe we make. Or if someone says, 'Look, she's an engineer. I could do that, too.' (One-on-one Interview, July 5, 2016)

Anna further proclaimed, "In my future, after I get a degree, I want to make sure I work with women in engineering, young women, specifically. Make sure that they know it's not strictly a man's field" (One-on-one Interview, July 5, 2016). Anna extended her desire to help beyond just females. She also explained, "I always want to learn things so that I can help other people, other

engineers that are my classmates, whoever I can" (One-on-one Interview, July 5, 2016). This desire to help inspired these female engineering majors to persevere through their challenging major.

Similarly, Gaby expressed interest in helping future female engineers. It is possible that she may want to help future female engineers alleviate any of the issues that she experienced herself. Gaby said, "I'm really interested in helping future females be able to feel comfortable because females are severely underrepresented and stepped down on in general, especially in engineering… I think females have that, they really just wanna help people" (One-on-one Interview, July 17, 2016). Like Gaby, Amanda had very personal experiences that sparked and fed her desire to help others. Amanda stated, "I have a little sister that has gobs of medical issues… my sister is a huge drive for me" (One-on-one Interview, July 5, 2016). Amanda further described,

> I have a younger sister who actually had gone through a lot of health stuff… And they don't really have a lot of devices or anything for her. And it was really frustrating for me to watch her go day to day and I knew what she needed, but what society had designed wasn't what she needed for her condition. (Focus Group Meeting, June 25, 2016)

For Gaby, being "really interested in helping future female engineers be able to feel comfortable" inspired her to persevere through the challenges she faced in her engineering major. This drive to help others, especially future females in engineering, propelled her and helped her persevere. Similarly, Amanda's sister's medical condition sparked her desire to help others and drove her to persevere in her engineering major. Regardless of the challenges, both Gaby and Melissa were determined to help others through engineering. This determination strengthened their resolve to persevere through the challenges of their engineering majors.

Then again, Lisa admitted that when she first decided to major in engineering, her desires were much different than they are today. Initially, Lisa was under the impression that

engineering was boring. Lisa stated, "I used to think it was just very, kind of boring. And you know, you would sit in this cubicle and just kind of do your own thing" (Follow-up Interview, August 9, 2016). What is more, she also admitted that when she first decided to major in engineering, her decision was based on the potential for monetary gain. She said that this could possibly have been a result of having all brothers and being close with her father. However, after some time researching and actually engaging in her engineering major, she changed her perspective. Lisa explicated,

> I was just mainly in it for, you know, the money and the scholarships and, you know, the monetary rewards for it. But me, I don't know, I searched out, you know. I tried a little bit of each branch of engineering. And I found the one that I like. So I realized that, you know, I can help people… and I don't have to sit in the cubicle. (Follow-up Interview, August 9, 2016)

As she progressed through engineering and conducted research of her own, Lisa's reasons for persevering changed from monetary reward to the desire to help. She no longer viewed engineering as "boring" but saw it as a way to help people. This newfound reason for pursuing engineering deepened her intention to persevere in engineering through any challenges she encountered.

Subtheme: Female Reasons for Persevering vs. Male Reasons for Persevering

Intriguingly, during the one-on-one interviews, four of the six students commented on the perceived dichotomy between female students' reasons for persevering in engineering and male students' reasons for persevering in engineering. Although Nancy did not explicitly state that she pursued and persevered in engineering because of a desire to help, she was very clear about why she believed male students pursued and persevered in engineering. Nancy declared,

> They're doing it for the money because they know that money attracts women. They looked at their potential and decided that, 'You know what? Engineering makes the most

> money of the sciences.' I think they're more motivated by what the degree means. The degree means a stable job with a sizeable income. A sizeable income means options, buys toys, women… prestige, expectation. Most women in engineering are doing it because they want to do it. (One-on-one Interview, July 7, 2016)

Nancy's opinion regarding why male students pursue and persevere in engineering clearly demonstrates the different reasons she perceives that lead males and females to pursue and persevere in engineering.

Nancy's opinions were validated by Melissa. Melissa claimed that females definitely pursue and persevere in engineering to help others, whereas males pursue and persevere in engineering for the money. Melissa described,

> I think most girls are like, 'I wanna help somebody.' It's really far between from the guys who are just like, 'I just wanna do this to make money…' The girls are more in it, like, 'I wanna help somebody…' Guys are just like, 'I'm here to make money and get a job…' I think that the monetary gain is what drives it most of the time… 'This is what I like to do, and this is what I can get paid the most doing it.' Girls are more, 'I wanna help somebody. This is how I can help somebody.' (One-on-one Interview, July 10, 2016)

Anna and Amanda both stated the same idea; however, they were not as explicit regarding the dichotomy between female and male reasons for pursuing and persevering. For example, Anna believed that males logically decided on engineering because of the job market. Anna stated, "A lot of times, they hear, 'Oh, it's a good job market. There's some good opportunity, and there's money in it" (One-on-one Interview, July 5, 2016). Amanda also commented that males looked at the job market logic. Amanda said, "I feel like a good chunk of guys I talk to… they know it's a secure job. They know it's stable" (One-on-one Interview, July 5, 2016).

In contrast, Gaby never experienced a situation that led her to believe male students chose to pursue and persevere in engineering for the job market or monetary gain. However, she did acknowledge it as a possibility. Gaby elucidated,

> Everybody that goes into engineering wants to be able to create something. They may want to do it for different reasons. Someone may want to do it to make the world a better place, someone may want to do it because they grew up loving to play with Legos. But I think the base desire to be an engineer is because you wanna create something… The monetary thing does help… I guess some people go and do it specifically for that reason… (One-on-one Interview, July 17, 2016)

This perceived dichotomy between female students' reasons for persevering in engineering and male students' reasons for persevering in engineering was interesting to note as it emerged through data collection and analysis. Four of the six female students believed that females persevered in engineering to help others, whereas males persevered for the job market and monetary gain. Regardless of the different reasons for why one group perseveres compared to another, comments concerning this dichotomy did emerge and should be noted.

## Summary of Research Question 2c

In regard to how the female engineering majors explained their reasons for persevering in spite of challenges, all six participants overwhelmingly explicated issues related to a burden of proof. All of the female students felt pressure to prove themselves in their engineering majors. The burden of proof was motivation for them to prove that they belonged. In addition, the six female students described the importance of support groups while persevering through their engineering majors. Participants commented that it was essential to have support groups both inside and outside of engineering. The female engineering students also detailed their desire to help others as a reason for persevering. Whether the desire to help was focused on future females in engineering or the participants felt the desire to help by engineering helpful products, the desire to help was present. Finally, four of the six female engineering majors commented on the perceived dichotomy between female students' reasons for persevering in engineering and male students' reasons for persevering in engineering.

## Chapter Summary

Chapter 4 presented the research findings of this study. Qualitative narratives were provided to illustrate and highlight the female engineering majors' responses from the focus group meeting, one-on-one interviews, and follow-up interviews. Multiple themes that coincided with each research question emerged.

The following themes emerged from Research Question 1: 1) Explicit and Implicit Experiences with Stereotype Threat, 2), Conformity, through language and dress attire, and 3) Increased Motivation. Notably, all female students said they made an effort to conform to their engineering majors, such as changing or adjusting their language or attire. Furthermore, some participants chose to entirely ignore or avoid the stereotype that "females are bad at engineering" and those who may perpetuate it. What is more, while acknowledging the stereotype that "females are bad at engineering," five out of six of the female engineering students experienced increased motivation to perform well in their engineering majors.

In regard to Research Question 2a, the female engineering majors revealed information that related to 1) Familial Connections and Support and 2) Coursework Affinity. The participants expressed how supportive family members, both siblings and parents, helped influence their decisions to major in engineering. Interestingly, all participants who shared an experience regarding familial connections and support discussed experiences involving male family members. Moreover, all of the female students who shared experiences that demonstrated their affinity for certain coursework mentioned the same two subjects: math and science.

The female engineering students' responses to Research Question 2b were quite raw and revealing. The themes that emerged were 1) Male Dominance, 2) Harassment, 3) Representing

My Gender Well, and 4) Teacher/Professor Comments and Behaviors. A subtheme developed concerning the anxiety participants experienced because of the harassment. The female students described how overbearing male dominance was a challenge for them. Furthermore, five out of six female engineering students discussed experiences where they endured harassment from their male peers. The female students also detailed how they felt pressure to represent their gender well. Finally, four out of six female students shared how teachers or professors within their majors made comments that had the potential to alter their course and life trajectories.

For Research Question 2c, the female engineering majors shared experiences related to 1) Burden of Proof, 2) Support Groups, and 3) the Desire to Help. All participants revealed how they felt pressure to prove themselves in their engineering majors. Also, all female students explained the importance of support groups, both inside and outside of their engineering majors. Five out of six female engineering students also described their desire to help others as a reason for persevering. Finally, four of the six female students commented on the perceived dichotomy between female students' reasons for persevering in engineering and male students' reasons for persevering in engineering.

In Chapter 5, the themes and their connections to the research questions will be further explored. What is more, relationship to the theoretical framework, implications of the study, potential interventions, and future research recommendations will be discussed.

# CHAPTER 5

# DISCUSSION OF FINDINGS

The purpose of Chapter 5 is to discuss the findings that emerged from the data collection process. Four major findings from this study are examined. The findings are also discussed as they pertain to the theoretical framework and past research. Implications, potential interventions, and future research recommendations are also explored.

This case study examined the experiences of upper-level, female, undergraduate engineering students – specifically, how those experiences have been impacted by stereotype threat. The major findings and their implications will help spark dialogue regarding stereotype threat as a potential reason for the underrepresentation of female students in engineering.

## Major Findings and Their Relation to the Theoretical Framework and Past Research

The four major findings of this study can be viewed through the lens of the theoretical framework presented in Chapter 2. For over 20 years, researchers have been analyzing the deleterious effects of stereotype threat. A voluminous body of quantitative research examining stereotype threat activation and its effects currently exists (Aronson & Inzlicht, 2004; Danaher & Crandall, 2008; Neuville & Croizet, 2007; Shapiro & Williams, 2012; Spencer et al., 1999; Steele & Ambady, 2006). This research is overwhelmingly quantitative and has been conducted in laboratory settings with a focus on stereotype threat activation and its effects (Ambady et al.,

2001; Appel, Kronberger, & Aronson, 2011; Aronson & Inzlicht, 2004; Danaher & Crandall, 2008; Inzlicht & Ben-Zeev, 2003; Neuville & Croizet, 2007; Shapiro & Williams, 2012; Spencer, et al., 1999; Steele & Aronson, 1995; Steele & Ambady, 2006). Considering that being in the minority can induce stereotype threat effects and create a threatening intellectual environment (Inzlicht & Ben-Zeev, 2003), this study sought to bridge the gap between what quantitative researchers have found regarding stereotype threat effects and the experiences and perspectives of individuals in the minority who face and struggle with stereotype threat.

Few qualitative studies exist that examine stereotype threat experiences from the perspectives of students (Cox & Fisher, 2008; Doan, 2008; Romkey, 2007; Sayman, 2013; Villa & Gonzalez y Gonzalez, 2014). In the United States, this is the only study in the field that employs a qualitative methodology with upper-level, female, undergraduate engineering students. That is to say, this exploratory qualitative study focused on how upper-level, female, undergraduate engineering students explained their experiences with stereotype threat in program areas in which they were seriously underrepresented.

The findings from this study point to the need to better understand the effects of stereotype threat on groups of people for whom a negative stereotype exists, how stereotype threat can be perpetuated, and how stereotype threat can be minimized. Three findings of this study support past research regarding the pernicious impact of stereotype threat, with one finding from the study adding new perspective to past literature. The four major findings follow.

## Conformity

In the context of this study, conformity referred to when a female engineering student knowingly diverged from her normal behavior to better fit in or to assist in accomplishing a task

while working with her peers. Researchers have found that when women face stereotype-threatening situations, they adjust their behaviors to avoid potential stress associated with certain roles, thus conforming to gender expectations widely accepted in society (Davies et al., 2005). Interestingly, in this study, the female engineering students felt the need to conform to behavior standards and customs set forth by their male peers to alleviate stress, harassment, and judgment from their male peers. In contrast to the study by Davies et al., the engineering students conformed to be more like their male peers to distance themselves from the negative stereotype of "females are bad at engineering" and subsequently be viewed as students first, as opposed to females first. The female students conformed in two distinct ways. The female students purposefully modified their language and volume. In addition, they intentionally modified their attire. Whether it was through the modification of their language and volume or of their attire, all participants engaged in at least one form of conformity.

Amanda, for instance, just wanted to be one of the guys. Gaby stated that she not only adjusted the tonal quality of her voice to sound similar to her male peers, but she also mimicked their behaviors while in groups. Like Gaby, Melissa mimicked male behavior by developing a much more colorful vocabulary and swearing like a sailor. Anna felt the need to be more assertive and "have no mercy." Lisa also described being more assertive but specifically mentioned being louder and putting herself out there more. These findings add to the research that the underrepresented status of women in engineering creates an immense need to feel more socially integrated and accepted in their male-dominated field (Holleran, Whitehead, Schmader, & Mehl, 2011). The findings show the lengths to which these engineering students went to make physical changes to distance themselves from the negative female stereotype and appear as "one of the guys."

The female engineering students used conformity as a strategy to integrate themselves into their engineering majors. By purposefully modifying their language and dress attire, they hoped to better fit in and distance themselves from the negative stereotype that "females are bad at engineering." However, this conformity had short-term gains for the individuals and long-term problems for the engineering majors and departments. As Nancy and Melissa described, a sort of "initiation" was required to be accepted by the male peers in their engineering majors. They saw conformity as a way to assist with the initiation into their male peer groups. Rather than being seen as females first, they sought to be seen as students in their engineering majors. Subsequently, by sacrificing their individuality and conforming, they were eventually "initiated." This allowed them to appear as "just one of the guys" and helped distance themselves from the stereotype associated with their gender and ability in engineering. Yet this conformity simultaneously presented long-term issues that reinforced the male-dominated culture. Rather than making attempts to change the male-dominated culture, conforming to the standards and conventions of their engineering majors inadvertently supported, maintained, and preserved the male-dominated culture that made them feel the need to conform in the first place (Miller, 2004)

To initiate real change – change that results in gains for all students – it may be wise to stop the conformity and start a conversation. It is quite possible that the College of Engineering and Engineering Technology, or educational institutions in general, are unaware of stereotype threat. The college may not know about stereotype threat as a theory or that students within the college have had their experiences shaped by stereotype threat. In addition, the college and other educational institutions may not be cognizant of stereotype threat's deleterious effects. First, raising awareness regarding this issue is paramount. Second, after raising awareness concerning this issue and ensuring that faculty and administrators are familiar with it, it would behoove the

College of Engineering and Engineering Technology to examine and implement possible interventions. Although these findings were specific to this research study, it would be advisable that other educational institutions consider these implications as well. In regard to interventions, the colleges and educational institutions can focus on de-emphasizing threatened social identities (Danaher & Crandall, 2008; Stricker & Ward, 2004). Modifying existing curricula, assignments, or procedures has shown to reduce the salience of stereotyped group memberships. In this case, disassociating tasks with possible connections regarding gender and ability could be a good starting point (Danaher & Crandall, 2008; Stricker & Ward, 2004). Also awareness needs to be raised about the issue, and subsequent training needs to be provided regarding the elimination of harassment from male peers and faculty.

