January 2018

Women Engineering Majors' Choice To Stay: A Phenomenological Exploration Of Persistence Experiences

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WOMEN ENGINEERING MAJORS' CHOICE TO STAY:
A PHENOMENOLOGICAL EXPLORATION OF PERSISTENCE EXPERIENCES

by

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A Dissertation

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

Grand Forks, North Dakota

August
2018

This dissertation, submitted by Victoria Morrissette in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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PERMISSION

Title	Women Engineering Majors' Choice to Stay: A Phenomenological Exploration of Persistence Experiences
Department	Educational Leadership
Degree	Doctor of Philosophy

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Victoria Morrissette
June 19, 2018

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ACKNOWLEDGMENTS

I am very grateful to my dissertation committee: to Marcus Weaver-Hightower and Zarrina Azizova for replacing lost committee members, thoughtful feedback, and much needed guidance through the writing process and to Rachel Navarro for sharing her expertise on SCCT. Thank you to my first chair, Margaret Healy, to Josh Cohen for signing on as chair when Margi retired after data collection and analysis, and to Deborah Worley and Cheryl Hunter for serving on my committee before leaving on sabbatical.

My sincerest appreciation to Chris Nelson, Associate Dean of the School of Graduate Studies for making my final defense happen in a timely manner. A special thank you to my support team: Sharon Fields, Administrative Assistant for logistical assistance, formatters Shari Nelson and Sandy Krom, and especially editor and formatter, Susan Lund for helping me make this dissertation the best it could be.

To my family, friends, and Higher Education cohort, many thanks for your on-going support and encouragement - and to my UND colleagues for reminding me that, "a good dissertation is a done dissertation!" Thank you to Dianne Paulsen, Julia Wallin, Shari Nelson, and Gerri Anderson for the TLC and keeping me on track. And finally to my highly accomplished sistahs and role models, Rana Limbo, Paulette Stall, Lynn Carey, Jane Karges, Sara Wheeler, thank you for nourishing my soul with abounding love and moral support, for always being there to listen, and for the endless movie quotes.

Dedication

To my husband Rick Dierker for loving support and enduring patience.

To my children Andrew & Beth Dierker and Diana & Nicholas Palm

for all your love and encouragement.

And finally, to my grandchildren Lukas & Eliza and Jackson & Greta

for repeatedly reminding me, “You can do it!”

ABSTRACT

The historical underrepresentation of women in engineering persists for women engineering majors in college and once they enter the workforce. While some engineering disciplines have seen an increase in women students, overall the numbers still have fallen well behind other STEM disciplines despite years of research. Most studies on this issue have been quantitative and have looked at factors associated with why women leave engineering. This qualitative study, in contrast, gave women engineering majors the opportunity to share their experiences in answer to the question of why women choose to stay in an engineering major. Phenomenological methods, including semi-structured interviews, yielded emergent themes, and new meanings generated from participants' responses provided a better understanding of their choices to persist in a traditionally male-dominated major. Results helped identify barriers and supportive factors to consider in educational program design to promote women's persistence in engineering.

CHAPTER I

INTRODUCTION

Women have narrowed the gender gaps in most Science, Technology, Engineering, and Mathematics (STEM) fields, but their underrepresentation in engineering continues today (National Science Board, 2016; Yoder, 2016). The gender gap remains despite years of research, and the significance of this difference in women compared to men in engineering fields grows as technological advances and global competition in the workplace continue to rapidly increase (Karoly & Panis, 2004; National Academies of Sciences, Engineering, & Medicine, 2016). However, regardless of a history of significant gender imbalance in engineering (Bix, 2004, 2013; Layne, 2009), some women do persist in their studies and graduate with degrees in engineering majors. These women's persistence prompted this study and included a search to identify and understand women engineering majors' experiences and characteristics that supported their perseverance.

The continued underrepresentation of women in engineering is concerning because of the possibility their voices are not being heard and the possibility of gaining a new woman's perspective in regards to engineering issues is diminished as the imbalance remains. Dutta, Patil, and Porter (2012) reported the United States "has one of the lowest rates of graduation of bachelor level engineers in the world: only 4.5 percent of our university graduates are engineers" (p. ix). While it is true that overall, higher education saw an increase in enrollment since 2000 with about 86 percent undergraduate students, the numbers in undergraduate enrollment between 2010 and 2013 decreased from 18.3 million to 17.7 million (National Science Board, 2016). Iskander, Gore, Furse, and Bergerson (2013) found a trend that showed that interest in engineering majors has steadily declined for both females and males since peaks in the early to mid-1980s. Sax et al. (2016) also reported concern over lower interest in engineering among women and noted the gender gap has widened because, even when more women become interested and state an intention to major in engineering, men's expressed interest increases at a faster rate. The gender gap and decreased undergraduate enrollment is concerning, especially for STEM fields, because some students do start undergraduate programs but either switch majors or drop out entirely (Beasley & Fischer, 2012; Goodman Research Group, 2002).

The National Science Board (2016) reported that since the late 1990s, 57 percent of all bachelor degrees and 50 percent of all science and engineering degrees were conferred to women. To clarify, more men earned bachelor's degrees in engineering, computer sciences, mathematics and statistics, and physics, while women earned more undergraduate degrees in the biological, agricultural, and social sciences and in psychology (National Science Board, 2016). At any rate, more men plan to earn and consequently do receive bachelor's degrees in science and engineering fields than women. The difference, specifically in engineering, is most striking as women earned roughly 20 percent of all engineering degrees. The National Science Board reported the percentage as 19.2 percent, but Yoder reported the percentage of engineering degrees earned by women has increased slowly from 18.1 percent in 2007 to 20.8 percent in 2016 (Yoder, 2016).

The gender imbalance in engineering majors continues once women enter the workforce. Researchers have reported that there has been an overall increase in the number of women in science and engineering fields. Conversely, the number of women entering the engineering field, by itself, continues to grow at a much slower pace (Bilimoria, Lord, & Marinelli, 2014; Ceci, Ginther, Kahn, & Williams, 2015; Fouad, Fitzpatrick, & Liu, 2011; Fouad & Singh, 2011). A report by the National Science Board in 2016 confirmed the trend, as it showed that, in 2013, the number of women rose from 23 percent in 1993 to 29 percent in the science and engineering workforce, but engineering careers alone continued to lag with only 15 percent being women.

Women earning only about 20 percent of all engineering degrees and representing only 15 percent of the workforce is appalling. There have been thousands of attempts to address and reverse this trend as researchers, authors, activist organizations, and governmental agencies struggled to find the answer to this on-going complex issue. Organizations such as the American Association of University Women (AAUW, 2018) have advocated for gender equity since 1881. For instance, the AAUW has produced reports such as *Why So Few? Women in Science, Technology, Engineering, and Mathematics* (Hill, Corbett, & St. Rose, 2010) and *Solving the Equation: The Variables for Women's Success in Engineering and Computer Science* (Corbett & Hill, 2015). In *Why So Few?,* the authors reviewed literature on women's underrepresentation in science and engineering and found aspects of social interaction and environment that contribute to the problem. These AAUW reports are discussed further in Chapter II. The U.S.

government has also taken an active role in addressing the issue, supported by President Barack Obama, who during a Google+ Hangout said:

> One of the things that I really strongly believe in is that we need to have more girls interested in math, science, and engineering. We've got half the population that is way underrepresented in those fields, and that means we've got a whole bunch of talent . . . not being encouraged the way they need to. (The Obama White House, 2013)

Legislators have also entered the conversation by enacting laws to promote equity. One such law is Title IX of the act, Education Amendments of 1972, a federal law that has supported gender equity in education for over 45 years (The United States Department of Justice, n.d.). Malicky (2003) highlighted social and ethical implications as women and other minorities continue to be underrepresented in the engineering field, despite Title IX and other legislative efforts to increase parity. Malicky (2003), Shapiro and Sax (2011), and Blickenstaff (2005) suggested that the engineering field is missing out by not developing its workforce with a labor source that could bring new ideas and diverse perspectives. The authors of *Solving the Equation* supported this notion, as they emphasized that the inclusion of women's perspectives and participation in engineering expands the workforce's ability to create, produce, and innovate.

Researchers have yet to find a solution to increasing the number of women in engineering. In the United States, the National Academy of Engineering (2008) presented the 21st Century's Grand Engineering Challenges to create interest in engineering and motivate engineers to address some of the most critical issues the world is facing. These issues included making solar energy affordable, providing power from fusion, providing access to clean water, and engineering better medicines. Also dedicated to this goal, members of the American Society for Engineering Education, including 122 engineering deans across the U.S., signed an open letter presented at a White House event on August 4, 2015 (American Society for Engineering Education, 2018). This letter, sometimes called the *Deans Diversity Initiative Letter* (Engineering Deans Council Diversity Committee, 2015/2017) detailed plans to educate and prepare young men and women to work on societal issues that demand the expertise of highly trained engineers. This action showed their commitment to the education of a new generation of engineers.

Also recognizing a critical need to develop the engineering workforce, the authors of *Solving the Equation* (Corbett & Hill, 2015) explained the U.S. would need 1.7 million engineers and computer scientists within the next 10 years to meet the increasing technological demands of American society. This study has aimed to support these goals using a phenomenological methodology to gain a new understanding of women's experiences in engineering education. Understanding their experiences through a qualitative lens may facilitate in-depth conversations to inform changes in education policies and program development that will expedite an increase in the number of women in engineering.

The gender imbalance in engineering also affects the ability of the U.S. to compete in the global market. Increasing the number of women in engineering will not only add to expanding workforce needs that have resulted from advancements in technology but will contribute another perspective for innovation through the inclusion of women's voices. In a 2011 U.S. Department of Commerce report, Beede et al. (2011) spoke to the issue of gender imbalance and American competitiveness in the global marketplace. Beede et al. reported that researchers had studied factors associated with gender imbalances in STEM, but they had not explained why the problem persists. Beede et al. went on to suggest that, "a lack of female role models, gender stereotyping, and less family-friendly flexibility in the STEM fields" (Beede et al., 2011, p. 1) could be responsible, and if addressed, could contribute to an increase in women's representation in STEM.

Bilimoria, Lord, and Marinelli (2014) recognized that the gender imbalance has contributed to women's inability to participate equitably as partners with men in the STEM workforce. Bilimoria et al. highlighted this issue in a discussion of how science and technological advancements affect economic competition around the world. Bilimoria et al. felt there was a need for the "full participation of women and men in STEM workforces" (Bilimoria, Lord, & Marinelli, 2014, p. 3) to meet future challenges. Chen and Soldner (2013) also addressed global competition. They cited political and educational entities that had identified the "ability to compete" as a critical need and called for an increase in the number of American STEM graduates to fill a gap created by the number of STEM jobs increasing at a faster pace than non-STEM jobs. Chen and Soldner specifically addressed the need to include women in STEM fields, as women tend to leave STEM fields more frequently than men. The trend continued as shown by Hunt (2016) who, in a study using data from the National Science Foundation, found that when compared to men, women left engineering positions at higher rates than women left positions in other fields. The imbalance will undoubtedly continue if researchers and academics cannot increase admissions and retention, and the industry does not find a way to stop the exodus of women from engineering once they enter the field. Post-graduation issues are beyond the scope of this study but should be the focus of future research.

Existing research on underrepresentation of women in STEM includes issues such as the leaky pipeline in STEM or engineering (Adelman, 1998; Alper, 1993; Berryman, 1983; Blickenstaff, 2005; Frehill, 2008; Frehill, Brandi, Lain, & Frampton, 2010; Gayles & Ampaw, 2014; Malicky, 2003; Miller & Wai, 2015; Svinth, 2006) and chilly climate (Allan & Madden, 2006; Blickenstaff, 2005; Hall & Sandler, 1982; Malicky, 2003; Morris & Daniel, 2008; Serex & Townsend, 1999; Simon, Wagner, & Killion, 2017; Walton, Logel, Peach, Spencer, & Zanna, 2015). Researchers have also identified measurable factors related to gender imbalance in STEM and engineering such as microaggressions (Beasley & Fischer, 2012; Camacho & Lord, 2011; Fouad, Fitzpatrick, & Liu, 2011; Hunt, 2016; Sue et al., 2007), grit (Bottomley, 2015; Duckworth, Peterson, Matthews, & Kelly, 2007; Farrington et al., 2012), STEM living learning communities (Allen, 1999; Hathaway, Sharp, & Davis, 2001; Leslie, McClure, & Oaxaca, 1998; Maltby, Brooks, Horton, & Morgan, 2016; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012; Szelenyi, Denson, & Inkelas, 2013; Szelenyi & Inkelas, 2011; Carrino & Gerace, 2016), gender issues (Amelink & Creamer, 2010; Bella & Crisp, 2016; Gayles & Ampaw, 2014), interest (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Iskander, Gore, Furse, & Bergerson, 2013; Navarro, Flores, Lee, & Gonzalez, 2014; Su, Rounds, & Armstrong, 2009), motivation (Bossart & Bharti, 2017; Matusovich, Streveler & Miller, 2010), confidence (Jagacinski, 2013; Litzler, Samuelson, & Lorah, 2014; Vogt, 2003), workplace barriers (Fouad & Singh, 2011; Fouad, Singh, Cappaert, Chang, & Wan, 2016; Williams, Li, Rincon, & Finn, 2016), attrition (Geisinger & Raman, 2013), and persistence (Ackerman, Kanfer, Beier, 2013; Concannon & Barrow, 2012; Marra, Rodgers, Shen, & Bogue, 2009; Shapiro & Sax, 2011). These studies, discussed in Chapter II, are among the many that have illuminated, on a macro level, some explanations as to why the problem of gender imbalance in STEM persists. Despite these studies, we do not have a good understanding of successful women engineering majors' experiences or what it is that drives their persistence.