## Role Models

Five female engineering majors in this study cited familial connections and support as a reason for pursuing a degree in engineering. When diving deeper into this theme, it became apparent that all five of these female students were influenced by males in their families. The female engineering students cited shared experiences with their fathers and brothers as influencing their decisions to pursue engineering.

For example, Anna described how bonding and sharing common interests with her father, a civil engineer, influenced her decision to major in engineering. She and her father spent time building Legos and watching engineering-inspired programming such as the History Channel's *How It's Made.* For Lisa, her father and her brothers played a role in influencing her decision to pursue engineering. She recounted her experiences helping her father work on cars and other things around the house. In addition, Lisa also shared experiences like playing Legos with her

brothers and participating in a Boy Scouts program. Gaby, who came from a long line of male engineers, felt that because her family fully supported and nurtured her interest in building things, this sparked her curiosity in engineering. This spark eventually burned into a desire to major in engineering. Finally, for Amanda, she credited the time she spent with her father on their farm tinkering and messing with things and simply being around her dad for influencing her decision to major in engineering.

Family members are a source of information and provide opportunities for experiences that shape a child's sense of possibility in life and school. Past research has shown the values and attitudes of family members heavily influence a child's academic and career goals (Dick & Rallis, 1991; Gilmartin, Li, & Aschbacher, 2006; Jodl et al., 2001). Research also suggests providing even a single role model who challenges stereotypic assumptions and who also happens to be of the same gender or race can reduce or eliminate stereotype threat effects (Blanton, Crocker, & Miller, 2000; Marx & Goff, 2005; Marx & Roman, 2002; Marx, Stapel, & Muller, 2005; McIntyre et al., 2005; McIntyre, Paulson, & Lord, 2003). Future research should further examine the importance of role models, including role models of the opposite gender or another race, in both inspiring young females to pursue engineering and in alleviating stereotype threat effects. Finally, it is important to note that not only did the female engineering students acknowledge the benefits of shared experiences with role models such as their fathers and brothers, they also stated their intentions to one day serve as role models for others – specifically, other female engineering students. As future role models, the engineering students in this study could help alleviate the stress associated with stereotype threat and provide information regarding their own experiences that could help future female engineering students persevere.

## Threatening Intellectual Environment

As Deaux and Major (1987) contend, the environment can serve as a causal factor and influence gender-based stereotypes to be activated. That being said, the stereotype itself needs not be made salient (Spencer et al., 1999). Inzlicht and Ben-Zeev (2003) found that one such environmental factor, being outnumbered by peers from the opposite sex, does cause the members of the minority in that environment to experience the pernicious effects of stereotype threat. This environment, where there is an increased risk of activating stereotype threat effects, is referred to as a "threatening intellectual environment."

The findings also demonstrated that a threatening intellectual environment existed within the college. The female students' group identification as engineering majors was threatened by societal stereotypes (Steele, 1997). According to the female students, they found themselves questioning their identity as engineering majors. In addition, Nancy and Gaby both described feeling like victims of "impostor syndrome" in which they found themselves doubting their abilities and place within their engineering majors. When faced with a situation in which they could be reduced to a negative stereotype, the female students were enveloped in a disruptive state that interfered with their participation in their engineering majors (Davies et al., 2002). Although gender may not have been made clear in the comments by their male peers, the female students perceived their comments in relation to their gender and their ability in engineering, causing some participants to quit engineering teams and extracurricular activities. Also, in light of their explanations regarding male dominance, harassment, teacher/professor comments and behaviors, and simply being in the minority, these female engineering majors regularly operated within a threatening intellectual environment (Inzlicht & Ben-Zeev, 2003).

This environment was maintained when male peers and professors perpetuated the negative stereotype in both explicit and subtle ways. As evidenced by the findings in Chapter 4, the female engineering students experienced overbearing male dominance, harassment, and teacher/professor comments and behaviors that perpetuated a misperception regarding their gender and ability to succeed in engineering.

## Male Dominance

All participants in this study experienced an overbearing male dominance in their engineering majors. As the females attempted to conform to distance themselves from the negative stereotype, this male dominance served to further expose the minority status of each female participant, making it difficult for them to disassociate themselves with the stereotype. For instance, as the only female in many of her classes, Gaby felt overwhelmed by her male peers, especially while engaged in group work. Gaby felt the actions of her male peers in the male-dominated environment were often oppressive and devaluing. She felt her male peers thought she did not know what she was talking about simply because she was a female. This finding is consistent with Heyman et al. (2002), who reported almost the same idea. In their study, female students commented that their male peers often dismissed them and treated them like they did not know anything.

Like Gaby, Nancy described being the only female in many of her classes. She noted that her minority status created a "spotlight" effect. She bemoaned how this "spotlight" effect made her feel extremely uncomfortable. Furthermore, Nancy felt that her male peers were constantly out to discredit her and make her feel less of a person or less of student. Similarly,

while in group work, Lisa described how the body language of her male peers sent an implicit message to just "let the boys talk." She felt side-lined and struggled to have her voice heard.

When it came to making friends in this male-dominated environment, Anna felt that her male peers had a much easier time because they shared similar interests. For her, this was intimidating. Melissa and Nancy agreed, stating that there was a cost of admission associated with becoming friends with their male peers. This admission often included putting up with rude and disrespectful comments before being taken seriously and feeling respected by their male peers. For Amanda, while working with her male peers in groups, she felt her male peers were resistant when she attempted to resolve conflicts within her groups. She felt that her male peers were able to resolve their conflicts much quicker if it was a male/male conflict as opposed to a male/female conflict.

Blickenstaff (2005) found that often females express concern about a "chilly" climate in science classes when they do not feel welcomed by their male peers. Statements made by the participants of this study provide evidence that their engineering majors would seem "chilly." It is important to acknowledge the notion that forces beyond the College of Engineering and Engineering Technology could have created or exacerbated these experiences. For example, in addition to being excluded and devalued in their actual classroom experiences, the female students could have felt excluded because of cultural messages about women in math and science fields.

Furthermore, the male dominance the participants experienced is similar to female engineers in the oil industry, where shared masculine interests often exclude women, and the dominant male culture reinforces the work divided by gender (Miller, 2004). The participants most certainly felt excluded. For instance, as Anna stated, her male peers had a much easier time

finding friends because they shared similar interests that she did not share. She mentioned feeling intimidated by this. Moreover, while the participants attempted to share their input during group projects, they were often shut down and made to feel undervalued. Furthermore, during group work, the female participants mentioned how they were often corralled into being the mother of the group, the secretary of the group, or other traditional gender roles. What made this even more unfortunate was the "it is what it is" mentality fostered and promulgated by adults such as teaching assistants in the engineering departments. As Miller states, "It is in the small, everyday acts that the gender regime is continually reconstructed" (p. 49). For the female engineering majors in this study, this gender regime was continually reconstructed and certainly shaped their experiences on a regular basis.

## Harassment

To reiterate, in the context of this study, harassment referred to incidents when participants experienced comments or behaviors from male peers or teachers/professors in their engineering majors that made them feel belittled, devalued, and uncomfortable. Five of the six female engineering majors described experiencing denigrating harassment that posed challenges for them in their engineering majors. For these participants, harassment was an extremely real and brutal issue. Some of these instances of harassment were so blatantly explicit, it is no wonder participants mentioned harassment as a challenge they experienced while pursuing their engineering majors.

Clearly, referring to a female as "just tits and ass," as some of Gaby's male peers did, is unacceptable. This made her feel completely degraded. What is more, during an engineering internship, one of Gaby's managers called her "stupid." This single remark led her down a dark

path of questioning her abilities and status as an engineering student. She pondered, "What am I doing here? I can't do this."

Unfortunately, demeaning remarks such as those experienced by Gaby were not completely uncommon. For instance, while working on a car with a group of male students, Melissa was asked to hold a part while the group of males headed to the other side of the car and proceeded to look down her shirt. This left Melissa feeling "oversexualized" and uncomfortable. Frighteningly, Melissa was also warned by a fellow female classmate that she could be raped by her male peers if she attended a trip that she was really looking forward to attending. She said she felt paranoid after this warning. She felt as though she did not know whom to trust. She was forced to look at her male friends in a different light. What is more, if Melissa ever seemed a bit irritated, her male peers would resort to sexist comments such as, "Are you on your period?" or "Are you PMS-ing?" Melissa disclosed that this harassment made the atmosphere within her engineering major so much more uncomfortable.

For Nancy, harassment took the form of vicious rumors. She knew of gossip circulating about her that rumored she and any other successful female students were only successful because they were attractive young women. Nancy believed that the rumors were a way for her male peers to not only degrade her but to dismiss her abilities and accomplishments. Both she and Gaby agreed that their male peers created and promulgated these rumors to rationalize the fact that some female students were doing better than them academically.

For some, their experiences with harassment were not as extreme. However, these instances still left participants feeling degraded or uncomfortable. Anna recalled being referred to as a "big shot" when she spoke in class. This reaction from her male classmates upset her. Also, as part of a club, the president of the club yelled at her and spoke to her disrespectfully in

front of the rest of her peers. This disrespect caused her stress to the point of feeling anxiety. In addition, it made her want to quit the team. For Amanda, she felt very uncomfortable under the "spotlight effect." She remembered feeling a bit uneasy when her male peers would approach her and speak to her as if they knew her. Although the contexts in which the harassment occurred may be different, the participants agreed that the message was still the same: when threatened, the female students felt that their male peers resorted to tactics that helped them feel on top or in control.

Instances related to how students treat and relate to each other have a tremendous impact on their overall experiences. In the case of this study, it quickly became evident that five of the six participants experienced harassment. For most people, the presence of any type of harassment can serve as a barrier. In engineering, a field in which female students are largely underrepresented, these barriers can push female students out of their majors (Chiosso & Tizard, 1990; Dececchi, Timperon, & Dececchi, 1998; Hill et al., 2010). The findings of this study support Chiosso and Tizard's (1990) findings that female participants who experienced instances of harassment dealt with the situations by simply "shrugging it off" or "dealing with it." The participants of this study showed exemplary strength and fortitude as they persevered through instances of harassment. It is important to note that these are the experiences of female engineering students who have persisted. What about the female students who did not persist? Did they experience even more severe instances of harassment? Or did these female students have, for whatever reason, increased resilience in the face of such harassment? If a threatening intellectual environment exists that perpetuates male dominance and harassment for female engineering students, is it any wonder why there is an underrepresentation epidemic in fields like

this? That being said, these instances should not be occurring in the first place, and no students should have to just shrug it off or deal with it when it comes to harassment.

## Resulting Anxiety

Unfortunately, because of the harassment experienced in their engineering majors, multiple participants also developed unhealthy levels of anxiety. For instance, Nancy, while battling her anxiety, forthrightly admitted smoking a lot of weed. Similarly, Lisa recalled drinking alcohol every weekend. Although Lisa later mentioned that those days were behind her, it leads one to ponder how prevalent these experiences are in the CEET. Gaby sought therapy to help with the anxiety resulting from harassment experiences in her engineering major. Melissa was abundantly clear when she expressed that her experiences with harassment and intimidation led to an actual anxiety disorder. In addition to the anxiety, she said that because of the harassment and intimidation, her grades began slipping. Melissa's issue with her grades slipping illustrates a connection between much of the past research that demonstrates how stereotype threat negatively hinders performance. Also, similar to Gaby, Melissa sought therapy. Clearly, as evidenced by the anxiety the female students faced as a result of the harassment from their male peers they experienced in their engineering majors, this college is a threatening intellectual environment.

## Teacher/Professor Comments and Behaviors

In addition to experiencing the challenges of male dominance, harassment, and resulting anxiety, the participants also contended with teacher/professor comments and behaviors. In this context, teacher/professor comments and behaviors referred to comments from professors

directed toward participants during class, face-to-face meetings, or extracurricular activities that negatively impacted their experiences in their major.

Anna's first experience with a faculty member from Pleasantdale College was disheartening. Before transferring to Pleasantdale, Anna had the opportunity to meet the dean of the College of Engineering and Engineering Technology face-to-face. When she told him who she was and what she planned to major in, he responded by attempting to redirect her into a different major. His reasoning for the redirection was that "more women are in that." This comment had the potential to seriously alter Anna's course and life trajectory. Unfortunately, this was not the only incident in which a teacher or professor made a comment that made Anna uncomfortable. While asking a question during class, Anna first made note of the fact that her question was not dissimilar to the questions asked by her male peers. The teacher responded by saying, "We don't ask these kinds of questions." Anna admitted to never following up with the teacher regarding the incident. Yet at the time this study was conducted, it still bothered her, especially because the concept was something she was struggling with and she needed help.

Nancy had a similar experience. When Nancy failed Calculus 1, her female professor told her that some people "just weren't cut out for this." Although the comment may seem subtle, Nancy felt that this comment had to do with her gender. For Nancy, not only was this upsetting, she was offended and began to heavily doubt herself in her engineering major. To use Nancy's words, "I was crushed." What is more, Nancy saw this comment from her female professor as the reason for changing her major from engineering to biology. Essentially, this comment was the catalyst that pushed Nancy to change her major and almost altered her life trajectory. Slights such as these, which may not have been gender related or intentionally devaluing on the part of the professor, have a cumulative effect. If these types of comments

continue over a sustained period, they will most certainly negatively impact those on the receiving end. As Nancy explained, this comment left her feeling "crushed" and resulted in her changing her major. Comments like this have a negative impact. When speaking with students, professors must consider the language they use and the actual message or underlying assumptions emanating from the language.

Similarly, Gaby, a nontraditional student, mentioned an experience in 2006 with a teacher that did alter her area of study trajectory, her career trajectory and ultimately, her life. In addition to the harassment she faced from her male peers, she stated that a professor also made her feel uncomfortable. This experience eventually pushed her to switch her degree to education. It changed her entire course trajectory, career plans, and her life, as she spent time teaching mathematics rather than finishing her engineering degree.

Melissa also agreed that she has had some issues with teacher comments. During one incident, she and a male peer, who was the same age as her, went to seek help from a teacher during his office hours. After both students expressed their concern and after asking the question, the teacher directed his attention at Melissa and chided her by stating that she "should have learned this already." During this incident, Melissa noticed that the teacher was not directing any of his comments to her male peer. Melissa also felt that her teachers were more willing to help her male peers compared to her female peers.

Stereotype threat is a source of stress or anxiety, and it directly affects cognitive functioning rather than performance (Allison, 1998; Clark et al., 1999; Pascoe & Richman, 2009; Steele, 2010). Some of the ways it impacts cognitive functioning are by increasing arousal (Ben-Zeev et al., 2005; Blascovich et al., 2001; O'Brien & Crandall, 2003), activating distracting thoughts (Cadinu et al., 2005), and depleting limited working memory (Beilock et al., 2007;

Schmader & Johns, 2003). While individuals under stereotype threat expend immense effort to perform well and disprove a negative stereotype, they also may attempt to overcome distressing thoughts or emotions (Johns et al., 2008; Logel et al., 2009). As a result of working in a threatening intellectual environment, the female students definitely faced distressing thoughts and emotions. Thus, their cognitive functioning in this threatening intellectual environment was most likely impacted as they struggled to fight distracting or distressing thoughts and emotions.

## Burden of Proof

The female engineering majors were motivated to prove to themselves and others that they belonged in engineering and that the group stereotype, "females are bad at engineering," was untrue (Inzlicht & Ben-Zeev, 2003; Steele & Aronson, 1995). At first, the participants felt increased motivation as a reactionary response when faced with stereotype-threatening experiences. It later became clear that the female students were continually faced with this desire to prove their worth, even when not faced with a stereotype-threatening experience. This was referred to as the burden of proof. The female engineering students were very concerned about proving themselves and disproving the negative stereotype, and this burden of proof pushed students to go above and beyond the requirements of an assignment or a task. Thus, the participants navigated a precarious terrain where they continually attempted to distance themselves from the negative stereotype, disprove it, or both.

While surrounded by male peers in her engineering major, Anna felt the pressure to "step up and try and be better than them [male peers]." She felt the pressure to not only prove that she could handle the assigned tasks, but she also could do those tasks better than her male peers. Also she wanted to disprove anything her male peers would say about her performance in the

class or on the assignments. Anna understood that her reputation as a female student in her engineering major was on the line. By desiring to "overcome" anything her male peers may say, she acknowledged that she was susceptible to their judgment based on her performance and needed to work harder to prove them wrong, be better than them, and disprove the negative stereotype.

For Nancy, proving herself in her engineering major often involved what she referred to as "showboating." Nancy's concern with proving herself pushed her to "go out of her way" to make flashy presentations and speak well in front of her peers to show off. Similar to Anna, she wanted to do better than her peers. For Nancy, she desired to prove that she belonged, that she identified as an engineering student, that the negative stereotype was untrue, and that there was nothing anyone could do to take her engineering identity away from her. As she declared, "I deserve to be here… I'm good at engineering… This is where I belong." Nancy had two words for those who disagreed with her identification as an engineering student: "Up yours!"

Gaby seemed very aware of her gender and how her gender was perceived in the sciences, especially engineering. She knew of the stereotype that females are bad at engineering. The pressure to disprove the stereotype was a burden, and Gaby saw it in terms of being "more than just a female." Along with the other participants, she wanted to be seen as a student first, rather than as a female first. Sadly, as a female, Gaby admitted that she has always felt the pressure to prove that she is not dumb and that she is completely capable. Like Anna and Nancy, Gaby also desired to be better than her peers. She wanted to outperform others to disprove any negative opinions they may have had about her or her gender. For Gaby, this pressure to prove herself also made her extremely competitive with grades.

Anna's, Nancy's, and Gaby's experiences confirmed Amanda's assertion that female students in engineering persevere to prove others wrong. She acknowledged that the burden of proof pushed her to prove others wrong. In addition to feeling the pressure to prove herself and disprove the stereotype, she also felt pressure associated with her own standards and expectations. Like Amanda, Melissa also commented that her own standards were more relevant and served as the major source of pressure. She was not as concerned with disproving the stereotype or being better than her male peers. To avoid stress, she tried to avoid comparing herself to others.

Similar to Amanda, Lisa also felt that the burden of proof was somewhat common for the female students in engineering. She described that females in engineering have to prove that they are not "lesser than the guys." One way Lisa attempted to prove that she was not lesser than her male peers was by not seeking help or assistance when she needed it. She did not want to "seem weak."

All of the female engineering students described feeling pushed to prove to themselves and to others that the negative stereotype was untrue. Research suggests that people are motivated to disprove negative stereotypes about themselves or their group (Kray, Thompson, & Galinsky, 2001; von Hippel et al., 2005; Yeung & von Hippel, 2008). Researchers have also found that feeling the pressure to disprove a stereotype so one will not be judged according to said stereotype causes anxiety, creates stress, lessens motivation, exhausts cognitive resources, drains working memory mechanisms, hinders learning activities such as test preparation, and impairs domain-specific executive resources (Appel et al., 2011; Beilock et al., 2007; Blascovich et al., 2001; Davies et al., 2002; Fogliati & Bussey, 2013; McKay et al., 2003; Quinn & Spencer, 2001; Schmader et al., 2008; Steele & Aronson, 1995). The female engineering

majors pushed themselves and exerted more effort to disprove a negative stereotype. It is important to note that these female engineering majors were continually faced with this desire to push themselves and prove their worth, even when not faced with stereotype-threatening situations. The burden of proof demonstrates how the concept of stereotype threat played out in the everyday lives of these female students. Finally, the findings of this study show that the female students did experience anxiety and felt stress. Although the female students discussed feeling increased anxiety and stress as a result of the harassment from their male peers, one cannot help but wonder if while pushing themselves to disprove the stereotype and prove to others that they belong in engineering, they added to their levels of anxiety and stress and, perhaps due to the stereotype threat, decreased their overall performance level.

## Implications of the Study

Stereotype threat is not a new area of research. Research on stereotype threat has been conducted for over 20 years. This social psychological phenomenon has raised concern since researchers first uncovered its profoundly negative impacts on the academic performance of individuals for whom a negative stereotype exists during testing situations (Shapiro & Williams, 2012; Steele & Aronson, 1995). Since then researchers have found more disturbing evidence that suggests the effects of stereotype threat can be physically, psychologically, or professionally detrimental (Niemann, 1999). For example, researchers have found that stereotype threat raises physical health concerns for negatively stereotyped individuals (Blascovich et al., 2001), reduces interest in stereotype-relevant careers (Davies et al., 2002), lessens self-efficacy beliefs (Aronson & Inzlicht, 2004), hinders learning activities such as test preparation (Appel et al., 2011), reduces motivation (Fogliati & Bussey, 2013), affects grade point average (Aronson & Jones, 1992), and

drains working memory mechanisms (Beilock et al., 2007; McKay et al., 2003). It should be noted that stereotype threat effects can be experienced by members of any group for whom a negative stereotype exists (Steele, 1997). Also internalizing negative stereotypes about one's group and then fearing the confirmation and subsequent judgment of that stereotype, action fulfillment happens to people for whom a negative stereotype exists probably several times a day (Steele, 2010). What is more, simply being in the minority can induce stereotype threat effects (Inzlicht & Ben-Zeev, 2003).

The first major implication of this case study is that stereotype threat did shape the everyday experiences of these participants. The findings suggest that the pressure to disprove the negative stereotype that "females are bad at engineering" is part of the female engineering students' normal experiences. These students felt this pressure in combination with other challenges they faced, such as male dominance, harassment, resulting anxiety, and stress-inducing teacher/professor comments and behaviors. All participants agreed to feeling pressure to disprove the stereotype and battled the burden to prove they belonged in their engineering major. It is possible that because of their support groups and strong relationships with their role models, these six female students were likely the best at or most capable of dealing with these challenges. Again, what about the female engineering students who did not persist? Is it possible that female engineering students who did not persist experienced elevated levels of harassment or other issues in the male-dominated culture? Are there different levels of coping skills that students may have and use? These questions and this implication shine light on the notion that only the most resilient female students may survive and persevere in such an environment. As evidenced by Gaby's initial departure from engineering, the environment proved too much for her. She left because of her experiences with harassment, male dominance,

and stress-inducing teacher/professor comments and behaviors. Although she did return, parts of her story were not all that uncommon, as other female engineering students in this study faced similar experiences. This begs the question, how many female students leave engineering for similar reasons but never return?

The second major implication of this study relates to the importance of role models. In this study, the female engineering students credited shared experiences with their fathers and brothers for influencing their decisions to pursue engineering. Interestingly, these findings suggest that role models need not be of the same gender to be considered influential. Outreach programs that encourage involvement from family members, such as Lisa's experience with her brother and the Boy Scouts program, demonstrate the potential for positive experiences to influence a person's decision to pursue a career path.

The third major implication is the need for further expansion of programs and initiatives such as the Society of Women Engineers (SWE). Pleasantdale College can also consider partnering with other organizations, such as Women in Engineering Proactive Network (WEPAN). SWE does wonderful things such as offering students the opportunity to collaborate and learn from female faculty members, coordinating alumni and corporate mentors for female students, and providing career success strategies ([redacted] 2015). However, the female engineering students in this study mentioned that they were not involved in the society and did not really intend to get involved. One must wonder if there is some way to help incentivize these students to get involved in the society, where they can then share their experiences and voice their concerns. In addition, WEPAN is an educational organization that strives for "change to enhance the success of women in the engineering professions" (Women in Engineering Proactive Network, 2016). It helps organizations form strategic partnerships and provides professional

development that equips "advocates with the tools to create sustainable, systems-level changes that allow ALL in engineering to thrive" (Women in Engineering Proactive Network, 2016).

The fourth major implication of this study is its focus on making the female engineering students' experiences visible. It was important to document their struggles, make note of the courage they displayed in the face of denigrating experiences, and bring attention to the barriers they faced while earning an engineering degree. An elevated awareness regarding barriers to female representation in the sciences, especially engineering, is essential for developing and implementing solutions. What is more, raising this awareness is essential for addressing and adjusting the behaviors of their male peers and their teachers/professors. It is important for male peers and teachers/professors to see and understand how their comments and behaviors can negatively impact the female students. What is more, understanding how their comments and behaviors can negatively impact the experiences of female students must matter to them, otherwise the male peers and teachers/professors may not be willing to make the necessary changes. Some researchers posit that stereotype threat is not a cause for female underrepresentation in math and science fields, including engineering (Stoet & Geary, 2012). However, if female engineering students face the type of threatening intellectual environment revealed in this study on a regular basis, it is not difficult to see why they may leak from the pipeline. In fact, one participant from this study did leak from the pipeline.

Finally, the fifth major implication of this study is that stereotype threat should seriously be considered as a hindrance for minorities in stereotype-relevant domains or careers. In this study, the female students' experiences with stereotype threat could most certainly be seen as barriers. Educational institutions and workplace organizations should contemplate the negative effects associated with stereotype threat and how their institution or organization may be

perpetuating an environment that could induce these deleterious effects. If educational institutions or workplace organizations are not willing to acknowledge that their institutions and organizations may be maintaining a threatening intellectual environment as a result of perpetuating stereotype threat, real and positive change will not occur. Removing barriers such as stereotype threat will not only help combat the underrepresentation of females in engineering but could help combat underrepresentation of stereotyped groups everywhere. Interventions aimed at reducing the harmful effects of stereotype threat and removing it as a barrier are recommended in the following section.

## Intervention Recommendations

As previously mentioned, stereotype threat is not simply a situational predicament. Students from stereotyped groups may live with these implicit and explicit stereotype threat experiences. The extra pressure to disaffirm stereotypes may exist wherever and whenever. For Steele, an African American male, experiencing stereotype threat and its effects was not limited to an academic setting. Steele (2010) asserts:

> It was a broad pressure, not confined to difficult tests. I felt it in classes, in conversations, while sitting around watching football games. It could cause paralysis of personality… even in informal situations like program picnics… the pressure wasn't confined to just one class. (p. 154)

Experiencing stereotype threat did not go away at the culmination of class. For him, the threat was salient, constantly in the air. It seems that the participants of this study have had a similar experience. There is a threat in the air. It is salient. It may dissipate some when not engaged in academic tasks. However, because they desired to identify as engineering students, that threat was always present.

Unfortunately, the exposure to sociocultural stereotypes can exert influence over individuals at very early ages. Luckily, researchers have found that performance is malleable and can be moderated by situational and psychological cues (Ambady et al., 2001). Therefore, it would behoove this educational institution to seriously consider the pernicious impact of stereotype threat and its effects and contemplate implementing possible interventions to alleviate stereotype threat experiences for students and employees. It must be noted that properly addressing this issue will require collective institutional change. The type of change needed to properly address this issue cannot be expected solely on the part of the individuals experiencing stereotype threat. The findings of this study demonstrate that a systematic issue is present. Thus, a solution that focuses on the entire system is required. However, it must also be noted, addressing systematic change is extremely complex. It requires the adjustment of cultural beliefs and the continued consideration regarding the conditions that are conducive to continuous improvement (Fullan, 2007). Thus, engaging in this type of change will require extensive time, training, and possibly even resources. The intervention recommendations throughout this section have been considered in light of the need for collective institutional change, as opposed to putting the onus for change on individuals. What is more, if this dilemma is not addressed, it may present a Title IX issue, which prohibits discrimination based on sex in any federally funded education program or activity (The United States Department of Justice, 2015).

The following suggestions could help Pleasantdale College and other educational institutions consider possible interventions and subsequently alleviate the detrimental effects of stereotype threat.