Much of the research to date has been quantitative and has focused on lack of interest, avoidance, or attrition from STEM fields in general, rather than on engineering, or more specifically, women in engineering. Quantitative methodology, nevertheless, does not allow for the inclusion of women's voices because its methods typically measure and analyze predetermined factors the researcher identifies. Results from such studies may be generalizable to groups of people but do little to help us understand individual study participants or the essence of their experiences that contributed to how they answered predetermined questions. The body of knowledge on women in engineering has grown, providing some insight into the gender imbalance. However, some researchers have expressed the need for continued gender-based studies, including qualitative studies to deepen understanding of women's experiences and expand on knowledge gained from quantitative studies (Inda, Rodríguez, & Peña, 2013; Lent, Brown, & Hackett, 2000; Miller et al., 2015; Painter, 2012).

The Society of Women Engineers (SWE) advocates for engineering research related to women's issues and has worked to increase equity in engineering for more than 65 years. SWE's goals include professional excellence, globalization, and advocacy in support of women engineers (Society of Women Engineers, 2018). SWE meets its goals in part through the presentation of an annual literature review of research conducted to explore, among other issues, women's underrepresentation in engineering. The 2014 SWE literature review (Meiksins et al., 2015) highlighted one study that made a significant contribution to research efforts. Specifically, they highlighted Bilimoria, Lord, and Marinelli's (2014) suggestion that we should stop asking why women leave or "leak out of" the engineering pipeline (Blickenstaff, 2005), and instead, ask why women stay. Bilimoria et al. suggested that since most researchers have studied attrition, we should focus instead on why women persist. Expanding on this idea, Demetriou and Schmitz-Sciborski (2011) suggested using a strengths-based research approach for retention and encouraged researchers to focus on successful students who persist so that we can use the knowledge gained to support all students.

Research Questions

Individuals selected to participate in this study were unique in that they chose to stay in an engineering major when many women do not enter or decide to leave once they start an engineering program. The following research questions facilitated the exploration of women's experiences as engineering majors.

1. What lived experiences do women engineering majors believe contribute to their choice to persist to graduation?
2. What personal characteristics do women engineering majors believe contribute to their choice to persist to graduation?
3. How do participants explain why they stay in an engineering major?

Study Purpose

The purpose of this qualitative study was to understand and construct meaning from the lived experiences of undergraduate women who chose to persist in an engineering major and to contribute to attempts to reverse the long-standing trend of women's underrepresentation in engineering. Over time, women have made progress in being accepted into engineering fields after historical exclusion from the engineering profession. Pursuing gender parity in engineering has been a prolonged process, and researchers have linked the slow progress to issues such as leaky pipelines and chilly climates. Research efforts have led to gains in some engineering fields, and academic policy revisions have reduced barriers in support of women's entrance into and persistence in engineering majors. This study delved deeper into the lived experiences of women engineering majors to understand their choice to persist, to add to the literature on women's persistence, and to support change in academic policy with a goal of encouraging more women to enter and continue in engineering majors and careers.

Significance of the Study

This study contributed to the literature on the underrepresentation of women in engineering majors by giving women the opportunity to describe in their own words what their experiences were, and how those experiences influenced their decision to persist. Findings supported previous research efforts and recommendations in some areas as responses indicated that most undergraduate engineering departments at Middle America University (pseudonym) and campus programming efforts were indeed supporting women students' success. A better understanding of the essences of women's experiences may support the development of curricula, programming, and environments that support women's entry and persistence in engineering programs and the overall goal towards parity in the engineering workforce. Gender balance in the workforce should strengthen the ability of the U.S. to solve critical issues such as energy, clean water, and medicine, and competition in the global marketplace.

Research Paradigm

This qualitative phenomenological study explored the lived experiences of women engineering majors through a constructivist lens. Schwandt (1998) explained that constructivists believe that "what we take to be objective knowledge and truth is the result of perspective. Knowledge and truth are created, not discovered by mind" (p. 236). Guba and Lincoln (1994) explained that in constructivism, humans co-construct, or make sense of their world, and as they become more aware or knowledgeable through interactions with others in the social world, they may adapt their thinking and assign new meaning to phenomena. They further explained that knowledge is co-constructed as a researcher takes on the role of participant and as such is described as a "passionate participant" (Guba & Lincoln, 1994, p. 112), actively interacting with participants and revising knowledge as new information is learned. In this phenomenological study, I viewed myself as a passionate participant due to my active engagement, listening and prompting to get deeper responses during the interview process. That said, I did not otherwise interfere with participants' sharing of experiences or interpret data collected until later during data analysis. This was consistent with the research paradigm for this study and phenomenological methodology.

Mason (2002) wrote about constructivism, including the belief that learning about an individual's perception and the meaning he or she constructs of the world is essential to understanding phenomena under study. The phenomenon in this study was women's persistence in engineering majors, so engaging directly with them was necessary for gathering data and gaining an understanding of the meaning they assigned to their experiences. Constructivism was appropriate for this study because there was a desire to understand individual participants' lived experiences and how participants made sense, or constructed and assigned meaning to those experiences, as they lived and interacted in the world as engineering majors.

Framework for Understanding Findings

Phenomenological epistemology and methodology guided the present study's data collection and analysis, as described in Chapters III and IV. Chapter II includes a discussion of the Social Cognitive Career Theory (SCCT) developed by Lent, Brown, and Hackett (1994, 2000). The SCCT model was used following data collection and analysis in this study and provided the primary framework for understanding the findings. Briefly, the SCCT model expanded Bandura's (1986, 1989b) Social Cognitive Theory (SCT). SCT was based on the idea that, as humans develop and evolve over time, their behavior is influenced by both external environmental and internal cognitive and emotional personal experiences; and their behavior, in turn, influences their environment and cognitive and emotional experiences. Simply put, as humans move about in their daily lives, they are influenced by and exert influence on their social world. SCCT extended SCT to include constructs such as self-efficacy beliefs, interests, outcome expectations, goal attainment, and contextual influences in relation to career development. Chapter V includes a discussion of the findings as related to the SCCT model.

Summary

Chapter I introduced women's historical underrepresentation in engineering fields of study and work and how this underrepresentation continues to be a focus of contemporary research. Researchers have recognized the issue of global competition and workforce development issues that contribute to the ability of the U.S. to compete globally, including gender inequity and the decrease in interest in engineering of both genders since the 1980s. There is an acknowledgement that the numbers of women are increasing in some areas of engineering, but the percentage of women participating in engineering fields still falls well behind men. The chapter also included discussion of the gender imbalance in engineering and attempts to reverse the trend. Finally, the chapter's introduction identified a need for qualitative research to learn more about the women who do persist in engineering fields and characteristics that support persistence.

This study's goal was to contribute new knowledge to the literature about women's choices to persist rather than leave engineering majors. As such, this research project gave women the opportunity to use their voices to contribute to the on-going conversation of how to reverse the long-standing trend of women's underrepresentation in engineering. The women in this study were the epitome of Bandura's (2001) conceptualized human agent in that they believed in themselves enough to take control of their educational journey towards future careers in engineering. They did not let anything stop them and in fact structured their environments by building support systems to use when challenged.

Data analysis led to a new understanding of participants' lived experiences as women in engineering majors. This new understanding led to findings and recommendations that may inform the policies and practices of engineering faculty and administrators. A more nuanced perspective may lead to the development of new programs to support new or enhance existing efforts to increase the number of women in engineering.

CHAPTER II

LITERATURE REVIEW

Chapter II begins with a brief review of the history of women in engineering and highlights the gender imbalance in this male-dominated field since engineering became a career field in the U.S. The chapter includes an exploration of research issues associated with engineering education; the need for qualitative, gender-based research; and a description of the study's theoretical framework, Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994, 2000).

Background

The gender imbalance in engineering goes back to the 15^{th} century when the all-male military began using engineering concepts for weapons development (Layne, 2009). Layne noted that engineering education in the early 1800s excluded women as it commenced at all-male institutions such as the U.S. Military Academy at West Point and the Rensselaer Polytechnic Institute, a civilian institute. While the first woman to graduate with an engineering degree was Elizabeth Bragg in 1876, she stayed at home to care for her family and never worked as a professional engineer (SWE Blog, 2018). It was not until 18 years later, in 1894, that Julia Morgan earned her engineering degree and continued to work as an architect (SWE Blog, 2018). Opportunities for women in engineering education programs remained limited through the early to mid-1900s, but efforts over time have supported women entering into the field. In writing about gender inequity in American engineering history, Bix (2004, 2013) described barriers such as gender discrimination in education preventing women being admitted into the best engineering schools until after World War II, and depictions of women as somehow being abnormal and unfeminine because they challenged gender norms.

To understand the history of gender imbalance in engineering, one must recognize the fact that the issue reaches farther out than engineering alone, and includes women's exclusion, lack of participation, and underrepresentation in all STEM fields. Rossiter (1983) argued:

> Women's historically subordinate 'place' in science . . . was not a coincidence and was not due to any lack of merit on their part; it was due to the camouflage intentionally placed over their presence in science in the late nineteenth century. (p. 10)

Rossiter explained that this *camouflage* was made up of both men's and women's actions as part of two co-occurring movements between about 1820 and 1920. The first movement was the expansion of higher education and the increase in middle-class women's employment outside the home. In a second, co-occurring movement, the fields of science and technology were advancing rapidly and becoming formalized professions within bureaucratic systems. During this time, even educated women usually took on stereotypical roles and activities associated with acceptable feminine attributes such as being gentle, empathic, sensitive, compassionate, and nurturing. Science stereotypes emerged as hard, masculine, and rational – just the opposite of feminine attributes. This contradiction led to and still leads to confusion for women considering a career in science, leaving them to choose socially acceptable roles and maintain their femininity or risk people labeling them as abnormal for choosing a “masculine” career.

Exploring enduring stereotypes in science, Losh (2010) explained stereotypes can be both positive and negative, and either way, the distance between students and their perceptions of science stereotypes is important and affects career beliefs and decisions. For instance, popular media historically showed scientists as single-minded, workaholic males, with women, if present, as assistants. Losh acknowledged a culture shift in perceptions of gendered science occupations and urged “public figures and media to stop portraying scientists as eccentric, obsessed, lonely workaholics, descriptions hardly calculated to increase personal respect for scientists or interest in science careers” (p. 381). Homsher (2011) addressed stereotypes, and specifically, women's exclusion from engineering, when she described the systematic efforts that have persisted for more than a century to discourage and exclude women from full participation in the profession. These include “convictions and beliefs promulgated more than 100 years ago: men’s ‘natural’ superiority in mathematics, women's ‘inferior’ psychological stamina (to withstand the rigors of an engineering curriculum or to manage male subordinates), etc.” (Homsher, 2011, p. 13). These convictions and beliefs continued despite research showing them to be inaccurate (Bing, 1999; Eliot, 2013; Kane & Mertz, 2012; Sadker & Sadker, 1986).

Gender inequity in education persisted well into the 20th century despite extensive research and legislation such as Title IX of Education Amendments of 1972. Title IX dictated that American classrooms would include gender balance. So why is it that more than 150 years after the first women engineering students’ graduations and 45 years after Title IX, more women do not access or persist in engineering education?

Feminism in Qualitative Research

Departing from positivistic research methodologies historically biased towards a culture of male dominance, Harding (1986) identified three approaches to feminist research including feminist empiricism, feminist standpoint science, and postmodernism. The work in this study most closely reflects the ideas of the feminist standpoint science approach. Weisman (2017) explained feminist standpoint epistemology includes a "belief that an individual's lived experience, her place in the world and culture, inform and builds not only her reality but also how she understands of her social position and of the larger sociocultural world" (p. 513). Feminist standpoint epistemologies assert the importance of focusing research on women because our knowledge and the way we make sense of our world is based on our social interactions and our place in society (Riger, 1992), and women's perspectives might be different than men's because our social interactions and roles in society have been different than men. Given these differing perspectives, I chose to speak only to women, not because their viewpoint was any more valid than that of men.

Thus, it was important to speak directly to women engineering majors to understand how their experiences' contributed to their persistence. Riger (1992) argued that feminist standpoint epistemologies afford a unique global understanding of our world, and that "giving voice to women's perspective means identifying the ways in which women create meaning and experience life from their particular position in the social hierarchy" (p. 734). Riger warned, however, that a problem with feminist standpoint epistemology is that all women's experiences are not the same and that varying levels of subjugation and biases contribute to differences in research findings. As such, a researcher should be mindful of diversity issues and understand that participants' responses may reflect a variety of cultural and societal beliefs.

While this qualitative study focused on women in engineering majors and shared epistemological and ethical considerations of feminism, it did not directly align with the political agenda in feminist research. Lindsey (1997) discussed similarities of feminist principles and qualitative methodology. She explained they emphasize the experiences and voices of participants as in phenomenology, the idea of multiple realities evolving through social interactions, an inherent subjectivity, and the need for researcher reflexivity. Lindsey also highlighted the fact that politics of feminism are often absent in qualitative research design.

Regarding feminist politics, Harding (1987) noted that "if one begins inquiry with what appears problematic from the perspective of women's experiences, one is led to design research *for* [emphasis added] women" (p. 8). In a literature review on the feminist agenda, Thompson (1992) explained the difference between doing research *on* women versus *for* women, "Research *on* women aims to document and correct for sexism. . . . Research *for* women is consciously aimed at emancipating women and enhancing their lives" (p. 4). Thompson added that research *on* women expands our knowledge about women's experiences, including those with "sexism and social injustice" (p. 4), whereas research *for* women more likely involves activism. While women benefit from research done *for* them, they are certainly capable of communicating their experiences themselves. As such, the intent of this study *on* women was to amplify women's voices and increase our understanding of their experiences as engineering majors in a male dominated field. Fawcett and Hearn (2004) discussed the complexities of researching others using qualitative methodologies and suggested approaching research questions with an "open-mindedness on the specificities of particular research and socio-political situations" (p. 216). They suggested key factors to use in judging the quality of such research might be factors such as how the research was conducted, level and type of participant involvement, ethical issues considered and addressed, and researcher reflexivity. This study incorporated these principles, which are described in detail in Chapter III.

Research Concepts Framing Women's Underrepresentation in Engineering

The underrepresentation of women in engineering education and careers has been a complex issue and has generated a great deal of research aimed at finding a way to reverse the trend. Li, Swaminathan, and Tang (2009) examined the literature to find what factors had been studied, how factors affected outcomes, and methods used. Li et al. concluded that many student characteristics had been studied but most reported correlations without examining interactive effects. They suggested future studies include a more comprehensive exploration of factors and interactions. Topics that elicit discussion repeatedly in the literature are the leaky STEM pipeline, the chilly climate in STEM classrooms and employment, and attrition and persistence factors. Each of these bodies of research are discussed in this chapter.

Leaky Pipeline

The term "pipeline" as a metaphor historically described movement into and out of STEM education and employment. Sue Berryman (1983) studied gender issues and initially used the term "pipeline" to describe the movement of women and minorities in mathematics and science from high school, through higher education to degree attainment at the doctorate level. The phrase "leaky pipeline" described the loss of women as they leaked from the STEM pipeline, and referred to the fact that, compared to men, fewer women who received STEM bachelor degrees went on to earn advanced degrees. Alper (1993) described the phenomenon as "bright women with scientific aptitude who get diverted into other careers" (p. 409).

In a literature review on underrepresentation and factors associated with an "unfriendly, even hostile" (Malicky, 2003, p. 2) environment for women in engineering, Malicky noted that we do not just need a bigger pipe, we also need to understand the many complex experiences women face before, during, and after they enter the pipeline. Frehill (2008) reported that women are more likely to leave, or leak out of the pipeline, and that interest was a major contributing factor. Frehill, Brandi, Lain, and Frampton (2010), in an annual review of the 2009 literature for SWE Magazine, also used the pipeline metaphor in their discussion of how research has shifted from a focus on self-esteem to self-efficacy. This change aligned with Bandura's (1997) work on self-efficacy.

Considering the persistence issue from a different angle, Blickenstaff (2005) suggested students do not merely leak out of the pipeline. Instead, he argued that the pipeline contains barriers, such as sexist course material and gender harassment, that act as a gender filter system that may block women's persistence in STEM education. Addressing gender imbalance from another perspective, researchers have suggested there is not a direct pipeline with holes or filters; instead, they described STEM paths or pathways that more accurately reflected different opportunities available to students and choices they make at various points regarding persistence. In fact, some researchers took issue with use of the *leaky pipeline* metaphor and contended that it was not a good descriptor of loss of women as they progress from school to employment in STEM fields. For instance, Adelman (1998) suggested using *pathways* as a metaphor instead as the word *leak* was value-laden and implied women were helpless victims that fell out of the pipeline. Whereas, using a term such as “migrate” (Adelman, 1998, p. 10) might better reflect an individual capable of making informed decisions and thoughtful career choices. Continuing along this line, Svinth (2006) called on researchers to discontinue use of the *leaky pipeline* metaphor, as it has been an oversimplification of gender inequity issues, has been negative and value-laden, and has not allowed for explanations of different entrance or exit points along a STEM career.

Miller and Wai (2015) agreed with Adelman (1998) and described the leaky pipeline metaphor as being outdated, considering their results in a retrospective study of the pipeline and persistence rates over a 30-year period. They argued the pipeline metaphor no longer worked because the gender gap decreased in the 1990s when more women persisted to earn doctorates. Sue V. Rosser, however, disagreed with Miller and Wai (2015) as she said (via e-mail to Jaschik, 2015), that she was skeptical that the results reflected progress for women: “The major finding of the study is the ‘leakage’ or loss of men. It's not so much that women are leaking less; in fact, it's pretty constant. It's just that the [number of] men receiving STEM Ph.Ds. [has] decreased." (para. 13). Also taking issue with the leaky pipeline metaphor, after studying persistence rates of men and women in STEM, were Gayles and Ampaw (2014). In their STEM persistence study, Gayles and Ampaw noted their results were consistent with other studies that showed that women did not complete bachelor’s degrees within 6 years at the same rate as their male counterparts, indicating that women were leaking out of the pipeline and not finishing at equal rates.

More recently, discussion regarding the use of the leaky pipeline metaphor continued. A 2016 report from the National Academy of Sciences concluded that the pipeline metaphor does not account for various routes into, through, and out of the path to STEM careers. They, too, suggested that the *pathway* metaphor is a more inclusive way of explaining the progression of students to graduation, including the institutional supports that help them succeed. The report also emphasized the “piecemeal” (National Academy of Sciences, 2016, p. 161) nature of undergraduate STEM reform efforts and noted an issue that needs addressing is diverse student characteristics and needs, the fact that students are changing, and policies that have not sufficiently met those needs. In an article on educational reform and science literacy, Eisenhart, Finkel, and Marion (1996) highlighted social and cultural barriers that limit or discourage women from participating in science, such as gender bias and stereotypes. They suggested policy makers expand their thinking regarding teaching practices and develop socially responsible scientific literacy for a more diverse group of students.

While beyond the scope of this study, the National Academy of Sciences (2016) report included discussion of a complex system of pathways that include changing demographics of undergraduate STEM students, varying entrance and exit points, and using multiple institutions and methods of curriculum delivery. The report also pointed to issues inherent in pathways research, including varying administrative policies and programs. Recommendations for policy change included revising the way student data is collected and used on an institutional and departmental level; and institutions, accrediting bodies, and funding sources should develop coordinated, systematic policies and processes for admission and retention efforts. For further information on recent gender bias in education studies, see the recently updated annotated bibliography by Savonick and Davidson (2017). Considering recent critiques and contributions to these metaphors, this study embraces the use of the phrase "pathways" in referencing data and findings related to women's movement into and out of engineering.

Chilly Climate

Gender equity has been an on-going issue in STEM classrooms from K-12 through higher education for some time. Uncomfortable experiences with gender stereotyping, bias, and sexual discrimination and harassment in academia have contributed to the gender imbalance in engineering and other STEM fields. This issue is commonly described as a chilly classroom or chilly climate. Serex and Townsend (1999) defined "chilly climate" as "a psychological climate in which students of one sex are valued differently and therefore treated differently than are students of the opposite sex" (p. 528). Widely considered a foundational study, Hall and Sandler's (1982) work on the chilly climate in education prompted numerous studies seeking to understand the phenomenon of gender inequity in education. Hall and Sandler reported women students felt devalued, ignored, isolated, and discouraged. They identified the chilly climate as a possible causal factor for why women avoided or left historically male-dominated fields such as engineering.

Since Hall and Sandler (1982), many researchers have studied the chilly climate, including Allan and Madden (2006), Blickenstaff (2005), Malicky (2003), Morris and Daniel (2008), and Walton, Logel, Peach, Spencer, and Zanna (2015). These researchers sought to understand the continued gender imbalance by examining possible contributing factors such as sexual stereotyping, differential treatment, perceptions, and expectations of the genders, and sex discrimination. The findings for these studies, presented next, expand the discussion and understanding of chilly climate research from a historical perspective.

Malicky's (2003) review of the literature provided a comprehensive assessment of existing gender in engineering research at the time. Malicky noted that ability, self-efficacy, and discrimination were the three most important factors that researchers understood the best among many other contributing issues. He concluded that most studies supported Hall and Sandler's (1982) work, and suggested models for studying self-efficacy as a factor contributing to the loss of women from engineering. Allan and Madden (2006) also supported Hall and Sandler's study on chilly climate in education. Allan and Madden did a mixed method study and found that 25 percent of respondents reported chilly behaviors in their classrooms. They also noted that all groups in their study disclosed some level of chilly behavior and that chilling behaviors reportedly were often quite subtle and occurred in male-dominant areas. Women in male-dominated fields reported the most blatant forms of discouragement were by faculty members, typically only one or two members on the faculty. Allan and Madden suggested that lack of women peers in a classroom can be chilling by itself and that men and women learn normalized cultural expectations of gender stereotypes and gender roles and, as such, they often may not recognize chilling behaviors as they occur. They observed that one outcome of the research on chilly climate has been a better understanding of issues regarding equity and quality education, but recommended using qualitative methodology research to get a deeper understanding of equity in a classroom.

Morris and Daniel (2008) examined studies that supported findings of chilly climate and those that did not. They reported there have been conflicting results from such studies; however, they concluded there were four studies that claimed to find no evidence of a chilly climate for women, but all four of them had studied classroom interactions rather than campus climate, which Morris and Daniel noted were not equivalent. Morris and Daniel also measured college student's perceptions of chilly climate and found that a chilly climate continued to exist in higher education, but opinions varied, and they were not able to explain the differences. Walton, Logel, Peach, Spencer, and Zanna’s (2015) findings spoke to a need to help students in cool less-than-friendly climates manage feelings of social marginalization. They suggested interventions for increasing gender equity and numbers of women in STEM and noted that any response must include efforts to reduce sexism and to support women in male-dominated STEM programs.

In a discussion about their study of STEM students’ personality traits, Simon, Wagner, and Killion (2017) explained stereotypical masculine traits are often attributed to boys and men and stereotypical feminine traits are assigned to girls and women in educational settings despite suggestions that such personality traits vary from person to person regardless of gender identity or anatomical sex. The assignment of gender-based stereotyped traits has led to barriers for women, such as a chilly climate in traditionally male-dominated science classrooms. Simon, Wagner, and Killion studied gendered personality traits of 752 undergraduate STEM students using the Bem sex-role inventory, and suggested gendered traits are not dichotomous, rather they fall on a continuum and are affected by socialization and cultural expectations. They concluded that masculine and feminine traits are rewarded differently in men and women in STEM careers, and women are at a disadvantage when men receive benefits not given to women in the same way. Simon et al. suggested researchers should explore these traits in relation to the gender gap in STEM careers.

When considering what to do about a chilly climate, Blickenstaff (2005) suggested rather than trying to change “the women” in engineering, environmental changes should include efforts to ensure all students have equal access to teachers and resources. Blickenstaff also encouraged teachers to minimize sexist behavior and language. Bottomley (2015) agreed with Blickenstaff that successful programs should focus on changing the learning environment and not try to fix female students or try to make them feel more comfortable. Bottomley and Titus-Becker (2015) suggested retention of women is most effective when an entire engineering college is involved and not when just a women’s group is responsible for recruitment and retention. Finally, in a report for the online resource Digital Science, Charman-Anderson et al. (2017) shared a collection of articles on STEM-related topics, all supporting continued change efforts towards gender parity and offering suggested solutions. Research on the chilly climate issue in STEM education, especially in the past few years, has made considerable progress and indicated that change is happening in academia. The following section includes examples of research efforts related to attrition and persistence in STEM. Engineering research in higher education was included when available as more researchers are addressing the gender imbalance in engineering classrooms.

Research on Attrition, Persistence, and Innovations to Support Women Engineers

Microaggressions

In addition to overt stereotypes and bias, also contributing to chilly climate are microaggressions. Sue et al. (2007) defined racial microaggressions as "brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults toward people of color" (p. 271). Extending the work of Sue et al. on racial microaggressions, Camacho and Lord (2011) explored microaggressions, race, sexism, and undergraduate engineering education. Camacho and Lord found that microaggressions exist in three forms including institutional, interpersonal, and jokes, and that women learned to respond to them in various ways such as asserting themselves by calling men out when they recognize microaggressions and adapting their behavior to disengage from antagonistic situations. In a study on gender and racial/ethnic barriers to STEM in high school students, Grossman and Porche (2014) reported participants more often recognized gender microaggressions than they did racial/ethnic microaggressions. Grossman and Porche suggested this might be more a function of a change to more implicit versus explicit behaviors than to a change in frequency. They also noted that young students' lack of experience in their social environments might contribute to not recognizing or identifying an act of discrimination as a microaggression. This phenomenon could explain Miller et al.'s (2015) report that gender discrimination was reported to have affected persistence by less than 2 percent of women respondents.