## Encourage the Proper Reporting of Possible Title IX Issues

Although the faculty may have been unaware of how their treatment could have negatively impacted the female students, they are mandated Title IX reporters. Even if the misconduct may only be a rumor or heard third-hand, faculty are obligated to report it. It is important for employees to report misconduct involving students, as this sends the message to students that the university takes their concerns seriously, will provide appropriate support and resources, and will follow up on the complaint where appropriate and necessary ([redacted], personal communication, January 24, 2017).

## Raise Awareness for Society of Women Engineers and Pathway Programs

As support groups and systems often help college students persevere, it would behoove a college to develop and implement support groups for its students (Felder et al., 1995; Jacobs, 2005; Lent et al., 2003; Lent et al., 2005; Marra, Rodgers, Shen, & Bogue, 2009). Pleasantdale College currently has a Society of Women Engineers (SWE). In addition, Pleasantdale College also implemented a pathway program that seeks to sustain female interest in engineering from middle and high school through college. However, the findings of this study demonstrate that the female engineering students felt isolated. Three participants from this study believed that SWE was not meeting the needs of female students because it was more focused on coursework and extracurricular activities than on the social-emotional aspect of being a female in engineering. SWE is an organization that focuses mostly on the advancement of women in STEM fields. The organization seeks to promote, encourage, and mentor women in the fields of science, technology, engineering, and math. However, the College of Engineering and

Engineering Technology, in partnership with SWE, should work together to develop a socio-emotional aspect of the organization. For instance, SWE could add a social support system or circle time that allows participants to openly and comfortably share their concerns in hopes of SWE offering practical solutions for relief. This focus on socio-emotional needs of students should be unrelated to career mentorship or advancement. When these circles allow for trusting, open dialogue in a comfortable and safe environment, they help build community, encourage authentic dialogue, instill a feeling that everyone belongs, and focus on responding to the socio-emotional needs and issues of the people involved (Clifford, 2013; Fronius, Persson, Guckenburg, Hurley, & Petrosino, 2016).

In regard to the Enhancing Engineering Pathways, this program partners mostly with Girl Scout organizations. Yet if young girls are not part of Girl Scout organizations, it is possible that they may miss these opportunities or at least not be aware of them. Therefore, if the pathway program also partnered with local schools, park districts, YMCAs, or Special Recreation Centers, there is more likelihood for increased program participation and success opportunities.

### Raise Awareness About the Ombudsperson

Pleasantdale College should raise awareness about its ombudsperson. The ombudsperson is designated as a neutral party who can provide informal and confidential assistance regarding the resolution of university-related concerns. Although the ombudsperson cannot advocate for an individual, offer legal advice, or impose solutions, this person can listen, analyze the situation, answer questions, and identify strategies and options for the successful resolution of university-related concerns. In addition, other resources include:

- Other confidential resources like a confidential advisor from the Counseling and Consultation Services
- Non-confidential resources like the Title IX coordinator and Office of Student Conduct

Though the university has a variety of resources for students, many of these resources put the onus on the student. The issues presented in this study would almost certainly require systematic and collective institutional action, as opposed to individual students seeking help with systematic issues occurring in their major. The following interventions seek to address the issue from a systematic point of view.

## Providing Training

Researchers suggest that teaching, training, and workshops could also help alleviate the negative effects of stereotype threat (Block et al., 2011; Johns, Schmader, & Martens, 2005). For example, in an organizational environment, Block and colleagues encouraged managers and consultants to work with human resources departments to develop and provide training and workshops that highlight stereotype threat and some typical responses to stereotype threat. The researchers postulate, "Providing individuals with this information may help to normalize the experience for people going through it and may provide a framework for managers to understand what their employees may be experiencing" (p. 591). Although Block et al.'s suggestion is intended for an organizational environment, the idea of training and workshops can be hybridized and provided on college campuses for both teachers and students. Pleasantdale College already offers mandatory Title IX training for students. However, recent training for the faculty and graduate assistants was provided during the summer, when both faculty and graduate

assistants were off-contract for the summer ([redacted], personal communication, January 24, 2017).

As this scheduling conflict presents an issue, the college could simply schedule mandatory training during the actual school year, so that faculty are obligated to attend. Also, the College of Engineering and Engineering Technology could hire consultants from the National Center for Women and Information Technology (NCWIT) to provide training and guidance regarding stereotype threat. If funding is unavailable for such an endeavor, NCWIT also encourages the use of its resources to raise awareness and provide training for staff.

In addition, the college should raise awareness and provide staff with training regarding asset versus deficit language. Staff should be trained to use asset-based language, where the focus is on the strengths of the individual rather than his or her problems, needs, or deficits (Green & Haines, 2012). This type of change represents a major shift in the mindset and professional practice of those who work with minorities. Of course, some staff may be reticent to this training. Therefore, the Human Resources Department will need to work closely with staff to help them understand how and why this is such a pressing issue. However, if staff members are still reluctant, the training may need to be mandated.

## Challenging and Changing Sexist Attitudes

It became appallingly clear that the participants of this study dealt with harassment that at times was sexual in nature. Most instances of harassment came from male peers. Furthermore, it is likely that faculty and students were unaware of what they were doing. In addition, some faculty may be holding on to antiquated ideas concerning past research that focused on male and female cognition.

Therefore, Pleasantdale College should first consider educating its students and faculty about how their behavior could be considered harassment. They need to be made aware that their behavior has had a negative impact on other individuals in the college. After raising this awareness, Pleasantdale should also consider providing faculty and staff with more current research that debunks the notion that women are not good at math, science, and engineering. Thus, raising awareness about this issue should come first, then policies could be created and enacted. Chiosso and Tizard (1990) recommend that colleges make it abundantly clear that harassment of any kind will not be tolerated.

In addition, developing and implementing a mentorship program could help faculty and students grow and learn together. For instance, Clifford (1999) found that good mentor partnerships between teachers helped instill protégés with a sense of empathy. In fact, she concluded that the empathic tendencies of the mentors helped build transformative relationships for both the mentor and the mentee. If the level of empathy is increased for the male peers and teachers/professors, it is likely that they may better understand and relate to the nature of being a minority female in a heavily male-dominated field like engineering. Pleasantdale College could use the Mehrabian Emotional Empathic Tendency Scale (Mehrabian & Epstein, 1972) to identify empathic mentors and begin partnering them with others. From there, Pleasantdale would need to determine the duration, actual activities, and the depth and proper implementation criteria for its mentorship program. However, the idea that empathic mentors can instill their mentees with an elevated sense of empathy, which could then help students and teachers/professors better relate to their female students, should be considered.

While protecting the identity of study participants, the findings of this study should be presented to all faculty members of the College of Engineering and Engineering Technology and

other educational institutions. Then collaboratively created and clearly delineated policies that describe harassment and the repercussions tied to harassment offenses should be addressed. Furthermore, it behooves faculty to take a lead role in challenging sexist attitudes rather than perpetuating them, as was the case for some participants in this study. If training is necessary, the College of Engineering and Engineering Technology and other educational institutions could find consultants to provide such workshops.

## Nullifying the Threat

Researchers have found that stereotype threat effects can be nullified to optimize performance. The faculty in the CEET could lessen the impact of stereotype threat by explicitly addressing the relevant stereotype and stating that it does not apply. Clearly, if faculty were to state that a stereotype does not apply, this would require faculty and students to acknowledge that a stereotype exists in the first place. And for some, the stereotype need only be acknowledged for it to have an effect. Thus, this intervention could be a double-edged sword. Researchers have found promise with this approach (Aronson et al., 1999; Smith & White, 2002; Spencer et al., 1999; Stangor, Carr, & Kiang, 1998; Steele & Aronson, 1995).

## Providing Anxiety Support

The CEET and SWE could also provide students with information regarding anxiety support. Specifically, multiple resources for Pleasantdale College students are available, such as the Counseling and Student Development Center, the Counseling Laboratory, the Psychological Services Center, and the University Resources for Women. The female engineering majors in this study seemed aware of these services, as some of them mentioned utilizing their services.

First, it is important that all students are aware of the resources provided by Pleasantdale College. In addition, care should be taken to encourage all students in all programs to seek these resources if they experience anxiety.

### Emphasizing the Growth Mindset or an Incremental View of Intelligence

Research has shown that embracing the growth mindset, or an incremental view of intelligence, as opposed to the fixed mindset can reduce or even eliminate stereotype threat (Aronson et al., 2002; Good, Aronson, & Inzlicht, 2003). The CEET faculty must embrace the growth mindset that emphasizes motivation and effort rather than inherent talent. The findings of this study certainly illustrate the solid effort and motivation exemplified by the female students. The faculty should stress effort over inherent talent or intelligence to help individuals embrace the growth mindset. This would require education and professional development for faculty. If further education or professional development are necessary, the college could hire consultants to provide such workshops.

## Future Research Recommendations

The following recommendations have been organized according to the study's data collection methods and the coinciding research study recommendations. Table 11 suggests recommendations for future studies.

Table 11

Future Research Study Recommendations

| **Theme** | **Research Study Recommendation** |
|---|---|
| Qualitative studies | ● As this study only had six participants, all of whom stated they experienced stereotype threat in the past, future qualitative research should study the experiences held by those who do not report experiencing stereotype threat. This contrast may help provide more insight regarding the perceptions of those who do not share similar stereotype threat experiences.<br>● Again, because there were only six participants in this study, future qualitative studies should include a bigger sample size.<br>● Conduct more qualitative studies of stereotype threat in natural settings.<br>● Qualitatively explore the under-enrollment epidemic facing women in engineering. Under-enrollment itself may reinforce stereotypes about women's roles or abilities.<br>● Qualitatively explore how stereotype threat shapes the experiences of other minority students.<br>● Qualitatively explore how teachers or professors view their roles regarding the stereotype threat experiences of their students.<br>● Qualitatively study students who left engineering to evaluate whether they succumbed to stereotype threat.<br>● Qualitatively study the experiences of male students regarding their perceptions about stereotype threat.<br>● Qualitatively explore stereotype threat in opposition to postfeminism.<br>● Because priming need not occur to invoke stereotype threat activation, more naturalistic, qualitative studies should be conducted to better understand what types of experiences do activate stereotype threat.<br>● Future studies should attempt to bridge the gap between the stereotype threat findings of quantitative studies by including more qualitative or mixed methods. |
| Quantitative studies | ● More quantitative studies should focus on outcomes other than academic performance, such as emotional well-being during testing situations and presentations, the rate of active involvement in engineering extracurricular activities, and how stereotype threat may impact the way female engineering students treat each other.<br>● More quantitative studies should focus on outcomes outside of academic domains. For example, studies could focus on the effects of stereotype threat in:<br>○ An extracurricular activity<br>○ The workplace<br>○ A meeting<br>○ A social gathering<br>○ A competitive sport<br>○ A debate |
| Mixed-methods studies | ● A future mixed-methods study could quantitatively determine the single best support systems and then qualitatively explore why those support systems are so successful. In addition, the study could develop a plan for creation and implementation. |

# Conclusion

This case study qualitatively explored the ways stereotype threat shaped the experiences of upper-level, female, undergraduate engineering students. The results of this study demonstrated that while conforming to the standards and conventions of their engineering majors, these female students were experiencing short-term individual gains, which assisted with assimilation into their male peer groups, the subsequent distancing from the negative stereotype that "females are bad at engineering," and being seen as students first. Yet these short-term wins resulted in long-term failure to address the issues that made them feel the need to conform in the first place. In fact, the female engineering students were inadvertently maintaining and preserving this male-dominated culture. What is more, this study's findings also revealed the threatening intellectual environment these students faced on a regular basis. From simply being in the minority to the documented male dominance, harassment, resulting anxiety, and stress-inducing teacher/professor comments and behaviors, the female students were enveloped in an environment in which an increased risk for activating stereotype threat effects existed. Finally, all of the female engineering majors described feeling pushed to prove to themselves and to others that the negative stereotype was untrue. The female students pushed themselves and admittedly exerted more effort to disprove the negative stereotype.

In regard to female underrepresentation in science fields, including engineering, stereotype threat certainly has the potential to cause female students to question themselves, their abilities, their choice of an academic major, and to subsequently remove themselves from a hostile learning or working environment. "No matter who it affects… we need to be able to undo the damage of stereotypes to ensure that all individuals can achieve their best" (Smith &

White, 2002). Thus, educational institutions and workplace organizations are responsible for not only educating themselves regarding stereotype threat but also for taking steps to alleviate the pernicious effects of stereotype threat.

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# APPENDIX A

# LETTER TO THE DEAN OF THE COLLEGE OF ENGINEERING

Greetings [redacted]:

I hope this letter finds you well.

As one of the academic requirements for the degree of Doctor of Education in the Curriculum and Inquiry program here in the College of Education at [redacted], I must conduct empirical research for my dissertation. I seek permission to conduct an essential aspect of my study in the College of Engineering and Engineering Technology.

The purpose of my qualitative case study is to examine how stereotype threat shapes the experiences of upper-level, female, undergraduate, engineering students and how these students explain their reasoning for pursuing a degree in engineering.

If granted permission, I would first ask to be introduced to the department chairs of the electrical engineering, industrial and systems engineering, and mechanical engineering departments. Next, I would request that the dean ask the department chairs to send the Participant Screening Survey link to all students in the department. This screening survey will help identify participants that meet necessary criteria for the study. Based on the screening survey results, I would identify six participants who meet the necessary criteria and invite them to participate in a 90-minute focus group meeting. After the focus group meeting, I would conduct one-on-one interviews with the six upper-level, female undergraduate engineering students. I plan to conduct two separate, individual interviews. The first interview would last 45 minutes. The follow-up interview would last 30 minutes. If necessary, a monetary incentive would be provided to compensate participants for their time. Pseudonyms will be used to identify participants to preserve their confidentiality.

Your approval of my study would be immensely appreciated. I truly feel that my study has the potential to unearth important information that may benefit students and educators.

If you have any questions or concerns, please contact me.

I look forward to hearing from you.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX B

# LETTER TO THE DEPARTMENT CHAIRS IN ELECTRICAL ENGINEERING, INDUSTRIAL AND SYSTEMS ENGINEERING, AND MECHANICAL ENGINEERING

Greetings Dr. [redacted]/Dr. [redacted]/Dr. [redacted]:

I hope this letter finds you well.

As one of the academic requirements for the degree of Doctor of Education in the Curriculum and Inquiry program here in the College of Education at [redacted], I must conduct empirical research for my dissertation. My study was recently approved by the university's Institutional Review Board. Furthermore, I just received approval from Dr. [redacted] to begin collecting data.