Focusing on strengths, Bella and Crisp (2016) chose to look at benefits to women in STEM rather than looking at barriers in their quantitative work on gender and persistence. Their research included issues women in STEM face on an on-going basis such as stereotype threat (Steele & Aronson, 1995), discrimination, and negative implicit biases. In discussing their findings, Bella and Crisp suggested "chronic exposure to such experiences can stimulate the ability to deflect such stereotypes, and our results indeed suggest that women from STEM fields develop superior resilience to the impact of negative stereotypes as compared to women from non-STEM fields" (p. 195). Grossman and Porche (2014) also reported finding resilient behaviors in participants who had learned to cope with microaggressions as they worked towards their goals.

Continuing with another view of stereotypes and persistence, Beasley and Fischer (2012) studied stereotype threat, measured by performance anxiety and academic performance in STEM majors. They reported women and minorities underperformed under negative stereotyped conditions, and that African-American men and women, and Hispanic and White women disproportionately left STEM majors as compared to Asian and White males. Beasley and Fischer noted that relationships between persistence intentions and race and gender are issues require factoring in more than just levels of academic preparation or socioeconomic status as suggested in other studies. Results of these studies have contributed to the discussion of the need to address bias in support of retention efforts.

Grit

Duckworth, Peterson, Matthews, and Kelly (2007) defined grit as "passion for and perseverance toward especially long-term goals" (p. 1). Their research on grit suggested that while intelligence and conscientiousness are important in determining success, perseverance might be just as important. Duckworth et al. (2007) asserted, “Achievement is the product of talent and effort, the latter a function of the intensity, direction, and duration of one’s exertions toward a goal” (p. 1098), and that this means a person with a higher level of grit than someone else of equal intelligence may be more successful.

Farrington et al. (2012) discussed academic achievement and other factors to consider regarding engineering persistence and attrition in addition to intelligence and non-cognitive factors such as grit when examining goal attainment. They explained the educational achievement of minority and first-generation students is also affected by issues such as academic preparation for college, financial knowledge and resources, the availability and quality of programs facilitating transition from high school to college, and student academic support services. They also discussed social issues such as microaggressions that may deter minority and first-generation students as they adapt to a campus environment.

More recently, Bottomley (2015) reported early findings of a longitudinal study on gender and ethnicity using Duckworth and Quinn’s GRIT-S assessment (2009). Bottomley acknowledged data was limited at the time but suggested the GRIT-S assessment may have potential in the future for predicting success of undergraduate engineering students and for program enhancement and admissions decisions.

STEM Living Learning Communities

Leslie, McClure, and Oaxaca (1998) researched factors related to underrepresentation of women and minorities in science and engineering. They synthesized their own research data with those from other studies and recommended higher educational institutions support students using communal living environments to reinforce the goals of science and engineering programs and to minimize detractions. According to Inkelas, Vogt, Longerbeam, Owen, and Johnson (2006), "Living-learning programs can be described as communities in which students not only pursue a curricular or co-curricular theme together but also live together in a reserved portion of a residence hall" (p. 40).

Allen's (1999) study of living-learning programs (LLC) at the University of Wisconsin – Madison, known as the Women in Science and Engineering Residential Program, provided support for such residential programming for STEM students. Allen's findings showed students in the program benefitted academically and emotionally from peer study groups and had better grades than students did in other living situations. Hathaway, Sharp, and Davis (2001) also studied women in "Women in Science and Engineering Residential Programs" and found that participation in such programs included academic and personal support, and resulted in effective retention of science students, but not engineering students.

Using data from the 2004–2007 National Study of Living Learning Programs, Szelenyi and Inkelas (2011) studied LLCs and women's intentions to attend graduate school in STEM fields. Their results indicated that women who had lived in women-only STEM LLCs were more likely to go to graduate school in a STEM field than those who had lived in co-educational LLCs or traditional residence halls, or had participated in other living learning programming. Then in 2013, Szelenyi, Denson, and Inkelas used the same dataset from the 2004–2007 National Study of Living Learning Programs within the framework of Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994) to explore the long-term effects of living in an LLC. Their findings showed that co-educational LLCs contributed positively to professional outcome expectations. They noted the women's interactions with men in co-educational LLCs gave them an opportunity to experience and practice dealing with gender issues in an environment that might have had a more supportive climate than one at an actual worksite. They also suggested successful gendered interactions might boost women's confidence in their abilities to manage interpersonal relationships and work-life balance.

Soldner, Rowan-Kenyon, Inkelas, Garvey, and Robbins (2012) used SCCT as a framework for studying the effectiveness of STEM LLCs for student persistence. Soldner et al. (2012) reported support for STEM LLCs as findings showed them to have a positive impact on persistence through the inclusion of peer-to-peer academic support, faculty and student interactions in and out of the classroom, and social support needs. Maltby, Brooks, Horton, and Morgan (2016) studied first-generation first-year women in a STEM LLC at a large 4-year research institution. Their findings suggested students derived long-term benefits from living in an LLC that included co-curricular interventions such as "a supportive peer community, academic and career resources, mentoring, and community building activities" (p. 4).

Acknowledging the success of LLCs and attempting to discover and understand the underlying factors of LLCs, Carrino and Gerace (2016) analyzed 119 STEM learning community residents' narratives using a case study format. Carrino and Gerace identified psychosocial learning factors that were reported to have improved because of participation in a community including academic self-regulation, STEM professional/science identity, metacognition, and self-efficacy. Carrino and Gerace noted many studies have linked psychosocial learning factors with academic success and suggested such factors are necessary for success rather than just contributors to success. They also reported interactions with faculty and peers were important in residents' academic development. To summarize, LLC programs vary from campus to campus, but they have been effective in supporting student psychosocial development and retention. Students living in LLCs develop a sense of belonging and community and benefit academically and interpersonally through interactions with peers, mentors, and faculty.

Gender Issues Across Age and Settings

Related to research on chilly climate in engineering programs, Amelink and Creamer's (2010) study supports faculty engagement with students outside a classroom. Amelink and Creamer indicated their work supports other studies that have recommended regular interactions with faculty in and out of a classroom. Gayles and Ampaw (2014) studied degree completion in STEM fields and reported that some women were dissatisfied with their campus climate and that environmental factors continued to negatively influence women's persistence in STEM. Gayles and Ampaw also reported positive results that echoed Amelink and Creamer's, showing that faculty interactions facilitated women's persistence attempts. Gayles and Ampaw suggested encouraging regular faculty interaction and communication with students outside their classrooms as it may support degree completion.

Amelink and Creamer's (2010) findings also showed that lack of respect from peers was significantly related to persistence intentions in engineering, especially among women. Amelink and Creamer noted that such disrespect may negatively influence engineering students' beliefs in their ability to succeed. Amelink and Creamer also highlighted the fact that group work is often unsupervised by faculty and gender biased interactions in a male dominated culture may also impact retention.

Another finding cited by Amelink and Creamer (2010) was that women strive to develop and maintain work-life balance earlier than men, and a persistent sense of imbalance may lead to attrition from engineering programs. Amelink and Creamer suggested educating students through mentors or guest speakers who can share their struggles with work-life balance and show that it is possible to manage work-life demands. In their report, *Why So Few? Women in Science, Technology, Engineering, and Mathematics*, Hill, Corbett, and St. Rose (2010) reported similar findings in their extensive literature review and included recommendations for supporting young girls' interests and persistence in STEM. Recommended supports include increasing visibility of female role models, educating students about bias, and helping them understand that intellectual and spatial skills are not innate; rather, they can be developed over time.

Also concerned with climate issues and gender stereotypes, authors of the AAUW report *Solving the Equation* (Corbett & Hill, 2015) explained that while explicit bias has abated in recent years, implicit bias continues to be a concern. They noted however that bias can be reduced through education, and emphasized the need to help students understand connections between needs of society and relevance of science and engineering work. They also encouraged colleges to develop a sense of community and belongingness to support retention efforts**.**

Interest

Su, Rounds, and Armstrong (2009) completed a meta-analysis to examine inventories with data on sex differences and vocational interests for over 500,000 respondents. The sample was approximately half-female and half-male and the inventories spanned a 40-year period from 1964 to 2007. Their results indicated that men prefer working with things and women prefer working with people. The authors suggested that "interests" might significantly influence gendered occupational choices and gender disparity in STEM fields. Continuing the search for understanding of gender differences and interests, Iskander, Gore, Furse, and Bergerson (2013) conducted a 30-year analysis of ACT data including gender and intended college major of over 38,000,000 students who took the ACT from 1974 to 2006. Their findings "demonstrate a historically sustained presence of gender differences and expressed engineering interests" (p. 607). Although it is beyond the scope of this study, it would be interesting to examine racial and ethnic issues over time. Specifically, to explore the most recent data from about the year 2000 forward to see if there are any differences between them and the data from the 1960s and 1970s given evolving gender roles in the U.S. and other places across the world.

Navarro, Flores, Lee, and Gonzalez (2014) conducted a study of undergraduate engineering students at a Hispanic serving institution within a framework of Social Cognitive Career Theory (Lent, Brown, & Hackett, 1994, 2000). Their findings showed bidirectional interactions between self-efficacy and interest in engineering. They encouraged efforts towards development of self-efficacy in students early in their education to support student confidence in their ability to succeed. Byars-Winston, Estrada, Howard, Davis, and Zalapa (2010) also used SCCT to study interactions between social cognitive variables, ethnic variables, and climate perceptions with interests and goals of a racially and ethnically diverse group of students in undergraduate biological science and engineering programs. Byars-Winston et al. reported students who had a strong sense of self-efficacy and believed they could attain goals and receive desired rewards, also showed interest in completing an engineering degree.

Motivation

Also focusing on the positive were Matusovich, Streveler, and Miller (2010) who conducted a longitudinal investigation of student motivational values to answer the question of why students choose to enter and persist in engineering degrees. Matusovich et al.'s research involved a qualitative longitudinal examination of students' choices to enroll and persist in engineering majors. Matusovich, Streveler, and Miller noted important retention factors were interest and competence values and suggested focusing retention efforts on helping students understand and develop these values. Jones, Paretti, Hein, and Knott (2010) focused on motivational constructs related to persistence in engineering and reported both expectancy-related and value-related constructs of both men and women were helpful in understanding motivation. They suggested future researchers should look at multiple constructs and their interactions for persistence. Jones, Osborne, Paretti, and Matusovich (2014) explored motivation in terms of domain identification and found that students who identified with a domain such as engineering were more likely to value that identity, and this contributed to motivation to persist. These studies demonstrated that motivation is complex and retention efforts should take constructs such as interest, competence values, goal expectancy, and domain identification into consideration.

Bossart and Bharti (2017) analyzed 17 years of data from engineering departments at the University of Florida and the National Science Foundation to gain a better understanding of why some engineering departments have higher recruitment and retention rates than others. They found that it is important for engineering departments to engage women early during their first year so they can see real life problems and engineering examples that make a difference in solving societal challenges. Motivation for persistence can be supported by connecting with students early in their programs and by educating them about the realities of engineering and highlighting real life applications.

Confidence

Vogt (2003) framed her quantitative study with Bandura's (1986) SCT to measure factors related to self, behavior, and environment, including self-efficacy, confidence, and gender bias. Vogt found women had slightly less sense of self-efficacy compared to men, exerted more effort to succeed, were about as confident as men, and gender biases existed but appeared to be less of an issue than other factors. Jagacinski (2013) studied two types of competence perceptions, self-efficacy and perceived ability to succeed in engineering courses, in engineering students. Jagacinski found women engineering majors had lower competence perceptions and endorsed avoidance goals at a higher rate than psychology students did indicating fear of failure and anxiety possibly related to experiences in the engineering environment. Jagacinski acknowledged the study was not correlational but suggested that lack of confidence could contribute to lower competence perceptions.

Litzler, Samuelson, and Lorah (2014) studied factors related to self-efficacy. Litzler, Samuelson, and Lorah's findings suggested women generally undervalued their abilities, appeared less confident, and rated themselves lower on self-efficacy than men.

As such, women were more likely than men to leave STEM. Students who did not believe in themselves or their ability to succeed were at risk for attrition, so engineering departments should work to support students and build confidence and self-efficacy beliefs to increase retention.

Workplace Barriers

In the report *Stemming the Tide*, Fouad and Singh (2011) explored women's reasons for leaving or not entering the engineering workforce. They reported women left engineering due to dissatisfaction with working conditions such as lack of advancement, low salaries, chilly climate, and a desire to spend more time with family. Women who did not enter engineering jobs after graduating with an engineering major reported they perceived the environment to be inflexible or non-supportive, they lacked interest, or they had a desire to do other types of work with knowledge and skills learned as engineering majors. Women who were working in the engineering field at the time of the study reported their decision to stay was supported by respectful co-workers and supervisors who valued them and recognized their contributions. Fouad, Fitzpatrick, and Liu (2011) studied women's attrition from engineering once they enter engineering careers and noted that a chilly organizational climate that is not supportive of parenting and family roles or women's advancement into management often influences decisions to leave. Fouad et al. encouraged more research be conducted on exploring career commitment in engineering environments.