The purpose of my qualitative case study is to examine how stereotype threat shapes the experiences of upper-level, female, undergraduate, engineering students and how these students explain their reasoning for pursuing a degree in engineering.

With your help, I would request that you send my Participant Screening Survey link to all students in your department. This screening survey will help identify participants that meet necessary criteria for the study. Based on the screening survey results, I would identify six participants who meet the necessary criteria and invite them to participate in a 90-minute focus group meeting. After the focus group meeting, I would conduct one-on-one interviews with the six upper-level, female undergraduate engineering students. I plan to conduct two separate, individual interviews. The first interview would last 45 minutes. The follow-up interview would last 30 minutes. Pseudonyms will be used to identify participants to preserve their confidentiality.

Your help with this endeavor would be immensely appreciated. I truly feel that my study has the potential to unearth important information that may benefit students and educators.

After hearing from you, I will send you the Participant Screening Survey Introductory Letter and the link to the Participant Screening Survey that can simply be forwarded on to students in your department.

If you have any questions or concerns, please contact me.

I look forward to hearing from you.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX C

## PARTICIPANT SCREENING SURVEY INTRODUCTORY LETTER AND PARTICIPANT SCREENING SURVEY

My name is John R. Entsminger II, and I am a graduate student in the College of Education at [redacted]. The purpose of this study is to examine how upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat may shape their experiences and how these students explain their reasons for choosing a major, the challenges they have encountered in the major, and their reasons for persevering in spite of those challenges.

The Participant Screening Survey seeks to identify participants who meet the necessary study criteria. After successful completion of the Participant Screening Survey, participants who meet the necessary study criteria will be invited to participate in a 90 minute focus group meeting comprised of six participants. This meeting will convene at a time and place to be mutually agreed upon. Participants will also be invited to participate in one-on-one interviews. Two separate, individual interviews will be conducted with each participant. The first interview will last 45 minutes. The follow-up interview will last 30 minutes. Questions during the focus group meeting will focus on how participants explain their decision for choosing an engineering major and any challenges they may have faced in the major. Questions during the one-on-one interviews will further explore participants' decisions for choosing an engineering major and ask participants to explain their reasoning for persevering in obtaining a degree in engineering.

I am aware that my participation is voluntary and may be withdrawn at any time without penalty or prejudice, and that if I have any additional questions concerning this study, I may contact John R. Entsminger II at [redacted] or Dr. Beth Wilkins at [redacted]. I understand that if I wish further information regarding my rights as a research subject, I may contact the Office of Research Compliance at [redacted].

I understand that the intended benefits of this study may provide insight into how students persist through instances of stereotype threat, and how these instances may be alleviated to encourage more females to enter the field of engineering.

I have been informed that the potential risks and/or discomforts I could experience during this study include A) confidentiality concerns and/or B) adverse emotions after disclosing information about incidents with the researcher. I understand that all information gathered during this experiment will be kept confidential as the researcher will identify participants through the use of pseudonyms. However, I also understand that when participating in a focus group, the confidentiality of other members cannot be guaranteed. All recorded data will only be accessible to the researcher.

I understand that my completion of this survey implies my consent. I also understand that my consent to participate in this project does not constitute a waiver of any legal rights or redress I might have as a result of my participation, and I acknowledge that I have received a hard copy of this consent form.

I look forward to working with and learning from you.


| J.R. Entsminger, Researcher | Dr. Elizabeth Wilkins, Dissertation Chair | Office of Research Compliance |
|---|---|---|
| Email: [redacted] | Email: [redacted] | Phone: [redacted] |
| Phone: [redacted] | Phone: [redacted] | |

# Participant Screening Survey

Please identify your gender.

- Male
- Female

Are you enrolled as a full-time student in the university?

- Yes
- No

Are you an undergraduate student?

- Yes
- No

What is your academic major within the College of Engineering and Engineering Technology Department?

- Electrical Engineering
- Industrial and Systems Engineering
- Mechanical Engineering

What is your year in college?

- Freshman
- Sophomore
- Junior
- Senior

Were you a transfer student to this university?

- Yes
- No

Are you currently enrolled in an engineering course?

- Yes
- No

Has a parent, teacher, professor, or fellow student ever said to you that people like you are not good in engineering?

- Yes
- No

Is there a stereotype that women are not good at engineering?

- Yes
- No

Have you ever felt that your performance has been impacted because you identify as a woman and women are thought to be bad at engineering?

- Yes
- No

If you meet the necessary criteria for the research study, the researcher would like to contact you. Please provide your most frequently used email address. (Note: Your email address will be kept confidential)

*Note:* Adapted from *Mathematics stereotype threat experience survey* by Doan, 2008

# APPENDIX D

# LETTER TO THE PRESIDENT AND VICE PRESIDENT OF THE SOCIETY OF WOMEN ENGINEERS

Greetings Mrs. [redacted] and Mrs. [redacted]:

I hope this letter finds you well.

As one of the academic requirements for the degree of Doctor of Education in the Curriculum and Inquiry program here in the College of Education at Northern Illinois University, I must conduct empirical research for my dissertation. My study was recently approved by the university's Institutional Review Board. Furthermore, I just received approval from Dr. [redacted], [redacted], to begin collecting data.

The purpose of my qualitative case study is to examine how stereotype threat shapes the experiences of upper-level, female, undergraduate, engineering students and how these students explain their reasoning for pursuing a degree in engineering.

As the President and Vice President of the Society of Women Engineers, Dr. [redacted] recommended that I get in touch with both of you. Because of your involvement in the Society of Women Engineers, he stated that you would be able to help me identify participants for my study.

With your help, I would request that you send my Participant Screening Survey link to all students in the department. This screening survey will help identify participants that meet necessary criteria for the study. Based on the screening survey results, I would identify six participants who meet the necessary criteria and invite them to participate in a 90-minute focus group meeting. After the focus group meeting, I would conduct one-on-one interviews with the six participants. I plan to conduct two separate, individual interviews. The first interview would last 45 minutes. The follow-up interview would last 30 minutes. Pseudonyms will be used to identify participants to preserve their confidentiality.

Your help with this endeavor would be immensely appreciated. I truly feel that my study has the potential to unearth important information that may benefit students and educators.

After hearing from you, I will send you the Participant Screening Survey Introductory Letter and the link to the Participant Screen Survey that can simply be forwarded on to students in your department.

If you have any questions or concerns, please contact me.

I look forward to hearing from you.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX E

# RESEARCH STUDY CONSENT LETTER

I agree to participate in the research project titled "Stereotypes and STEM: A Qualitative Exploration of the Experiences of Upper-level, Female Undergraduate Engineering Students" being conducted by John R. Entsminger II, a graduate student in the College of Education at [redacted]. I have been informed that the purpose of the study is to examine how upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat may shape their experiences and how these students explain their reasons for choosing a major, the challenges they have encountered in the major, and their reasons for persevering in spite of those challenges.

I understand that if I agree to participate in this study, I will be asked to do the following: A) Complete the Participant Screening Survey. B) Participate in a 90 minute focus group meeting comprised of six participants. This meeting will convene at a time and place to be mutually agreed upon. C) Participate in one-on-one interviews. Two separate, individual interviews will be conducted with each participant. The first interview will last 45 minutes. The follow-up interview will last 30 minutes. Questions during the focus group meeting will focus on how participants explain their decision for choosing an engineering major and any challenges they may have faced in the major. Questions during the one-on-one interviews will further explore participants decisions for choosing an engineering major and ask participants to explain their reasoning for persevering in obtaining a degree in engineering.

I am aware that my participation is voluntary and may be withdrawn at any time without penalty or prejudice, and that if I have any additional questions concerning this study, I may contact John R. Entsminger II at [redacted] or Dr. Beth Wilkins at [redacted] I understand that if I wish further information regarding my rights as a research subject, I may contact the Office of Research Compliance at [redacted].

I understand that the intended benefits of this study may provide insight into how students persist through instances of stereotype threat, and how these instances may be alleviated to encourage more females to enter the field of engineering.

I have been informed that the potential risks and/or discomforts I could experience during this study include A) confidentiality concerns and/or B) adverse emotions after disclosing information about incidents with the researcher. I understand that all information gathered during this experiment will be kept confidential as the researcher will identify participants through the use of pseudonyms. However, I also understand that when participating in a focus group, the confidentiality of other members cannot be guaranteed. All recorded data will only be accessible to the researcher.

I understand that my consent to participate in this project does not constitute a waiver of any legal rights or redress I might have as a result of my participation, and I acknowledge that I have received a hard copy of this consent form.

_____ _____

-- Signature of Participant Date

I also give my consent for the researcher to audiotape the focus group and one-on-one interview in which I may participate.

_____ _____

-- Signature of Participant Date

J.R. Entsminger, Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins, Dissertation Chair
Email: [redacted]
Phone: [redacted]

Office of Research Compliance
Phone: [redacted]

# APPENDIX F

# PARTICIPANT GREETING LETTER

Greetings Participant:

Thank you so much for taking the time to complete the Participant Screening Survey!

Good news! You meet the essential criteria to participate in my research study.

As of right now, I do not have enough study participants to begin the data collection process. As the survey was only recently administered, I hope that more people will complete it in the coming week/weeks. As soon as I have enough participants who meet the study criteria, I will begin inviting participants to participate in a 90-minute focus group meeting. I will work to coordinate a date and time that is mutually agreed upon.

In the event that I do not receive enough participants who meet the necessary study criteria, I may ask that you recommend other participants for the study or encourage other people with whom you associate to complete the Participant Screening Survey. This is referred to as "snowball" or "chain" sampling.

Again, I am so appreciative that you took the time out of your day to complete the survey. I truly feel that my study has the potential to unearth important information that may benefit students and educators in engineering and beyond.

I am so interested in working with and learning from you.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX G

# FOCUS GROUP MEETING INTRODUCTION

**Welcome/Introductions**

I am so appreciative that you have agreed to participate in this focus group. I am very excited to learn from you all.

Moderator: My name is J.R. Entsminger. I am a graduate student and doctoral candidate in Curriculum and Inquiry department of the College of Education. As part of my dissertation, I must conduct a research study. This focus group is part of my data collection procedure.

Assistant Moderator: If there is an assistant moderator, she will introduce herself at this time.

**Basic Details**

The focus group will last 90 minutes.

**The Purpose Behind This Focus Group/Overview**

I am conducting this focus group to better understand how the experience of stereotype threat can shape the experiences of upper-level, female undergraduate engineering students. I also hope the information provided by participants will illuminate how upper-level, female, undergraduate, engineering students explain their reasons for choosing to pursue a degree in engineering.

**Ground Rules**

1. Participants have the right to decline to answer any question with which they are not comfortable.
2. It is important for the participants to do the talking. Your experience and the information you provide today is paramount. I may call on you if you have not participated in a while.
3. Please be honest.
4. There are no right or wrong answers. Every participant's experiences and opinions are extremely important. Feel free to agree or disagree.
5. Confidentiality. This is a safe room. What is said in this room will only be heard by the participants and the researcher. Please feel comfortable sharing if and when sensitive issues arise.
6. As stated in the consent form, this focus group will be audiotaped. Pseudonyms will be used in the report. You will not be identified in any way.

# APPENDIX H

# FOCUS GROUP MEETING PROTOCOL

| Research Questions | Focus Group Meeting Questions |
|---|---|
| How do upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences? | **-Is there a stereotype that people who are like you are not good at engineering?**<br>-Do you think these stereotypes shape your experiences in your classes? How?<br>-Are you in the minority in your engineering program? Do you feel any pressure to do well on academic performances in light of being in the minority? Why? What do you think would be the cause of that pressure?<br>-Suppose you had one minute to talk to a person who has embraced the stereotype about women in engineering. What would you say to that person?<br>-How do you think we can attract more female students to the field of engineering? |
| How do upper-level, female, undergraduate, engineering students explain their reasons for choosing their major? | -**Briefly share the story about how you decided to become an engineering major.**<br>-How are your classes going in your declared engineering major?<br>-Are there any particular experiences that led you to your current position as a student in the engineering department?<br>-What was your best/favorite moment so far?<br>-What was your least favorite moment so far?<br>-Currently, how do you feel about your decision to be an engineering major?<br><br>*Ask these scaffolding questions first. |
| What are the challenges upper-level, female, undergraduate, engineering students encountered in their major? | -**What sorts of challenges have you encountered as an engineering major?**<br>-Consider these challenges that you've faced. What do you think causes those challenges?<br>-Do you think these challenges are particular to women in engineering?<br>-What are specific challenges that women face in engineering?<br>-Do you think any of these challenges have impacted your performance in the program? Do you think challenges that have been mentioned may have impacted the performance of others in the program?<br>-Can you explain an experience that really made you question your decision to be an engineering major? |

| | |
|---|---|
| How do upper-level, female, undergraduate, engineering students explain their reasons for persevering in spite of those challenges? | **-In the face of these challenges, what has made you want to continue to persevere in obtaining a degree in engineering?**<br>-What kinds of coping strategies or techniques help you persevere in your major?<br>-Do you have any support systems that help you? What are they? |

# APPENDIX I

## ONE-ON-ONE INTERVIEW AND FOLLOW-UP INTERVIEW PROTOCOL

| Research Questions | Interview Protocol Questions | Follow-Up Interview Protocol Questions |
|---|---|---|
| How do upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences? | **-When do you believe was your first encounter with the stereotype that women are not good at engineering?**<br>-Do you think these stereotypes, or experiencing these stereotypes shape your experiences in your classes? How?<br>-In this underrepresented setting, do you feel more pressure to prove yourself and disprove a stereotype?<br>-Would you consider the pressure to disconfirm a negative stereotype a part of your normal experience in your major?<br>-Think back to when you worked on your first group project in an engineering class. What did you see? What did you feel? Is that different from what you see or feel now? Why? | -Multiple participants talked about this idea of assimilation, or being more like the guys. Maybe for acceptance or to alleviate any harassment from the guys. Have you ever found yourself "assimilating?" (swearing more, talking loud, modifying your attire, etc.)<br>-How has your understanding of engineering, both as a major and as a career, changed since you started college?<br>-If you could change something about your education as an engineer, what would it be? Why?<br>-Female numbers in engineering remain relatively low. Why do you suppose that is? |
| How do upper-level, female, undergraduate, engineering students explain their reasons for choosing their major? | **-Have you ever experienced a situation where your gender made you question your choice to pursue engineering? Can you explain?**<br>-Do you think that females have different reasons than males for pursuing engineering?<br>-Do you think the experience as a student is different for males and females? If so, why? | |
| What are the challenges upper-level, female, undergraduate, engineering students encountered in their major? | **-Do you think that females face different challenges than males in your engineering major?** | -Do you feel any pressure to represent your gender well in your classes or in your engineering major?<br>-Do you feel any anxiety you believe results from something that has occurred in your engineering major? |
| How do upper-level, female, undergraduate, engineering students explain their reasons for persevering in spite of those challenges? | **-How would you explain your reason for persevering in obtaining a degree in engineering?**<br>-Some people would consider engineering to be a difficult major. What has helped you persevere?<br>-Do you think males have similar reasons for persevering in obtaining a degree in engineering? Why or why not? | -While talking about coping strategies, participants mentioned support groups, like supportive family members or friends, both inside and outside of engineering. Besides support groups, what other coping strategies do you use? Have you ever had to turn to coping strategies such as counseling services? What about alcohol or drugs, whether prescription or not?<br>- What to you is the most important thing we discussed? |