More recently, in a quantitative study on attrition in science and engineering, Hunt (2016) used 2003 and 2010 National Survey of College Graduates data from the National Science Foundation. Hunt's review of available literature showed factors contributing to attrition included work-life balance, isolation as a minority, lack of mentoring and networking opportunities, risk-taking environments, and hostility and discrimination in a male-dominated culture. Hunt's results, however, indicated that women do leave engineering at a higher rate than other fields and that the primary reason for women leaving engineering is "dissatisfaction over pay and promotion opportunities" (p. 221). Findings also showed that while more women than men cite family issues as a reason for leaving, women in engineering do not cite family issues at a higher rate than women in other STEM and non-STEM fields. Also in 2016, Fouad, Singh, Cappaert, Chang, and Wan reported they did not find differences in self-efficacy or outcome expectations between a group of women engineers who were currently working in the field and a second group of women who had left engineering careers. They also reported the two groups did not differ in career interest or workplace barrier issues. However, the women who stayed in the field reported more support for family responsibilities and advancement opportunities.

Bias was another complex issue considered to be a barrier in the workplace, specifically gender and racial bias as researched by Williams, Li, Rincon, and Finn (2016). Williams, Li, Rincon, and Finn's 2016 report on gender and racial bias in the engineering workforce examined quantitative survey data from over 3,000 respondents and qualitative data from 897 of the 3,000 total respondents. The authors included an extensive literature review on social psychology studies of gender and racial bias in the work setting. Results indicated considerable gender gaps in three areas: (a) prove-it-again bias with women reporting having to prove themselves repeatedly to get the same level of respect as their engineering coworkers; (b) tightrope bias with women reporting gendered expectations and restrictions on acceptable behavior; and (c) maternal wall bias with women reporting that family and childcare responsibilities affected colleagues' perceptions of their commitment to their work. The authors' discussion indicated that while some individuals noted positive changes in the engineering workplace, most described persistent bias as has been reported in research for many years. While the study focused on implicit and subtle bias, participants reported examples of blatant bias that were in some cases, noted to be illegal. The results supported previous research that showed that while explicit bias has decreased over time, implicit bias remains and is active in the workplace.

Attrition

Cadaret, Hartung, Subich, and Weigold (2017) studied relationships between engineering self-efficacy and stereotype threat (Steele, & Aronson, 1995) as a proximal contextual variable. They showed that awareness of gender stereotypes was negatively related to self-efficacy, and they suggested that low self-efficacy related to stereotype threat awareness might have adverse effects on persistence. In addition, Geisinger and Raman (2013) focused on attrition and conducted a literature review on why undergraduate students left engineering majors. Their study examined 50 studies on student attrition from engineering programs and an additional 25 studies that focused on retention efforts. They noted that reasons for attrition included the following six factors: (a) classroom and economic climate, (b) grades and conceptual understanding, (c) self-efficacy and self-confidence, (d) high school preparation, (e) interest and career goals, and (f) race and gender. The authors highlighted the high cost of attrition and a need for engineering programs to focus on retention efforts and noted that successful programs focused on at least one of the above six factors that drive students to leave.

Persistence

Researchers have focused on factors that account for women's persistence in engineering such as choice of STEM major. Shapiro and Sax (2011) highlighted a need to decrease the gender imbalance in STEM careers and explored women's choices of STEM majors. They focused on four indicators that researchers had shown were predictors of women's interest in engineering and their decisions to declare a STEM major, including: (a) academic preparation, (b) collegiate culture and teaching practices, (c) instructor interaction, and (d) classmate and coursework connections. They emphasized the need for strong pre-college math and science preparation; for explanation of the connections between STEM careers and real-world applications, especially in relation to improving daily life and activities; for faculty support and mentorship; and for collaborative learning. Lee, Flores, Navarro, and Kanagui-Muñoz (2015) conducted a longitudinal study using the social cognitive career theory's academic persistence model. The studied Latino/a and White male and female engineering students and found that students who scored highly on the Math and Science sections of the ACT were likely more confident and more successful in coursework in their majors. Lee et al. also showed that in relation to self-efficacy and persistence intentions, academic success early in college was more important than past cognitive abilities, and high persistence intentions were related to actual persistence in an engineering major.

Ackerman, Kanfer, and Beier (2013) examined gender differences, traits, and gender interactions for predicting STEM persistence. They noted men who leave and women who leave have different profiles, specifically men had lower scores on Mastery/Organization trait complex and lower scores on the Anxiety trait complex than women had. Women on the other hand had lower scores on Math/Science Self-Concept and higher scores on the Anxiety trait complex. They suggested trait complexes were significant predictors of STEM persistence. Ackerman, Kanfer, and Beier concluded that it is still unknown which variables were the most important in determining issues related to women's persistence, but they encouraged support for STEM education before students reach high school.

Also focusing on persistence, Concannon and Barrow (2012) conducted a quantitative study of 493 undergraduate men and women who intended to graduate with an engineering major. Using Bandura's 1997 work on self-efficacy, Concannon and Barrow found that academic standards were more important for persistence for women than for men, as failure affected women at higher rates than men. They also found that gender bias in a classroom impacts engineering self-efficacy, especially if an instructor explicitly or implicitly discriminates by gender regardless of intent. Buse, Billmoria, and Perelli (2013) used a grounded theory approach in a qualitative study of self-efficacy and women engineers' persistence in U.S. engineering careers. They found that in addition to career challenges, self-identifying as engineers motivated persistence, which was consistent with Jones, Osborne, Paretti, and Matusovich's (2014) work on domain identification.

Marra, Rodgers, Shen, and Bogue (2009) conducted a multi-year, multi-institution study of women engineering students and self-efficacy. They reported correlations that showed that self-efficacy was related to women students' plans to persist in engineering, a male dominate field. Specifically, they reported that strong self-efficacy beliefs could help women persist when they are in the minority in classes and succeed later when they enter the workforce.

Research on feminism, leaky pipelines and pathways, chilly climates, attrition and persistence factors has contributed to our understanding of factors related to the gender imbalance in engineering. Such efforts have been beneficial and recent research has shown changes are occurring, but more research will help to find ways to continue to reduce barriers and support efforts to end the gender imbalance in engineering.

Qualitative Research on Female Engineers

"There is not a significant body of literature on female engineers" (Fouad, Fitzpatrick, & Liu, 2011, p. 71). Much of the research at the time of Fouad et al.'s article had been quantitative. In a qualitative study on persistence of women in engineering careers, Fouad et al. argued that use of qualitative methodology in their study was appropriate because previous research did not explain or contribute to an understanding of the underlying factors associated with women's persistence in engineering. They went on to explain how qualitative research could yield rich data as participants could share their personal experiences and what those experiences have meant to them, which adds to our knowledge and understanding of their persistence. Painter (2012) conducted a quantitative study on self-efficacy in STEM students and recommended a qualitative methodology to get a broader and more detailed understanding of students' experiences.

Fouad, Fitzpatrick, and Liu (2011) used Lent, Brown, and Hackett's (1994) Social Cognitive Career Theory (SCCT) as the framework for their study on women's persistence. SCCT, based on Bandura's (1986, 1989b) Social Cognitive Theory, also explored the interaction between psychological variables, environment, and career decision making. Miller et al. (2015) conducted a qualitative analysis of responses to open-ended survey questions to study engineering majors' adjustment experiences within an SCCT framework. They suggested future studies ask gender questions to understand how gender affects adjustment experiences in engineering. Lent, Brown, and Hackett (2000) also used SCCT to analyze articles on supports and barriers to career choices and suggested qualitative researchers use phenomenological methods to identify and explore contextual factors, and their meanings to participants.

Gender-Based Research on Women's Persistence

Chou did a content analysis of 51 research articles from 2000 to 2009 in three refereed journals including the *Journal of Engineering Education*, the *International Journal of Engineering Education*, and the *European Journal of Engineering Education*. Chou noted that unless there had been an issue for women in engineering, research centered on women college students' learning experiences and general engineering rather than focusing on specific disciplines. Pawley, Schimpf, and Nelson (2016) conducted a content analysis of 132 gender-related engineering education research (EER) articles in the *Journal of Engineering Education* (JEE) from 1998-2012. They concluded there has been a lack of diversity in research on gender-related issues and a need to study gender in broader contexts.

This section provided discussion on the need for gender-based qualitative research for women persisting in engineering. One of the most critical issues is global competition, and the need to develop a workforce that is strong in number, perspectives, and innovation in an age of rapid technological advancement. Changing the conversation

(National Academy of Sciences, 2008) to include more women's voices should enhance our ability to compete on the world stage. Therefore, I used phenomenological methodology as a way of understanding women engineering majors' experiences and providing a vehicle for their voices to be heard.

Theoretical Framework

This section introduces basic elements of Bandura's (1986, 1989b) Social Cognitive Theory as it is a foundational theory for Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994, 2000). Results of this phenomenological study were examined within the framework of SCCT and will be discussed in Chapter V.

Social Cognitive Theory (SCT)

Bandura's (1986, 1989b) Social Cognitive Theory (SCT) expanded on social learning theory by considering the interactions an individual has with their social environment. SCT suggests that as humans develop and evolve, external environmental and internal cognitive and emotional personal experiences influence their behavior. Their behavior, in turn, affects their environment and cognitive and emotional experiences. Triadic Reciprocal Determinism, shown in Figure 1, is the process of bidirectional exchanges between behavior, the environment, and personal (B-E-P) experiences and includes overlapping interactions at times. Simply put, as humans move about in their daily lives, their social world influences them, and they exert influence on their social world. B-E-P experiences interact bi-directionally and can coincide. For example, a passive (P) person might avoid (B) social situations where she might make business contacts who could advance her career (E). She ends up staying (B) in a dead-end job, getting depressed (P) and staying home alone to watch movie marathons on TV (B). The model in Figure 1 shows on-going bidirectional interactions that can occur between Behavior-Environment-Person.

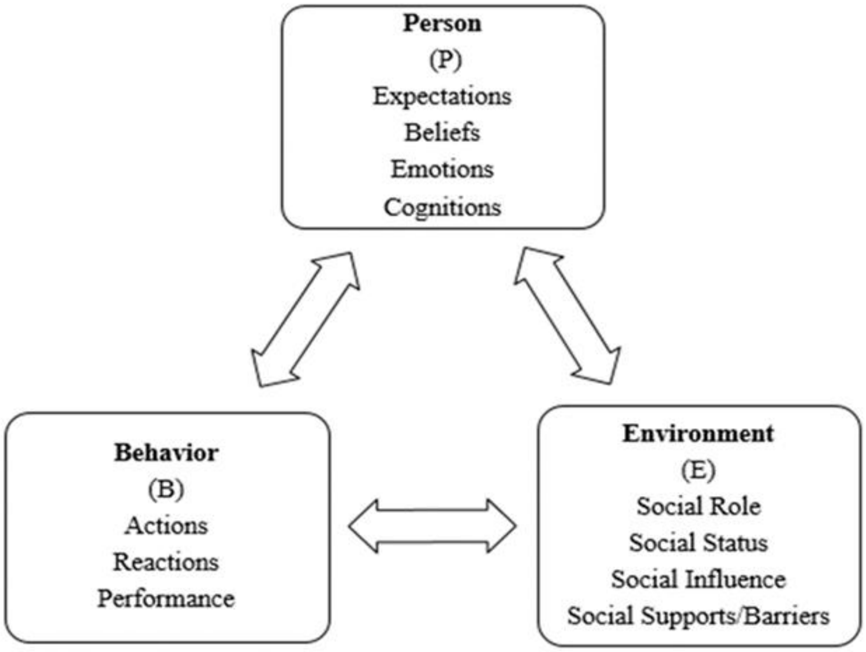

Figure 1. Triadic Reciprocal Determinism Model. Adapted from “Social cognitive theory,” by A. Bandura, 1989, in R. Vasta (Ed.), *Annals of child development* (Vol. 6), pp. 2-5. Copyright 1989 by JAI Press.

Bandura (1977, 1997) explained the concept of self-efficacy as an important part of B-E-P interactions. Self-efficacy is “the conviction that one can successfully execute the behavior required to produce the outcomes” (Bandura, 1977, p. 193). In other words, one must believe in oneself and one’s abilities before one will act to move towards a goal. As SCT evolved, Bandura (1989a, 2001, & 2006) conceptualized individuals as human agents or contributors to their lives and not just products of their environment or social interactions. This process included the concept of personal agency, or as Bandura (2001) explained, humans are “agents of experiences rather than simply undergoers of experiences” (p. 4), and further, that agents are those who intentionally influence their behavioral and environmental interactions (Bandura, 2008). Lent, Brown, and Hackett (1994) merged SCT with components of prevailing career theories to develop Social Cognitive Career Theory.

Social Cognitive Career Theory (SCCT)

In Social Cognitive Career Theory (SCCT), Lent, Brown, and Hackett (1994, 2000) extended SCT by combining existing career theory with other constructs beyond self-efficacy, including outcome expectations defined as “a person's estimate that a given behavior will lead to certain outcomes” (Bandura, 1977, p. 193), interests, goal attainments, and contextual influences. Figure 2 shows these constructs in the career choice process.

There are two types of contextual factors: distal and proximal. Distal contextual factors refer to a person’s background variables and environments, and the role they play in molding self-efficacy beliefs and outcome expectations. Background variables develop

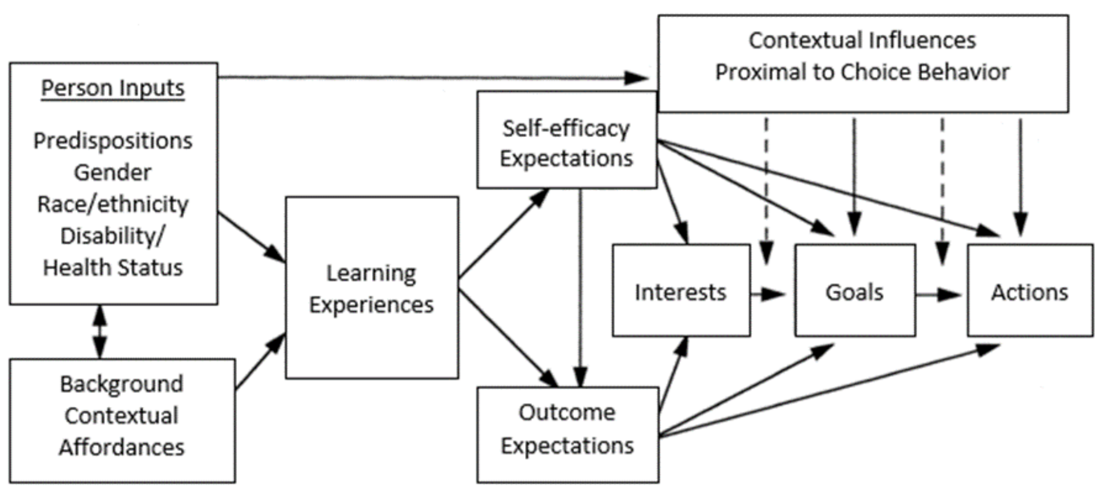

Figure 2. Social Cognitive Career Theory Model. Adapted with permission from “Toward a Unifying Social Cognitive Theory of Career and Academic Interest, Choice, and Performance,” by R. W. Lent, S. D. Brown, and G. Hackett, 1994, *Journal of Vocational Behavior*, *45*(1), p. 93. Copyright 2018 by Elsevier B.V.

from contextual factors such as family dynamics, parental influences, and cultural socialization, and contribute to learning experiences that in turn affect self-efficacy and outcome expectancies (Byars-Winston & Fouad, 2008). For example, children raised by parents who encourage and provide opportunities for them to explore their interests and possible future careers may have higher levels of self-efficacy and outcome expectations and be better prepared to make informed career choices than children in homes where parents cannot or do not support such efforts. Proximal contextual factors include environmental and societal supports and barriers that affect career development, such as sexism or racism (Byars-Winston & Fouad, 2008). For example, if a student feels confident and has a strong positive sense of self-efficacy, he or she may be able to cope better in a sexist or racist (real or perceived) environment than a student who is full of self-doubt and does not believe she/he can succeed. Among others, Lent and his colleagues have tested SCCT models extensively to study contextual supports and barriers, including various social cognitive factors such as interest, satisfaction, goal attainment across gender, and race/ethnicity (Lent et al., 2003, 2005, 2013, 2015).

This study sought to understand successful women engineering majors' persistence as they acted as agents who were in control of their lives and choices – proactively or reactively – and who made meaning from their contextual experiences to support their persistence to graduation in a male-dominated field. After data analysis, Lent, Brown, and Hackett's (1994, 2000) SCCT model framed the examination of findings. Findings in this study showed that participants' behavior, person, and environmental factors interacted with, and were influenced by, their personal agency, and their contextual experiences were related to their persistence as engineering majors.

Summary

Even as our society becomes increasingly dependent on technology, and global competition for resources increases, underrepresentation of women in engineering persists. It is crucial that we find a way to reverse this trend. Studies discussed in Chapter II provide an overview of history of women in engineering, research on the underrepresentation of women in STEM, and some research specific to women in engineering. STEM research was included because many studies relevant to this study focused on STEM in general rather than engineering, specifically.

CHAPTER III

METHODOLOGY

This methodology chapter extends Chapter I's presentation of the study's framework and the constructivist paradigm that provided the lens for this study's phenomenological research approach. The chapter includes discussion of the study design, data collection, and data analysis, and ends with a review of the themes that emerged from the data.

The purpose of this qualitative study was to explore successful women engineering majors' lived experiences as they persisted towards graduation. Lent, Brown, and Hackett's Social Cognitive Career Theory (SCCT; 1994, 2000) provided the framework for understanding study results. SCCT offered an understanding of participants' contextual experiences related to persistence in engineering.

Research Questions

Englander (2012) explained that in Husserl's (1931) descriptive phenomenology, a research question concentrates the meaning an individual participant has assigned to a phenomenon under study. As such, the following research questions framed this study on lived experiences and characteristics of women engineering majors' that contributed to their persistence, their ability to stay in this male-dominated field.

1. What lived experiences do women engineering majors believe contribute to the choice to persist to graduation?

2. What personal characteristics do women engineering majors believe contribute to the choice to persist to graduation?

3. How do participants explain why they stay in an engineering major?

Phenomenological Methodology

In this study, I used a qualitative research approach as it allowed me to work with participants to explore their understandings of the social world in which they lived, and the significance of the meanings they assigned to their experiences within their social interactions. A qualitative methodology, particularly phenomenology, was appropriate because the study sought a personal understanding of lived experiences the women described (Crotty, 1998). It was my desire to understand those experiences that led to the choice of phenomenology for this study's methodology.

Husserl (1931) is widely accepted as the founder of phenomenology in modern research through his work to find an alternative to objective scientific measurement for research on human interaction. He was concerned with how to measure or make sense of the world without the constraints of quantitative research protocols. Quantitative research is concerned with cause and effect, as is qualitative research at times, but qualitative research using phenomenological methods can examine and gain insight into studied phenomena.

Husserl (1931) focused qualitatively on the need to reflect on and interpret experiences as described by individuals in their own words. In explaining phenomenology, Husserl described a constant interaction of a mind with the world around it. To learn about a person's interactive experiences with the world and what those interactions mean to an individual, a researcher must go "back to the things themselves" (Moustakas, 1994, p. 26), meaning a researcher goes to an individual and learns from them directly about their lived experiences. According to Husserl, it is through study and reflection on participants' personal experiences, that a researcher can identify themes within data. This process leads a researcher to construct a new understanding of experiences and make explicit the meaning that once was implicit to a participant.

Phenomenological methodology allowed me to use Husserl's (1931) strategy of going back to things themselves, as I attempted to understand and construct new meaning from descriptions of participants' personal experiences in engineering. Phenomenology was suitable for this study because it fit well with my desire to have women's voices heard, and as Balls (2009) suggested, phenomenology was useful when exploring experiences that may not have seemed important at the time but later became apparent that the experiences were significant due to the depth and richness inherent in an event or interaction. Providing the opportunity for women to reflect on formative experiences and share their personal experiences yielded data that was thicker and richer than any of those found using quantitative methods.

Methods

This study explored women's experiences using phenomenological methods as guided primarily by Giorgi (1997, 2012) and data analysis strategies adapted from Moustakas (1994). The goal was to identify experiences and what they meant to individual participants and from that construct new meaning of the essence of experiences across participants. Giorgi's (1997) phenomenological research approach guided this study. It included use of in-depth, semi-structured interviews (Lichtman, 2010); repeatedly listening to audio tapes and reading participants transcripts; reflection on participants' descriptions of experiences as engineering majors; systematic analysis of data; and description of the essence of participants' experiences. The process for analyzing data was adapted from Moustakas' (1994) framework for data analysis that facilitated generation of a new meaning of women engineering majors' persistence experiences. The steps followed in this study, described in detail in an upcoming section are typical to phenomenological research.

Research Design

This study examined lived experiences of women engineering majors through a constructivist lens. According to Guba and Lincoln (1994), constructivists think people make meaning of their experiences and may make revisions as they interact with others socially. Schwandt (1998) agreed that constructivists believe that knowledge is created in social interactions, not discovered by an individual; and one's perspective provides the frame or lens through which experiences are examined and understood. Creswell (1998) and Mason (2002) explained that in constructivism, it is essential to learn about the meaning an individual assigns to an experience to understand a phenomena under study.

Creswell (2014) described the process of qualitative research as emergent, meaning that a researcher starts with a foundational research question then follows their data, making adaptations to a study's design and being open to searching for patterns and themes in the data analysis process. Patton (2002) explained the flexibility of an emergent design as an "openness to adapting inquiry as understanding deepens and/or situations change" (p. 40). This strategy allows a researcher the freedom to follow participants' leads during data collection and facilitates a researcher's interpretation and description of the essence of participants' experiences.

This phenomenological study had an emergent design that allowed participants and the researcher freedom to explore participants' lived experiences in depth. During data collection, women participated in interviews and identified experiences they believed contributed to their persistence in an engineering major. Together, we (researcher and participants) sought to understand meanings participants assigned to their experiences as participants described them from their perspectives in their own words. As the researcher driving this study, I analyzed all participant data, identified patterns, and developed new understandings of participant experiences and the contribution of those experiences to persistence.

Site Selection

This study was conducted at Middle America University (pseudonym) a four-year, public research institution in the Upper Midwest of the United States. The selected university had approximately 15,000 students, including about 11,000 undergraduate students for 2016-2017, with 52 percent men and 48 percent women. There were around 1850 engineering students with about 85 percent men and 14 percent women. The engineering programs represented in this study were not identified to protect confidentiality. Changes made for confidentiality reasons included descriptions of projects and interactions with classmates in the findings discussions found in Chapter IV.

Participant Criteria

Study participants were part of a purposive sample (Miles & Huberman, 1994) as the women were invited to participate because they were "Society of Women Engineers" members who had stated an intention to persist to graduation with an engineering major. Additionally, participants were women undergraduate students who were enrolled full-time in traditional campus-based classes, had earned a minimum of 45 credits, had declared an engineering major, and were members of the Society of Women Engineers student organization. Participants all had begun taking engineering courses in their current majors and expressed an intent to persist to graduation with a degree in that major. Undergraduate women with fewer than 45 credits did not meet study parameters, as many beginning engineering students do not continue (Knight, Louie, & Glogiewicz, 2011), and this study focused on why women stay in an engineering major. Part-time and distance students were also excluded, as their motivation or curricular experiences may have substantially differed from selected participants. Other STEM fields were not studied because the most significant gender imbalance is in engineering (National Science Board, 2016).

Participants

Nine women participants of about 60 possible participants met the study criteria during the spring 2017 semester. These women represented about 17 percent of approximately 400 upper-level students who had declared an engineering major at the study site and had enrolled full-time in traditional campus-based engineering classes.

Participant Recruitment

Participant recruitment began after I received approval from the study site's Institutional Review Board (IRB) to conduct the study. The Society of Women Engineers (SWE) student organization president at the site forwarded an invitation to participate (Appendix A) to members via email. SWE is an organization devoted to supporting women engineers and young female students who are considering or have chosen an engineering major. Another method of recruitment, snowball sampling (Miles & Huberman, 1994), engages individuals who are familiar with a study's goals and available participants assist in recruitment by referring others who meet the study's parameters. In this case, snowball sampling provided additional participants as SWE members referred others to the study. Ten women responded, but one dropped out before beginning the study. All nine remaining participants signed IRB approved consent forms, completed a demographics form, and finished both parts of the study, including an initial interview and a second interview used to clarify data and gather any additional information offered by participants.

Participation Incentives

I was responsible for all costs associated with this study. I gave participants notice of an incentive strategy during the recruitment phase. All participants who completed an initial interview were entered into drawings for one of four $25 gift cards, and all participants who completed a second interview were entered into another drawing for one of two gift cards (one $25 gift card or one $50 gift card). Winners were notified and received their preferred type of gift card to a local retail store via email.

Demographic Information

Nine participants were invited to voluntarily complete a demographics form after their first interview. I informed participants that data would be de-identified. In other words, data could not be traced back to a unique participant. Participants chose pseudonyms to be identified by that were used in the findings, as shown in Table 1. One person wanted a name that was the real name of another participant. Instead of asking her to choose a new pseudonym and risk identifying the other participant, I assigned her a different pseudonym after the completion of the interviews.

Table 1. Participant Demographic Data.