# APPENDIX J

# SUPPORT SERVICES FOR PARTICIPANTS

Dear Participant:

Should you feel the need to seek counseling services as a result of any of the discussions had during the focus group meeting or the one-on-one interviews, I encourage you to contact a service below:

Counseling and Student Development Center, [redacted] (Students Only)

- Purpose: This service provides students with short-term, individual or group counseling for a broad range of personal concerns. Career counseling services, educational counseling services, and assessments of drug and alcohol abuse are provided.
- Phone: [redacted]

Counseling Laboratory, [redacted]

- Purpose: Counselors offer a wide range of services including both personal and vocational counseling. Counselors utilize an approach that promotes growth and focuses on increasing emotional well-being and self-awareness.
- Phone: [redacted]

Psychological Services Center, [redacted]

- Purpose: Services, which include individual, family, and group psychotherapy, are tailored to meet the specific needs of each client.
- Phone: [redacted]

University Resources for Women

- Purpose: Short-term counseling services for individuals regarding academic progress, careers, personal development, and other special concerns are provided.
- Phone: [redacted]

For a more comprehensive list of services, including services provided outside [redacted] please visit the following website: [redacted]

You may also contact me if you have any questions or concerns.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX K

# MEMBER CHECK EMAIL

Greetings Participant:

Thank you so much for all your assistance with my study. Without you, this would not be possible.

To help ensure the validity of this study, I am emailing you the transcripts of your one-on-one interview. I would like to provide you with as much cognitive space as necessary to vet this transcript. By revisiting the collected facts, experiences, and feelings of study participants, these member checks will help me attain advanced levels of accuracy and consensus. Please take the time to judge the accuracy and credibility of the transcripts. Feel free to contact me with any concerns you may have regarding your transcript.

Again, thank you so much for all that you have done for me as I endeavor through my doctoral dissertation.

If you have any questions or concerns, please let me know.

Respectfully,

J.R. Entsminger
Doctoral Candidate & Researcher
Email: [redacted]
Phone: [redacted]

Dr. Elizabeth Wilkins
Dissertation Chair
Email:
Phone: [redacted]

# APPENDIX L

## SIGNIFICANT THEMES AND SUBTHEMES EXTRAPOLATED FROM DATA

| Theme and Statement # | Significant Statement | Connection to Theme | Source |
|---|---|---|---|
| **RQ1: How do upper-level, female, undergraduate, engineering students perceive the possibility of or experience with stereotype threat as shaping their experiences?** | | | |
| **Theme 1: Explicit and Implicit Experiences with Stereotype Threat** | | | |
| **Explicit Experiences with Stereotype Threat** | | | |
| 1 | That is why a lot of women change their majors. Like the Society of Women Engineers. We get a lot of incoming freshmen. We recruit really hard, but they fall off because… you know, the emotional abuse of people just constantly reminding them, 'Hey, you're a woman'... I think it's really hard for them, because then they take it as a sign of weakness. | She suggested that female students being constantly explicitly reminded of their gender in the context of engineering constituted emotional abuse. Simply being in the minority can cause stereotype threat effects. This could create a threatening intellectual environment for the female engineering students. | Nancy, Focus Group Meeting, June 25, 2016, p. 9 |
| 2 | Imposter syndrome is a real thing. You're looking around and you're like, 'What am I doing here? | She felt that constantly being reminded of her gender in engineering caused her to experience Impostor Syndrome, where she experienced confusion regarding her academic major. Again, this could create a threatening intellectual environment for the female engineering students. | Nancy, Focus Group Meeting, June 25, 2016, p. 10 |

| | | | |
|---|---|---|---|
| 3 | I guess that I'm just nervous that I don't know enough and I guess I get that imposter syndrome sometimes. Where I know that I know some things, but I don't feel like I belong. I don't know how I got here! | As a result of not knowing certain things in her major, she also experienced imposter syndrome which led her to feel that she did not belong. | Gaby, Focus Group Meeting, June 25, 2016, p. 10 |
| **Implicit Experiences with Stereotype Threat** | | | |
| 1 | I'll explain that I'm coming to school at [Pleasantdale College], so they'll ask you specifically, 'What are you doing?' And I'll say, 'Engineering.' And then they will want to know what kind of engineering or whatever. So that's when I'll specify I'm in bio-medical engineering, and they'll kind of go, 'Oh, you must be really smart…' They sound surprised. | The reactions of her peers caused her to realize that her peers questioned her choice. These surprised reactions from her peers suggest a belief that she was not capable of meeting the requirements of her engineering major. Though implicit, the message communicated in this situation could have led her to question her beliefs about ability and her decision to pursue and remain in her major. | Amanda, Focus Group Meeting, June 25, 2016, p. 11 |
| 2 | Nobody said anything, but you could definitely feel that… I feel like there's an unwritten stereotype in there that we're all supposed to be either… either the really smart, nerdy one, or you're the really pretty one that shouldn't be there. | As a result of the "unwritten stereotype," she experienced a dichotomous dilemma that forced her and other female engineering majors to embrace one of two identities: "the really smart, nerdy one" or "the really pretty one that shouldn't be here." While faced with this predicament, female students could have questioned their status as engineering majors. | Amanda, One-on-one Interview, July 5, 2016, p. 11 |

| | | | |
|---|---|---|---|
| 3 | I was the only girl in almost all of my classes… I didn't have any female teachers in the math and science program here… I wasn't exposed to any female engineers until my last semester… It was kind of like, 'Where are they?'... I just didn't really ever see them… I think it's something that gets thought in the back of our heads, 'Oh, they're not around.' | Being in the minority has the potential to activate a negative stereotype. Simply being in the minority was enough to create a threatening intellectual environment. In this threatening intellectual environment, students in the minority perform below their potential and feel pressure to prove to themselves that the negative stereotype is untrue. | Anna, One-on-one Interview, July 5, 2016, p. 12 |
| 4 | I don't know if I've ever had someone tell me, 'Oh, women aren't meant to be engineers.' It's more so just directing you somewhere else. So, if you're in math or something, they're like, 'Why don't you go into English?' It's not like telling you you can't do it. It's just directing you to something that is more widely accepted. | In her experience, one of the ways that classmates or teachers implicitly perpetuate the negative stereotype is when they redirected her attention and interests to other academic areas. | Melissa, One-on-one Interview, July 10, 2016, p. 12 |
| **Theme 2: Conformity** | | | |
| **Subthemes: Modifying Language & Volume and Dress Attire** | | | |
| 1 | I think that it's a part of the normal college experience if you're a female and in STEM or just engineering. | For female students, conforming is an expectation in engineering majors. | Lisa, One-on-one Interview, July 25, 2016, p. 3 |
| 2 | You get really uncomfortable with a whole bunch of guys around and they make inappropriate comments. It just gets uncomfortable sometimes and I feel like I have to be really forceful, stubborn, and loud just to get heard, and not to be pushed around. Kind of pushed around and told what to do. | As a result of inappropriate comments, and to alleviate future negative comments and treatment, she had to adjust her normal speaking behavior to be seen as one of the guys and to be heard. | Gaby, Focus Group Meeting, June 25, 2016, p. 4 |

| | | | |
|---|---|---|---|
| 3 | I find myself talking more like the other guys and just mimicking their behaviors. | Her attempts to conform caused her to talk like the other guys and mimic their behaviors. | Gaby, Follow-up Interview, August 24, 2016, p. 4 |
| 4 | The volume and the tonal quality becomes a bit more gruff. I tend to lower my voice a little bit instead of having a more natural, higher pitched voice just to sound similar to fit in. | She attempts to adjust the tonal quality of her voice, which diverges from her normal, natural, higher pitched voice, to sound like her male peers and fit in. | Gaby, Follow-up Interview, August 24, 2016, p. 4 |
| 5 | When I was a freshman here, I didn't swear. I was right out of Catholic school… I was like, 'Oh my God, I'm just gonna be sweet as pie and all these guys are gonna make friends quickly.' I now swear like a sailor because that's the only way that guys will respect me. I have to be loud. I have to swear. And as much as possible. I swear more than the guys to the point that they are shocked at what words I know. | She purposefully changed her language, including the content of her language usage, to gain respect from her male peers. She felt that she needed to swear and swear more than her male peers. | Melissa, Focus Group Meeting, June 25, 2016, p. 4 |
| 6 | I did end up talking a lot louder just to be heard… Otherwise, they forget that I'm there… | She talked louder because she felt that her male peers would forget she was there if she did not. | Melissa, Follow-up Interview, August 17, 2016, p. 4 |
| 7 | You've got to struggle to get your voice heard. You have to be louder and you kind of have to put yourself out there more to make your voice heard with them. | She felt the need to be louder and more abrasive to make her voice heard among her male peers. | Lisa, Focus Group Meeting, June 25, 2016, p. 4 |
| 8 | If I do feel confident in that particular subject, then I have to put on this persona where I'm loud and commanding for them to hear me out. | She felt that she had to adjust her persona to be loud and commanding so that her male peers would hear her. | Lisa, One-on-one Interview, July 25, 2016, p. 4 |
| 9 | I do assimilate. I do talk louder. I guess I am little more aggressive in how I approach group work. | She admitted to conforming by talking louder and being more aggressive than she usually would be. | Lisa, Follow-up Interview, August 9, 2016, p. 4 |

| | | | |
|---|---|---|---|
| 10 | I have to get angry and raise my voice… I don't like to do that, but it's almost like you have to prove yourself. | Even though she did not like to adjust her language in this way, she felt it necessary to get angry and raise her voice to prove herself. | Anna, Focus Group Meeting, June 25, 2016, p. 4 |
| 11 | I really wanted to make sure that I was one of the guys. I definitely tried to just be like one of them. | She felt the need to conform so that she would be seen as one of the guys. | Amanda, One-on-one Interview, July 5, 2016, p. 5 |
| 12 | I like to go with full eye shadow because I don't understand why I cannot be feminine and be an engineer… I'm not going to dress down for them… I can be smart, whatever, wearing whatever makeup I want to wear. | Although she did conform in terms of language usage, she defiantly opposed conforming by modifying her dress attire. | Lisa, Focus Group Meeting, June 25, 2016, p. 6 |
| 13 | When it comes to how I look, I kind of try to, what's the word, exaggerate a little bit more… just not hide myself… I apply glittery makeup, gold lips… I like to make engineering a little more fabulous… There's no need for me to dress down… I don't think it affects my grades or anything. | Again, although she did conform in terms of language usage, she defiantly opposed conforming by modifying her dress attire. In fact, she chose to do the opposite. She tried to make engineering a little more fabulous. | Lisa, Follow-up Interview, August 9, 2016, p. 6 |
| 14 | If I wear heels or anything like that, it's just a free for all… You're asking for it at that point is what it comes down to. So, I go to work and I have to be very professional and then I usually stop and I change before class. Because, if I go to class wearing my professional clothes, you get stares, people comment… So, I find myself dressing down, trying to appear as like one of them [male peers]. (Focus Group Meeting, June 25, 2016) | She felt that wearing professional women's attire would attract negative attention. She actually stopped home before attending class to change into attire more fitting for her engineering major. To conform, she dressed down. | Nancy, Focus Group Meeting, June 25, 2016, p. 6 |

| | | | |
|---|---|---|---|
| 15 | I take off my makeup. I put on sweats… You draw less attention if you are dressed like a bum. | Again, to draw less attention to herself, she conformed by modifying her dress attire to the perceived standards and conventions of her engineering major. | Nancy, Follow-up Interview, August 12, 2016, p. 6 |
| 16 | I totally do that… I mean, I changed like the clothes I wear so that I mean, like somebody wouldn't be looking down my shirt. I wore makeup more but not like red lipstick, more just like a natural foundation just so… but they wouldn't make comments. | to alleviate any possible sexual harassment from her male peers, she purposefully adjusted her dress attire. She also purposefully modified her makeup so that her male peers would not make comments. | Melissa, Follow-up Interview, August 17, 2016, p. 6 |
| 17 | I don't want to go back being a blonde because I feel like I'm getting enough grief as it is as a woman. I feel like honestly, a woman with blonde hair, they just take you like a stereotypical Barbie. I feel like the brunette gives me a little more power. They [male peers] seem to take me more serious. | She refused to change her hair color because of fear that she would receive more negative treatment from her male peers. Also, she felt that her brunette hair color gave her more power and caused her male peers to take her seriously. | Amanda, One-on-one Interview, July 5, 2016, p. 7 |
| 18 | I definitely have… It'll be like different situations where I don't necessarily get all fancy and I'll purposely not wear a dress. I'll just be in jeans and a t-shirt just to look more functional. I can get in there and help the guys more rather than just a preppy, little secretary, supervisor, whatever… | She purposefully adjusted her normal dress attire to diverge from traditionally female roles. | Amanda, Follow-up Interview, August 11, 2016, p. 7 |
| 19 | I probably wear a little bit more, just a little bit more conservative just to alleviate some of the comments that could be said. | She adjusted both her clothing and makeup to alleviate comments from her male peers. | Gaby, Follow-up Interview, August 24, 2016, p. 7 |