Pseudonym	# Credits	GPA	Engineer Family Member	Advance Placement Classes / STEM	# Student Organizations (includes SWE)
Angela	55	2.75	No	No/No	2
Jamie	76	3.8	No	Yes/Yes	2+
Rebecca	60	3.0	Yes	Yes/No	2+
Ashley	110	3.97	No	No/No	2+
Michelle	140	3.7	Yes	Yes/No	2+
Quinn	78	3.9	No	Yes/Yes	2
Julie	60	-	Yes	Yes/Yes	2+
Marge	120	3.65	Yes	Yes/Yes	2+
Rose	100	3.3	Yes	Yes/No	2+

Credit hours completed ranged from 55-140 with an average number credit hour completed of 88.78. Grade point average ranged between 2.75 to 3.97 with an average GPA of 3.51 for eight of the nine participants. One participant did not report a GPA. Five participants had one or more close family members who were engineers. Family members included parents, siblings, and extended family members such as grandparents, aunts, and uncles. Seven women took advanced placement classes in high school, and of those students, four took STEM-related advance placement classes. All participants were SWE members and were involved in at least one other student organization. The exact number of student organizations was not identified to protect confidentiality.

Table 2. Site Participant Ethnicity.

Ethnicity	# Women at Site	# All Women Engineering Majors	# Women Engineering Major, Full-time, Traditional Class
Am. Indian	121	3	1
Asian	97	6	2
Black	113	13	3
Hawaiian	5	1	0
Hispanic	187	13	1
Non-Resident Alien*	322	12	1
Not Specified	147	5	2
Two or more races	189	12	4
White	5450	197	80
Summary	6631	262	94

Note: Data retrieved from the study site's institutional research office.
* Non-Resident Alien is included as defined by the Integrated Postsecondary Education Data System (IPEDS). A non-resident alien is "a person who is not a citizen or national of the United States and who is in this country on a visa or temporary basis and does not have the right to remain indefinitely. Note: Nonresident aliens are to be reported separately in the places provided, rather than in any of the racial/ethnic categories described above" (U.S. Department of Education, 2017, para. 9).

Race and ethnicity data were not included as eight of the nine participants were White and it could have led to participant identification as shown in Table 2. Specifically, 82 percent of the women at the site were White, 75 percent of all women engineering majors at the site were White, and 85 percent of full-time, women engineering majors attending via traditional class format were White.

Data Collection

I collected data using a two-interview process. I gathered demographic information via an optional demographics form that participants completed after their first interview. Finally, the study site's institutional research office provided demographic information related to engineering programs at the school participating in this study.

Data Confidentiality

Interviews were audio recorded for transcription accuracy and stored password protected on a flash drive. Transcriptions were password protected on a flash drive, and on my (the principal investigator's) password protected computer. A professional transcription service used uploaded de-identified audio files to transcribe interviews. Once interviews were transcribed, I reviewed each transcript and made corrections and added punctuation as needed. I printed one copy of each transcript to use for review and analysis. The flash drive containing audio files and transcripts, consent forms signed by participants, interview and study journals, and printed verbatim transcriptions were stored in a locked cabinet in my home office. All study materials have been scheduled to be destroyed 3 years after the study's completion. Only I (the principal investigator) will have access to original recordings of interviews unless my dissertation chair requires a review. Assigned pseudonyms have protected participants' identities and were used with all study materials and quotes in the written manuscript.

Interview Location

Interviews took place on campus or at another private location chosen by a participant. Following Balls (2009) suggestion, I provided a list of location choices that were private, quiet, and familiar to participants to facilitate a relaxed atmosphere. Sites included meeting rooms at the campus library, a coffee shop meeting room, and classrooms in a building near, but not associated with, STEM classes of departments. Participants were offered a chance to choose an alternate site, but no one chose one**.**

Interview Process

Marshall and Rossman (2006) suggested using in-depth interviews for studies focusing on learning about and understanding participants' lived experiences. Glesne (2011), Rubin and Rubin (1995), and Patton (2002) suggested working closely with participants to set a conversational tone. This method allows an interviewer an opportunity to listen without judgment, empathically, to actively engage with participants, and to encourage them to share as much information as possible about their experiences.

Englander (2012) explained there is no one way to conduct a phenomenological interview, but a semi-structured interview should gather descriptions of lived experiences from participants, and a researcher should ask follow-up questions to go deeper into the meaning of participants' experiences. To learn as much as possible, it was essential to have each participant explain in her own words what meaning she had made from her experiences as a woman engineering major.

As the researcher, I served as an instrument in the research process. This process included conducting interviews for data collection, analyzing data using an inductive search for themes and patterns, and finally using the deductive method of creating descriptions of the essences of participants' experiences (Glesne, 2011; Kvale, 1996; Lichtman, 2010; Marshall & Rossman, 2006). Before beginning interviews, I also practiced epoche (Husserl, 1931; Moustakas, 1994), a process that involves acknowledging biases when recognized that might compromise a study's trustworthiness. This process included writing a reflexivity statement after reflecting on biases and stereotypes prevalent in American culture. Such biases might include a belief that women who are interested in engineering are more masculine and less attractive, or that innate gendered differences prevent women from doing as well in math and science, and the women who do enter engineering fields must be "nerds" and socially awkward. I set aside such biases during the interview process so I could focus on each participant and their description of their lived experiences.

Interview Protocol

Semi-structured interviews were the primary source of data, and I used an interview protocol to structure each of two meetings with participants. Glesne (2011), Jacob and Furgerson, (2012), Mason (2002), Patton (2002), and Rubin and Rubin (2005) provided guidance and structure for the interview protocol. The purpose of the protocol was to ensure consistency, standardization of process to surface data that addressed research questions (Patton, 2002). The protocol did not restrict conversation; instead, it included a list of opened-ended questions meant to encourage conversation and freedom in responses. I conducted a pilot study to practice interviewing and to test potential interview questions (Appendix B). I then revised interview questions from the pilot study to develop new interview questions for this study's interview protocol and to align the interview protocol with the literature review. The interview protocol for the first round of interviews in this study is included in Appendix C. Some sample interview questions follow:

1. When you told your family and friends you were going to go into

engineering, what did they say, or how did they react? How did you feel and what did you think about it?

2. What were some of the pros and cons you considered as you chose an engineering major?
    a. Have you encountered these in your program? (If so, what did you do? How did you feel?)
3. a. Please describe an experience when you felt encouraged about going into engineering.
    b. Please describe an experience when you felt discouraged about going into engineering.
4. Please think your life as an engineering major and tell me about your most memorable experiences in your program.

Semi-Structured Interviews

I engaged with participants using semi-structured interviews to explore their experiences of what it meant to be a woman in engineering. Interviews took place around final exam time during and just after the spring 2017 semester following approval of my dissertation proposal by my dissertation committee members and IRB. The study involved two 60-90-minute audiotaped interviews. Interviews began and ended with scripted statements. After explaining consent and having participants sign a consent form, I proceeded with interview questions, going slowly to build rapport and to help each participant be as comfortable as possible with the process (Patton, 2002). The second interview followed a similar format as outlined in the protocol for the second interview (Appendix D).

During the first meeting with participants, I conducted a semi-structured interview using questions on the study protocol for an initial interview (Appendix C). Before the second interview, I used an online transcription service to transcribe audio tapes from the first round of interviews. I up-loaded de-identified audio interviews to a password-protected website. Once transcribed, I reviewed verbatim transcripts while listening to corresponding audio tapes to ensure transcripts were as accurate as possible, as suggested by Patton (2002) and Rubin and Rubin (2005). I made notes for follow up questions.

During the second round of interviews, also audio recorded, each participant read their interview transcript from their first interview, and then we reviewed it together for accuracy. We discussed any issues or thoughts that arose as we went through the transcript. I asked follow-up questions informally based on first interview data and the second interview's discussion. Participants had an opportunity to clarify data and correct any misconceptions I had so I fully understood their intended message. This "respondent validation" (Maxwell, 2013, p. 126) process is widely known as member-checking (Lincoln & Guba, 1985) and is a way to support trustworthiness in a study. Participants did not review second interview transcripts as I took notes while we talked to ensure accuracy and to avoid having participants give up additional study time. I used transcripts from both interviews in the data analysis process. I used all interview data, including any participant feedback collected during the study, in the data analysis process. All nine participants completed both interviews.

Data Analysis

Data analysis for this phenomenological study involved thematic analysis. The process of analysis began with mindfully attending to participants' words during in-depth interviews and reviewing tapes and transcripts, and continued with repeatedly reviewing data while reflecting on participants' descriptions of their experiences as engineering majors. Initial codes were identified while making corrections to electronic transcriptions and reading and re-reading transcripts. I coded interviews using Atlas.ti (ATLAS.ti 8 Windows) qualitative data analysis software. While streamlining the analysis process, Atlas.ti allowed me to manage the massive amount of data in an efficient manner. I coded everything and then reduced the data repeatedly to find and further analyze the most significant data for this study. The final stage included thematically analyzing the data in search of patterns and themes that led to construction of new descriptions of the essence of participants' experiences. Figure 3 shows the process of data analysis in this study.

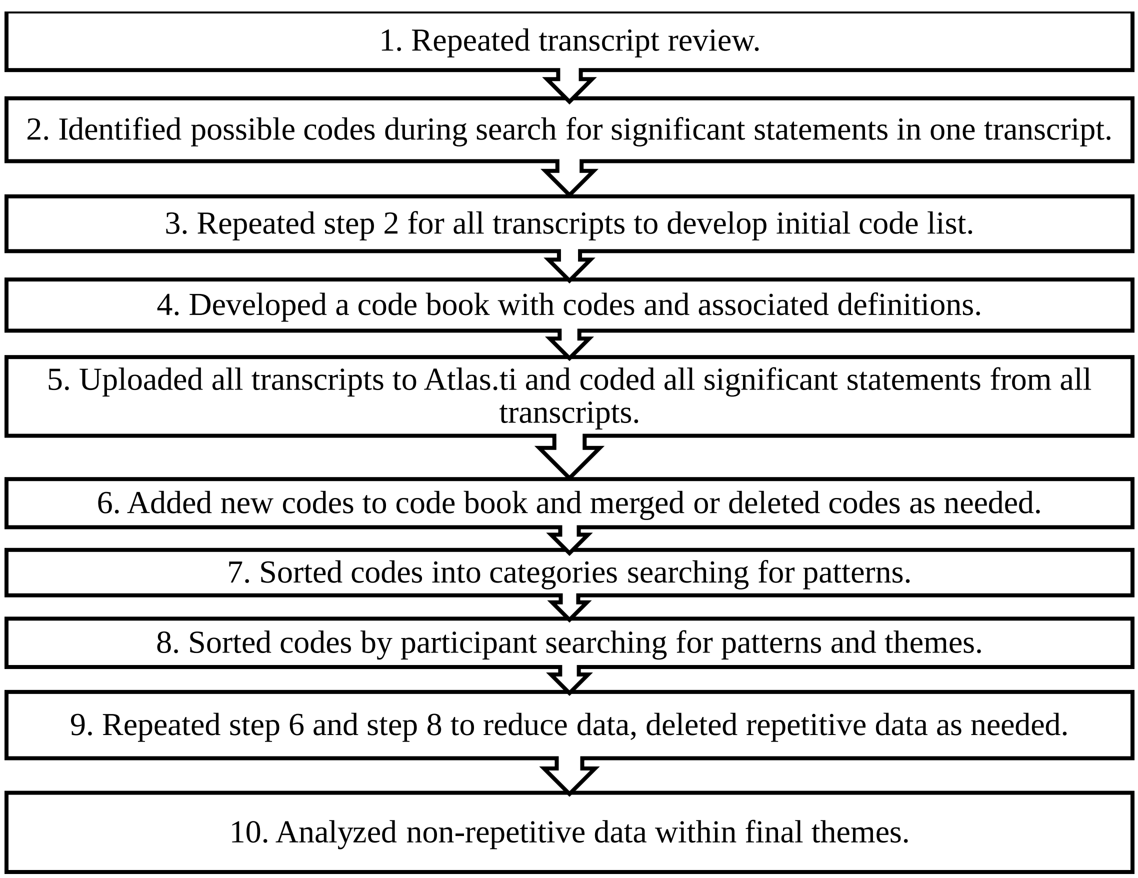

Figure 3. A Brief Description of the Data Analysis Process Followed in This Study.

Audit Trail Summary

Qualitative research has few established rules that are rigidly followed, but trustworthiness is concept that supports the validity of social research. While others have provided a list of steps to show trustworthiness in the research process, Colaizzi (1978) emphasized flexibility and that one should modify steps as elements of a study emerge. The steps I took to document my research included use of a journal to document my work and creation of an audit trail I later used to summarize the data analysis process I used as adapted from Moustakas (1994) and shown in Figure 4. The process of reducing data to identify themes is known as phenomenological reduction and is described in this section.