| Theme 3: Increased Motivation | | | |
|---|---|---|---|
| 1 | I think it pushes me to perform harder… It definitely pushes me to try harder all the time. | As a result of perceiving a negative stereotype concerning females and engineering, she felt increased motivation to try and perform harder. | Gaby, Focus Group Meeting, June 25, 2016, p. 14 |
| 2 | The stereotype is that women are not good at engineering. So, like I said, I was showboating. I am good at engineering. I know what I'm talking about. It's more of a, I guess, staking a claim. This is where I belong. | Because she knew about the stereotype and believed that others held it as true, she showboated during presentations to prove that she was good at engineering and this was where she belonged. | Nancy, One-on-one Interview, July 7, 2016, p. 14 |
| 3 | I think it just aggravates you to the point where you wanna try harder. In most of the cases when girls experience it, I think it's either you're gonna be motivated to try harder or you're gonna be I don't wanna deal with it and you leave. And it's not that you don't want to be in engineering. It's just that you don't wanna deal with it. | She described that experiencing stereotype threat would either motivate females to try harder or leave. | Melissa, One-on-one Interview, July 10, 2016, p. 15 |
| 4 | So, I think guys have a little bit more of an easy time finding friends and being comfortable talking with people with the same interests and same backgrounds… I remember being, being kind of intimidated by all of them, because they would work in groups outside of class, and I really was too scared to ask them to join in. | The dominating male presence caused her to feel intimidated in her engineering major. | Anna, One-on-one Interview, July 5, 2016, p. 24 |

| | | | |
|---|---|---|---|
| 5 | My friends are like big brothers to me at this point, where they have made all of their jokes and now we've gotten past it sort of thing. Now we can be friends. But like, they have to get it of their system, I feel like, to some degree, before… To be part of that group, you have to get picked on significantly before you can be friends with them. | for this female to be accepted into the male dominated environment, she needed to go through an initiation. | Melissa, Focus Group Meeting, June 25, 2016, p. 24 |
| **RQ2A: How do upper-level, female, undergraduate, engineering students explain their reasons for choosing their major?** | | | |
| **Theme 1: Familial Connections and Support** | | | |
| 1 | My dad works in the civil engineer field, so I don't know if he pushed me so much, but [engineering]was always in the mindset when we played with Legos and we watched the History Channel and *How It's Made* all the time. | She credits the connection and the time she spent with her dad as influencing her decision to major in engineering. | Anna, Focus Group Meeting, June 25, 2016, p. 18 |
| 2 | I just kinda got into whatever I wanted and my parents were like, 'Good. We'll support you if you want to do it [engineering]... They're very supportive. My family was a really big backup. | Again, her family was always there to support her, no matter what she chose to do. | Anna, Focus Group Meeting, June 25, 2016, p. 18 |

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| 3 | I have all brothers, so since I was little I was pushed into Legos, helping my dad with the cars and stuff around the house… My senior year, they [brothers/family] pushed me to do this Boy Scouts program with my brother. We went to an engineering company in my home town, and we got to learn about the different engineers that were working around there. I liked it. | Building strong connections and relationships with the males in her family led to her engaging in non-traditionally female activities, which subsequently influenced her decision to major in engineering. | Lisa, Focus Group Meeting, June 25, 2016, p. 18 |
| 4 | My brother is an electrical engineer. My uncle is an electrical engineer. My grandfather was an electrical engineer. My dad is a computer programmer. So, I figured I would give it a try, and I've loved it so far. | She had many familial connections that influenced her decision to major in engineering. | Gaby, Focus Group Meeting, June 25, 2016, p. 19 |
| 5 | My family just fostered that sense that I could really - no matter what - anything that I really wanted to. If I wanted to open up a computer and play with that, I could do that. If I wanted to build a structure outside, I could go and do that. They were just there and 100% behind me, no matter what I wanted to do. | Her family supported her no matter what she decided to do. | Gaby, Focus Group Meeting, June 25, 2016, p. 19 |
| 6 | My dad is a farmer. He [dad] does a lot of things himself and when things broke down, he fixed a lot of things himself… I was always out with him, tinkering with stuff and messing with stuff, and oiling… So, I think a lot of it was honestly more me being around my dad… I think being exposed on the farm the way I was honestly - as weird as that sounds - being exposed on the farm was really, and messing with stuff, what kind of kicked me. | Working with her father on the farm influenced her decision to major in engineering. | Amanda, Focus Group Meeting, June 25, 2016, p. 19 |

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| **Theme 2: Coursework Affinity** | | | |
| 1 | I loved biology in high school, and I really loved my drafting classes… I kind of always knew I was going into the sciences | She expressed affinity for her science classes as an influence in choosing to major in engineering. | Nancy, Focus Group Meeting, June 25, 2016, |
| 2 | I had always had really great teachers since third grade, who taught math and science… So that always made me closer to them. I would go to their office hours, and we would go chat, and they would show me things, like after school. | In addition to showing signs of coursework affinity, she also talked about having good teachers. | Melissa, Focus Group Meeting, June 25, 2016, p. 20 |
| 3 | As I was going to school, in high school and stuff, I was always a little bit better, not good, but better, at math and science. | In high school, she had an affinity towards math and science. | Lisa, Focus Group Meeting, June 25, 2016, p. 21 |
| 4 | From junior high school, I switched schools… I was really able to see, 'Oh yeah… math and science are my thing. I really like this kind of stuff. | She noticed an affinity for math and science as early as junior high. | Amanda, Focus Group Meeting, June 25, 2016, p. 21 |
| **RQ2B: How do upper-level, female, undergraduate, engineering students explain the challenges they have encountered in their major?** | | | |
| **Theme 1: Male Dominance** | | | |
| **Subtheme: Resulting Anxiety** | | | |

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| 1 | They wouldn't value my opinion. I would try to contribute to group projects, and they would just kind of talk over me and shut me down. If I would say one thing, they'd be like, 'No, no, no.' And then a male would say the exact same thing and they're like, 'Oh yeah, that's great!' So I was made to feel that I wasn't good enough, I wasn't smart enough to be in engineering because I was female... I feel like it is so hard to get myself to be heard. I've had people say, 'Oh, she doesn't know what she's talking about.' 'Oh, she's a female. She's gonna get emotional.' I'm called the mother of my group sometimes… I just feel like I'm being insulted, and they don't think I actually know anything, just because I'm a female. | She experienced overbearing male dominance to the point where it made her feel devalued and oppressed. | Gaby, One-on-one Interview, July 17, 2016, p. 23 |
| 2 | You kind of feel like, with their body language, they're just telling you, 'Let the boys talk.' You're just like on the sidelines of the group, and you've got to struggle to get your voice heard. You have to be louder, and you kind of have to put yourself out there more to make your voice heard with the team. | For her, male domination presented itself in the form of their body language and sent the message that the boys should do the talking. | Lisa, Focus Group Meeting, June 25, 2016, p. 23 |
| 3 | It's always like, out to discredit you sort of thing, anything to take you down a notch and make you seem like less of a person or less of a student compared to them. | She felt male dominance when her male peers attempted to discredit her and make her feel like less of a person or less of a student compared to them. | Nancy, Focus Group Meeting, June 25, 2016, p. 23 |

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| **4** | So, I think guys have a little bit more of an easy time finding friends and being comfortable talking with people with the same interests and same backgrounds… I remember being, being kind of intimidated by all of them, because they would work in groups outside of class, and I really was too scared to ask them to join in. | The dominating male presence caused her to feel intimidated in her engineering major. | Anna, One-on-one Interview, July 5, 2016, p. 24 |
| 5 | My friends are like big brothers to me at this point, where they have made all of their jokes and now we've gotten past it sort of thing. Now we can be friends. But like, they have to get it of their system, I feel like, to some degree, before… To be part of that group, you have to get picked on significantly before you can be friends with them. | for this female to be accepted into the male dominated environment, she needed to go through an initiation. | Melissa, Focus Group Meeting, June 25, 2016, p. 24 |
| **Theme 2: Harassment** | | | |
| 1 | I was called terrible, terrible names for being the only girl in a group, and just harassed… Actually, I took an Intro to Engineering class when I started my first degree… the way that I was treated in that class was the reason why I didn't pursue engineering with my first degree. I switched to education because I couldn't handle the way that guys would talk to me, the way the teacher would talk down to me… I just couldn't do it. | Being called terrible names by her classmates and being talked down to by a teacher caused her to switch her area of study. | Gaby, Focus Group Meeting, June 25, 2016, p. 25 |

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| 2 | They openly made comments in front of me, including ones like, 'Oh, she's only running, she's just tits and ass.' It was extremely sexist and degrading to me, to be told that in earshot of like 20 people that I don't actually have anything valuable to add to the club. | Her male peers made sexist and degrading remarks about her when she ran for a position on the Election Board of the Robotics Club. | Gaby, Focus Group Meeting, June 25, 2016, p. 26 |
| 3 | They get intimidated by smart females. And if a female is doing better, then obviously she is sleeping with somebody, or she's cheating. | Her male peers felt intimidated by smart females, which resulted in harassment. | Gaby, Focus Group Meeting, June 25, 2016, p. 26 |
| 4 | During my internship last year, I hadn't actually taken any engineering classes yet, and my manager called me 'stupid.' And it just made me wonder, 'What am I doing here? I can't do anything he wants me to do. Why am I going into engineering? I can't do this.' And just having… That made my… it made me really question myself last summer. It made me think about not going back the next semester. | Her manager at her engineering internship called her stupid, which caused her to question her abilities and actually think about not returning the next semester. | Gaby, Focus Group Meeting, June 25, 2016, p. 26 |
| 5 | It makes me uncomfortable being the only female because there is sexual harassment that I have dealt with. I don't want people saying that the only reason I got a good grade is because I could be potentially sleeping with a professor. | She has dealt with sexual harassment in the past, and did not want her male peers to think that she only gets good grades because she was sleeping with a professor. | Gaby, One-on-one Interview, July 17, 2016, p. 26 |

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| 6 | So, I would be working on the car and I would bend over, and they would be like, 'Hey, can you stay there for a second?' And I'm like, 'Sure, I'm just holding a part.' And then they would all go on the other side of the car and look down my shirt. So I mean, I stopped wearing… You have to be careful of your neckline. | She dealt with sexual harassment while working on a project with her male peers. | Melissa, Focus Group Meeting, June 25, 2016, p. 26 |
| 7 | They're like, 'Are you on your period?' | Her male peers would make sexist remarks when she got emotional. | Melissa, Focus Group Meeting, June 25, 2016, p. 27 |
| 8 | Because of what those guys said and how intimidating they are. That's really stressful, so my grades slipped because of how stressful it was, just being harassed by guys for three semesters. | The comments and remarks from her male peers caused her to feel stress and intimidation. As a result, her grades slipped. | Melissa, Focus Group Meeting, June 25, 2016, p. 27 |
| 9 | I've been to the counseling services, and they say I should go take tests in private and all these things. And I refuse to do it because I feel like the guys are gonna notice, and they'll make comments or things like that. | She has been to counseling services for her stress and anxiety resulting from harassment from her male peers. The counseling services recommended that she take tests in private. | Melissa, Focus Group Meeting, June 25, 2016, p. 27 |
| 10 | They still make sexist comments… I don't know, and then just comments about, 'Oh, are you PMS-ing?' All those little comments make it harder and harder... Girls are getting all of these comments, and guys don't have to get those comments. I mean, guys oversexualize you to the point where it's uncomfortable, and they make comments that aren't okay to make. And it just makes the atmosphere more uncomfortable than it should be… | For her, sexist comments from her male peers made the environment very uncomfortable. | Melissa, One-on-one Interview, July 10, 2016, p. 27 |

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| 11 | Just from me to you, don't go on the trip because bad things happen on those trips. And it's very likely you could end up being raped on that trip…' It makes you look at your friends in a different light. You feel like you know them. And then it's like if someone else is making these comments, did they have an experience with these people or are they just paranoid? It makes you a little bit paranoid about your friend group. | A fellow female classmate warned her that she could be raped by her male peers while participating in a club. | Melissa, One-on-one Interview, July 10, 2016, p. 27 |
| 12 | But, the president just looked at me, and kind of almost yelled, 'So, are you actually going to do that?' I don't know why it happened, and I just didn't say anything for the rest of that meeting… None of the guys would make eye contact with me for a good week or two. It was really like, it was stressful. I wanted to quit the team… I don't need this stress. I don't need to be treated this way. | A male peer yelled at her in front of the rest of her team, which caused her stress. She wanted to quit the team. | Anna, Follow-up Interview, August 11, 2016, p. 28 |
| 13 | There's a lot of rumors going around… They go around about me too… We're only in our positions because we're attractive young women. | Rumors circulated that she was only in her position because she was an attractive young women. | Nancy, One-on-one Interview, July 7, 2016, p. 28 |
| **Subtheme: Resulting Anxiety** | | | |
| 1 | I smoke a lot of weed for my anxiety… The electrical engineering students, we have like, 'You're not a real engineer until you smoke something. | She self medicated with marijuana to alleviate her anxiety that resulted from harassment in her engineering major. | Nancy, Focus Group Meeting, June 25, 2016, p. 29 |
| 2 | I was drinking every weekend. | Similarly, she was self-medicating by drinking alcohol every weekend. | Lisa, Focus Group Meeting, June 25, 2016, p. 29 |

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| 3 | Things that other students have said have made me feel uncomfortable. I feel the need to perform extremely well, and that just adds to anxiety… I've gone to therapy before… to cope with anxiety that was produced… by engineering. | As a result of the anxiety that stemmed from the harassment she experienced, she felt the need to perform extremely well. She sought treatment in therapy. | Gaby, Follow-up Interview, August 24, 2016, p. 30 |
| 4 | I started getting really bad anxiety my freshman year. Because I didn't understand a lot of the terminology of engineering. I was too scared to ask my teachers too, most of the time, either for fear of what my classmates would say. I mean, you know, kind of social anxiety. And so, I just had a lot of anxiety throughout my whole career of being a student… The anxiety is the biggest thing that pulls me back from engineering. | She was scared of the potential harassment she would face if others found out that she was not knowledgeable about certain things. She started getting bad anxiety her freshman year. | Anna, Focus Group Meeting, June 25, 2016, p. 30 |
| **Theme 3: Representing My Gender Well** | | | |
| 1 | So, I guess I don't compare myself to the stereotype, but I'm aware of it. And I wanna represent girls well… I wanna do well so other girls see they can do well. | She wanted to represent girls well so they could see that they could do well, too. | Melissa, One-on-one interview, July 10, 2016, p. 31 |
| 2 | Well, there's only a handful of girls, so anything we do is obviously going to be reflected off of the rest of them. | She felt that no matter what, anything her and her female classmates did would reflect on females in general. | Nancy, Follow-up Interview, August 12, 2016, p. 32 |

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| 3 | Always. I'm always one of the few female students, so I feel like I have to… show up and not even just physically, but mentally I have to show up and be ready and be on my game, and just show men we make up 50% of the population. And there's such a few that even if a female doesn't think that they're gonna represent the female gender, they do no matter what. | She always felt that she needed to show up and represent her gender well. She also stated that for those females who believed that they did not represent their gender, they most certainly did no matter what. | Gaby, Follow-up Interview, August 24, 2016, p. 32 |
| 4 | I always feel like even if maybe I don't feel confident in this particular subject, sometimes I feel like maybe I shouldn't open my mouth because I don't want to take a step backwards for all girls… I just keep my mouth shut because I don't want to embarrass girls. | If she was not confident in something, she would keep her mouth shut in fear of taking a step backwards for all females. | Lisa, One-on-one Interview, July 25, 2016, p. 32 |
| 5 | I had another class… And this group was horrible. I had another girl in it. And I was really excited because it's like, 'Oh, yeah! We're going to be friends. It's going to be great. Another professional, smart, working woman.' Unfortunately, she's not smart and it really upsets me because I feel she actually perpetuates that girls are bad at engineering… I was trying to combat the rest of my group's opinion of this girl by proving that I deserved to be here even if she didn't... It was horrible. | She wanted so badly to represent her gender well that she got angry with female classmates that perpetuated the negative stereotype. | Nancy, One-on-one Interview, July 7, 2016, p. 32 |

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| 6 | I know I've been guilty of judging other girls. One time, I was in a computer lab, and there was this girl that was a couple of seats down from me. And I know her from my classes. And she was just crying and crying because she didn't get the grade that she wanted. I feel bad about it now. But in the moment, I was just judging her hardcore for setting us back, you know, making us look weak… | Similarly, she wanted to represent her gender well and got mad when other female classmates perpetuated the negative stereotype. | Lisa, Follow-up Interview, August 9, 2016, p. 33 |
| 7 | I feel like it's definitely more pressure that we all succeed, and that the few of us that actually made it in, continue to go through even though it may or may not be exactly what we want. | For her, it was so important to represent her gender well that she believed that other female students should stick with engineering even if it was not a good fit for them. | Amanda, One-on-one Interview, July 5, 2016, p. 33 |
| 8 | I definitely feel the pressure to represent. But, I feel more like I wanna represent myself… I mean, obviously, I am a woman. I represent all women, but I'm more concerned with representing myself. I wanna do well in school. I want a higher GPA. I wanna be able to get my job. I wanna be able to represent myself really well, and say, 'Hey, this is all the stuff I have done,' and I guess I focus more on… me and like what I wanna do in my personal goals rather than, like, women as a whole. | She felt pressure to represent her gender well, but also to represent herself according to her own standards. | Amanda, Follow-up Interview, August 11, 2016, p. 34 |

| **Theme 4: Teacher/Professor Comments and Behaviors** | | | |
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| 1 | I met the our previous dean… I met him at a community college, 2014, so two years ago now, and that was the first time I had met him. It was just one-on-one because he happened to be there that day. And I said, "Hi, I'm looking into doing mechanical engineering, and I want to go to [Pleasantdale College]." He was like, "Oh, don't you want to go into Electrical/Industrial? More women are in that." I said, "No! I'm going into mechanical." | Her first interaction with the dean of the engineering department had the potential to change her academic and career path. | Anna, Focus Group Meeting, June 25, 2016, p. 35 |
| 2 | When I changed from bio-medical to biology, the big catalyst was I had failed Calc 1, and the professor, Katherine Highland [name changed for confidentiality purposes], a woman, told me that some people just weren't cut out for this… Which is why I ended up switching to biology, which is the soft math STEM major. I didn't feel like I was good enough. I felt like I was an imposter, because I couldn't even get simple calculus. | Comments regarding academic ability from a female professor caused her to change her major. | Nancy, Focus Group Meeting, June 25, 2016, p. 35 |
| 3 | I was kind of offended and then I did doubt myself heavily because of that… If that professor didn't think you can do it, that's very negative... So when she said that, I was just crushed…. | She felt crushed as a result of the negative comments about her ability that came from a female professor. | Nancy, One-on-one Interview, July 7, 2016, p. 35 |

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| 4 | I was getting my first degree back in 2006, and I went into engineering and was made to feel uncomfortable by a professor with all the other males in my courses, and I switched to education… It basically changed my entire career path… It took 8 years later for me to be able to have the confidence to be able to say, 'This is what I really want to do, and I'm not going to let anybody discourage me from that.' | Comments from a professor made her feel uncomfortable which caused her to switch majors, thus changing her career path. | Gaby, Focus Group Meeting & One-on-one Interview, June 25, 2016 & July 17, 2016, p. 36 |
| 5 | This one teacher… I think I was the only girl in the class… And I asked him a question. It was kind of similar to other questions that everyone else had been asking before me… He's like, 'We don't ask these kinds of questions.' But he would answer everyone else's. So, I didn't really understand why I wasn't being helped with it, especially because it was something I was struggling with. | She asked a question similar to the questions other students were asking but received a surprising and negative remark from her professor. | Anna, One-on-one Interview, July 5, 2016, p. 36 |
| 6 | I think teachers, as much as they're like, we're equality and everything, I think they'll definitely be different towards the guys, and they'll be more willing to help one-on-one sort of thing… Me and my friend went in to go talk to a teacher, and we asked for a question on homework help. And he was on me about my age, and he goes, 'Well, shouldn't you have learned this in high school? You should know this already…' So, he was picking on me, and he left the guy alone [who was of the same age]. | Even while approaching a professor with a male peer of the same age, she felt that this professor singled her out and made a comment directed at her that she should have learned certain content in high school. | Melissa, One-on-one Interview, July 10, 2016, p. 36 |

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| 7 | I think the teachers we have right now, they're really trying, I mean, I guess they're trying, but I think they don't have that natural way of getting along with students, and then some of them are clearly more like, guy-driven. It's definitely a thing where they relate a lot more to guys. | She acknowledged that her professors were trying, but that they related to their male students more than their female students. | Melissa, Follow-up Interview, August 17, 2016, p. 37 |
| **RQ2C: How do upper-level, female, undergraduate, engineering students explain their reasons for persevering in spite of those challenges?** | | | |
| **Theme 1: Burden of Proof** | | | |
| **Subtheme: Female Reasons for Persevering vs. Male Reasons for Persevering** | | | |
| 1 | I feel like… because I was surrounded by guys, I had to step up and try and be better than them… equal or better than my peers… I think I try a little harder to overcome whatever they say [negative comments]. | As a result of being a part of the minority in her engineering major, she felt the the need to prove herself and prove that she belonged to be in her major. | Anna, One-on-one Interview, July 5, 2016, p. 39 |

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| 2 | I'll go out of my way to use an application like Prezi because it has so much more flash and obviously, I make sure that my work is top quality. So, I go out of my way to do things when I present… to go into further details just to show off… I deserve to be here… I'm just trying to be better than everyone else is what it comes down to… So, if I go up and present, I give them a very smooth speech and have a flashy presentation. It just makes me look so much better… I was showboating. I am good at engineering. I know what I'm talking about… This is where I belong. | By showing off, she wanted to prove that she knew what she was talking about and that she belonged in her major. | Nancy, One-on-one Interview, July 7, 2016, p. 39 |
| 3 | I want to prove that I'm more than just a female… to show everybody that I can do it, and I can do it just by being smart and working hard. | She wanted to prove that she was more than just a female and that she could succeed by being smart and working hard. | Gaby, Focus Group Meeting, June 25, 2016, p. 40 |
| 4 | It definitely pushes me to try harder and to prove everybody wrong… it pushes me to prove everybody wrong | Being a female in engineering pushed her to try harder to prove everybody wrong. | Gaby, Focus Group Meeting, June 25, 2016, p. 40 |
| 5 | It's made me want to try harder just to prove not only just to myself but prove to others that I'm more than just capable. That makes me wanna be better than people, makes me wanna be better than their opinions. I wanna outperform people because of adversity that I may face from other students and their opinions… it just makes me wanna be even more competitive with grades. | She wanted to be better than other people and their opinions. | Gaby, One-on-one Interview, July 17, 2016, p. 40 |
| 6 | I always have to prove that I'm not dumb and that I'm actually capable | She was very concerned with proving herself while considering her gender. | Gaby, One-on-one Interview, July 17, 2016, p. 40 |

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| 7 | So I just never asked for help and sometimes that kinda hinders me… I'm stuck between a weird place wanting help but not wanting to seem weak. | To avoid appearing weak, she would never ask for help. | Lisa, One-on-one Interview, July 25, 2016, p. 41 |
| 8 | I think guys will never question that they're doing the right thing or they'll never feel insecure with their answers in class… They don't have anything to prove, I guess, versus when women, you know, we have to kind of prove that we're not lesser than the guys. | She felt that her male peers had nothing to prove and never had to feel the pressure to prove anything to anyone. | Lisa, One-on-one Interview, July 25, 2016, p. 41 |
| **Theme 2: Support Groups** | | | |
| 1 | I think it's really important to have friends outside of engineering, as well as in engineering because you have the people in engineering to study with. But then you have the people outside of engineering to vent to and be like, 'I'm frustrated with this. This is what happened today…' I think it's just healthy to have a balance inside and out because it's really hard to just have one friend group… Engineering is a smothering program. You're buried under homework until you graduate. | She felt it necessary to have support groups both inside and outside of engineering. She emphasized having a healthy balance. | Melissa, One-on-one Interview, July 10, 2016, p. 42 |
| 2 | Support system is really key… sometimes family. I have friends outside engineering… there's things outside of engineering that are really important. | In addition to friends, her family also served as a support system. | Gaby, One-on-one Interview, July 17, 2016, p. 42 |

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| 3 | It's definitely like the groups outside of engineering. Work is kind of an escape sometimes. I have some really awesome coworkers… It's just kind of nice to have other people to talk to about this kind of stuff… not doing all engineering all the time definitely helps. Going to work honestly is kinda therapeutic to me. | Again, friends outside of engineering were an important support system for her. She mentioned that work felt like an escape. | Amanda, Focus Group Meeting, June 25, 2016, p. 42 |
| 4 | I played tennis in community college, so I've always had sports as an outlet for me. So I played in the tennis team here, the club team. So that was something I had to look forward to two or three times a week. | She stated that her tennis team provided her with an outlet and support. | Anna, Focus Group Meeting, June 25, 2016, p. 43 |
| **Theme 3: The Desire to Help** | | | |
| 1 | I think most girls are like, "I wanna help somebody." | She felt that most girls decide to major in engineering because of their desire to help. | Melissa, One-on-one Interview, July 10, 2016, p. 43 |
| 2 | It's kind of like a fulfillment of what I should be doing, what I think I should be doing with my life. Hopefully, it's something I love doing, and it'll help someone else out in the future. Either with what I do or what I physically do at work, and what products maybe we make. Or if someone says, 'Look, she's an engineer. I could do that, too.' | She felt this desire to help so strongly that she stated that majoring in engineering was the fulfillment of what she should be doing with her life. | Anna, One-on-one Interview, July 5, 2016, p. 43 |
| 3 | In my future, after I get a degree, I want to make sure I work with women in engineering, young women, specifically. Make sure that they know it's not strictly a man's field. | After she got her degree, she wanted to work with young women in engineering to show them that it is not just a man's field. | Anna, One-on-one Interview, July 5, 2016, p. 43 |

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| 4 | I'm really interested in helping future females be able to feel comfortable because females are severely underrepresented and stepped down on in general, especially in engineering… I think females have that, they really just wanna help people. | Similarly, she wanted to help young women in engineering. She also felt that females really just want to help people. | Gaby, One-on-one Interview, July 17, 2016, p. 44 |
| 5 | I have a younger sister who actually had gone through a lot of health stuff… And they don't really have a lot of devices or anything for her. And it was really frustrating for me to watch her go day to day and I knew what she needed, but what society had designed wasn't what she needed for her condition. | She stated that her desire to help her sister helped her persevere in engineering. | Amanda, Focus Group Meeting, June 25, 2016, p. 44 |
| 6 | I was just mainly in it for, you know, the money and the scholarships and, you know, the monetary rewards for it. But me, I don't know, I searched out, you know. I tried a little bit of each branch of engineering. And I found the one that I like. So, I realized that, you know, I can help people with mine, and I don't have to sit in the cubicle. | Though she started with a different mindset, she eventually realized that she could help people with her engineering degree. | Lisa, Follow-up Interview, August 9, 2016, p. 45 |
| **Subtheme: Female Reasons for Persevering vs Male Reasons for Persevering** | | | |

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| 1 | They're doing it for the money because they know that money attracts women. They looked at their potential and decided that, 'You know what? Engineering makes the most money of the sciences.' I think they're more motivated by what the degree means. The degree means a stable job with a sizeable income. A sizeable income means options, buys toys, women… prestige, expectation. Most women in engineering are doing it because they want to do it. | She felt strongly that her male peers were in engineering for the monetary gain. | Nancy, One-on-one Interview, July 7, 2016, p. 46 |
| 2 | I think most girls are like, 'I wanna help somebody. This is what I wanna do.' It's really far between from the guys who are just like, 'I just wanna do this to make money…' The girls are more in it, like, 'I wanna help somebody…' Guys are just like, 'I'm here to make money and get a job…' I think that the monetary gain is what drives it most of the time… 'This is what I like to do, and this is what I can get paid the most doing it.' Girls are more, 'I wanna help somebody. This is how I can help somebody' or that sort of mentality. That's where we're motivated differently. | She described that most girls were in engineering to help people why the guys want to make money. | Melissa, One-on-one Interview, July 10, 2016, p. 46 |
| 3 | A lot of times, they hear, 'Oh, it's a good job market. There's some good opportunity, and there's money in it. I feel like a good chunk of guys I talk to… they know it's a secure job. They know it's stable. | She felt that her male peers chose engineering because of the job market. | Anna, One-on-one Interview, July 5, 2016, p. 47 |

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| 4 | Everybody that goes into engineering wants to be able to create something. They may want to do it for different reasons. Someone may want to do it to make the world a better place, someone may want to do it because they grew up loving to play with Legos. But, I think the base desire to be an engineer is because you wanna create something… The monetary thing does help… I guess some people go and do it specifically for that reason… | She felt that everyone who decided to major in engineering did so because they want to create something. | Gaby, One-on-one Interview, July 17, 2016, p. 47 |