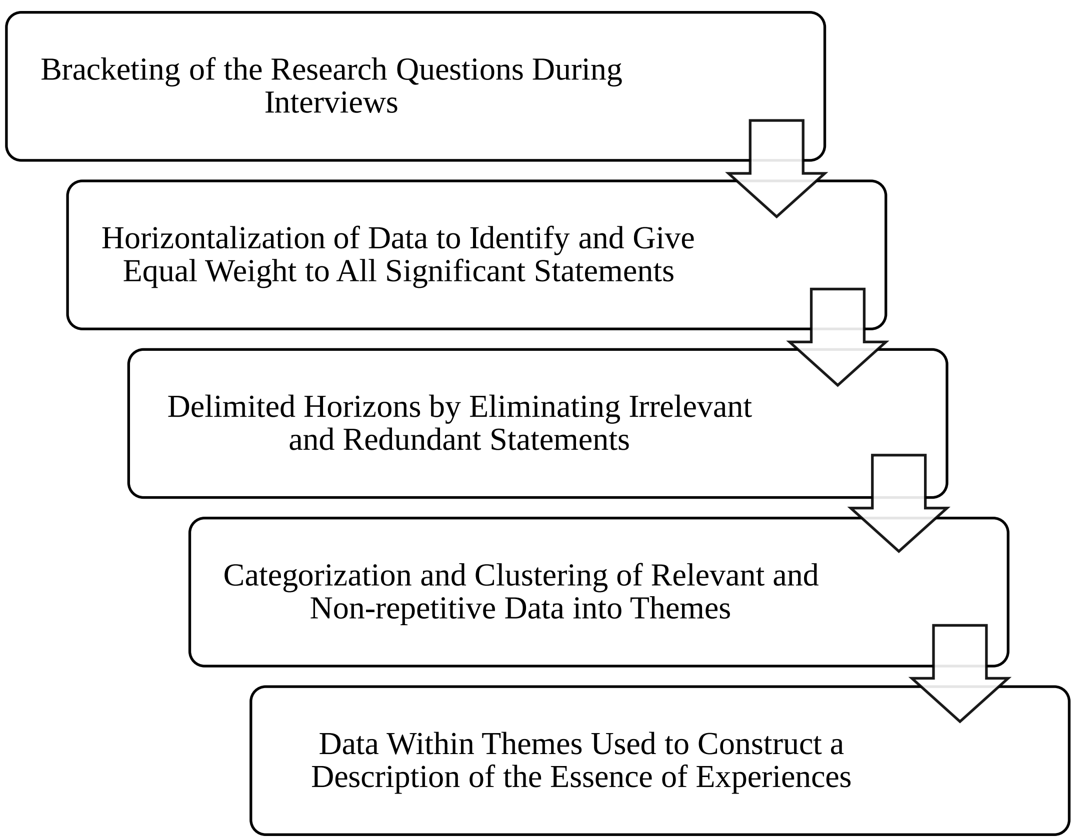

Figure 4. Phenomenological Reduction Process. Adapted from *Phenomenological Research Methods* by C. Moustakas, 1994, p. 180. Copyright 1994 by Sage Publications, Inc.

Epoche – Avoiding Bias

I wrote a reflexivity statement to identify and explore personal biases before meeting with participants. A reflexivity statement identifies origins of my interest in research and gender issues, including gender equity experiences, and my work as a long-time clinical mental health counselor in Student Affairs. Acknowledging bias and setting aside research questions allowed me to sit with participants and focus on their descriptions of their lived experiences.

Bracketing

During interviews, I set aside the research questions and concentrated on participants' words as they responded to open-ended interview questions. Through conversation, I encouraged them to go more in-depth with their answers to learn as much as possible about their lived experiences and personal characteristics, and how those experiences and characteristics related to persistence.

Horizontalization

Horizontalization is the process of identifying all possible significant statements and giving them equal weight – not ranking statements so some statements become more important than other statements. Once all interviews were completed and transcribed, each transcript was read twice, and notes were made by hand identifying preliminary codes. Repeated codes across transcripts were noted to get a sense of what participants as a group deemed worthy of inclusion. An initial code list of 95 codes was developed from the notes. Examples of these initial codes include: Ambition, Ask for Help, Ask Questions, Believe in Self, Challenging - Like the Challenge, Determination, Don't Be Afraid, and Engineer in Family. The data was then coded with Atlas.ti (ATLAS.ti 8

Windows) using the initial list of 95 codes with additional codes added as needed. The coding process yielded 1431 significant statements. At this point in the process, all statements were considered equally important.

Delimited Horizons

The term *delimited horizons* refers to a reduction of all data identified and placed, figuratively, in horizontal layers of equal weight, as described next. As coding of significant statements continued, codes were revised, new codes added, others similar in meaning were merged, and codes were further defined for clarity and consistency in coding. As additional codes emerged through the coding process, I added each new code and its definition to the Code Book and all previously coded transcripts. Some of the new codes were self-explanatory; others were not as clear and were given a description to clarify the intended meaning as used in this study. This process resulted in 136 codes and they are shown in Table 3.

Table 3. Sample Code List With Definitions.

Codes	Definitions
Advice	From lessons learned; own experiences
Ambition	Desire to succeed in career/move up in ranks to level you want
Ask for Support	Get needs met
Ask Questions	Ask for help when needed
Assertiveness	Stand up for oneself
Awkwardness Lessens Over Time	Feel more welcome, accepted

It soon became evident that the 1431 significant statements contained irrelevant and redundant comments, so a review of the entire process was completed. Analysis of data included rereading transcripts, reflection on codes and significant statements, and a return to the research questions. Data analysis led to the realization that many codes, while interesting, were not particularly relevant to this study. I first removed very similar/overlapping codes and then removed 22 additional codes that were duplicated elsewhere or were irrelevant. This reduction process left 114 codes. I repeated the process combining similar codes and removing unrelated codes. This last reduction process resulted in the final 32 merged codes with 1014 associated significant statements (see Code Book in Appendix E.) Table 4 shows a sample of the data when I had 136 codes with associated categories sorted by participant. Table 5 shows a sample of the final 32 merged codes and categories sorted by participant (see complete table in Appendix F).

Table 4. Sample Code Frequencies With Categories Sorted by Participant.

Code (136 Codes)	Categories	Participants								
		Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Ambition	Personal Supportive Factors Why I Stay		X	X	X					
Ask for Support	Advice Personal Supportive Factors		X					X	X	X
Ask Questions	Advice Personal Supportive Factors	X		X	X	X			X	X

Categories and Themes

In reviewing significant statements and codes, initial categories emerged and codes were assigned to those categories to start identifying patterns and themes in the categories. Grouping of codes into categories and themes included several methods so I could look at the data from different angles. These included rereading transcripts, repeating review of significant statements, mapping codes into thematic diagrams, and using word clouds. I completed these procedures both by hand and with the Atlas.ti (ATLAS.ti 8 Windows) software program. The first attempt to group codes into categories yielded eleven categories including: Career, Engineers, Faculty, Gender, Group, Personal, Supportive Factors, SWE, Discouragers, Advice, and Why I Stay. I then assigned codes to these categories by hand. I went through many revisions before identifying any themes.

Table 5. Sample Final List of Merged Code Frequencies With Categories by Participant.

Code (32 Merged Codes)	Categories	Participants								
		Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Ask for Support / Ask Questions / Office Hours	Supportive Factors Faculty	X	X	X	X	X		X	X	X
Believe in Self / Worth Getting to Know	Personal	X	X		X	X	X		X	X
Career/Do What You Love	Career Personal Support Factors Why I Stay	X	X	X	X	X	X	X	X	

Construction of Descriptions of the Essence of Experiences

Themes emerged from my data analysis that began to shed light on women's persistence in engineering. There were six themes (Table 6) found using consensus data, meaning that at least seven of the nine participants spoke about an issue.

Table 6. Emergent Themes With Associated Codes.

Theme	Code
Theme I: As an engineer, I will build a better life for others and myself.	• Engineers Do Big Things (And I Want to Be a Part of That) • Engineers Make a Better Life • Enjoy Learning About Engineering*
Theme II: I have what it takes to succeed in engineering, even though others may not think so.	• Believe in Self* • Challenging - Like the Challenge • Determination* • Put Things into Perspective* • Self-Talk* • Sense of Accomplishment • Strong Independent Woman (I Can Do It Myself) • Validation
Theme III: Gender influences persistence.	• Educate Young Girls to Increase the Number of Women in Engineering • Faculty Sexism • Gender Imbalance* • Gender Stereotypes*
Theme IV: Support factors contribute to student success.	• Ask for Support • Communication (General Soft Skill) • Encouraged • Faculty Support* • Family Support* • Make Connections for Support* • Study Groups • SWE Student Organization • Tutoring • Work/Life/Family Balance

Table 6. cont.

Theme	Code
Theme V: Use your talents to do what you love in your engineering career.	• Career/Do What You Love* • Choice of Major Decision • Money/Income
Theme VI: Discouragers must be overcome in an engineering major.	• Challenging (Frustrating) • Discouraged* • Engineering Major Is Hard Work* • Isolation

Note: (*) denotes code includes statements from all nine participants.

Discussion in Chapter IV provides an in-depth discussion of the themes with direct and paraphrased interview quotes for support. Individual quotes were labeled with the pseudonym assigned to each participant. After analysis, some words, phrases, and names were changed for reporting purposes in this chapter to protect the speaker, but the changes did not alter the meaning of the intended message.

Trustworthiness

To ensure the trustworthiness of this study, I was careful throughout the processes of study design, data collection, and data analysis, for it is "through analysis of carefully collected data, the qualitative researcher can develop compelling arguments about how things work in particular contexts" and generate "very well-founded cross-contextual generalities" (Mason, 2002, p. 1). Lincoln and Guba (1985) established a means to determine the quality or trustworthiness of a qualitative study. They said researchers should demonstrate trustworthiness (rigor) through credibility, transferability, dependability, and confirmability. Additionally, they noted that qualitative researchers should ensure dependability by developing and following protocols systematically, and authenticity through reflexivity, a process of reflection by a researcher to acknowledge and address biases directly and openly. In this study, I addressed the following:

. . . *credibility* by using in-depth interviews; by taking reflexive notes during and after an interview process; by conducting member-checking, a process that allows participants to confirm data are accurate and conveys intended messages; by keeping an audit trail journal to track the whole data collection process and how decisions were made regarding data collection and analysis; and by being open with participants regarding the purpose of the study and using an IRB approved informed consent form to ensure participants were aware of study parameters and participation details;

. . . *transferability* by using purposive sampling – participants were selected from an SWE student group believed to be an information-rich group (Patton, 2002), by going through a reflexivity exercise prior to and during the study, and by including thick descriptions (detailed descriptions of the essence of participants' experiences that included direct relevant quotes from participants) in the findings;

. . . *dependability* by using an audit trail journal, reflexivity statement, and journaling as described above; and

. . . *confirmability* by using an audit trail journal, reflexivity statement, journaling as described above, and the use of direct quotes from raw data (interview transcripts).

Regarding transferability, one issue I considered during data collection and analysis was identified in a 2016 literature review by the Society for Women Engineers (Meiskins et al., 2017). Meiskins et al. cautioned readers to avoid grouping all women engineers into a single group, as they do not all hold the same beliefs and aspirations. This issue was important because themes emerged from consensus data (at least 7 of 9 participants spoke on several points) in this study, but that does not mean that data were generalizable to all women engineering students. For example, some participants in this study wanted to become CEOs while others prioritized home and family over career advancement, and some wanted high salaries while others indicated they would be satisfied with a level of income that would support them in their desired lifestyle. The task then for this qualitative study, was to demonstrate a satisfactory level of transferability by thoroughly describing of the phenomenon and by providing sufficient data so a reader can understand the context of the study well enough to explore the possibility of comparison to other groups (Shenton, 2004). To further support the trustworthiness of this study, I have included outliers not found in the consensus data for purposes of negative case analysis (Patton, 1999) in Chapter V.

Throughout interviews, transcript reviews, coding, and analysis processes, I was careful to pay attention to words and phrases offered to identify themes and patterns in participants' responses, as well as to identify what they were not saying. Additionally, the flexible nature of a phenomenological design allowed me to collaborate with participants in conversations as their stories unfolded (Rubin & Rubin, 2005). This method supported trustworthiness and helped with my synthesis and interpretation of the data.

Researcher Reflexivity Statement

Descriptive phenomenological researchers use reflexivity to ensure they understand their values, life experiences, and biases so they do not interfere with their research (Dowling, 2006; Husserl, 1970; Patton, 2002). Writing about ethical research practices, Sultana (2007) described the importance of "reflexivity, positionality and power relations" (p. 383) in research. This reflexivity statement includes a brief review of my life history as it relates to my choice to study women in engineering and a discussion of my assumptions and biases related to this study.

As a doctoral student nearing the end of my working years, I had no need to find a topic that would build a resume for a future career. My stage in life gave me the freedom to choose a dissertation topic on something I care about with the hope that the findings might contribute to our understanding of the enduring gender imbalance in engineering. I chose to study women engineering majors because they face the most significant gender imbalance of all STEM fields. I have never worked in engineering. I was, however, a child of the 1960s who grew up with the promise of equal rights for women.

My interest in research and gender issues developed during college. I earned a Bachelor of Science in Psychology in 1982 and a Master of Arts in Counseling in 1984. My final Master's project was a quantitative study on gender and sex-role stereotyping. My work history includes about 20 years as a clinical mental health counselor, and more recently, work in Student Affairs. In my current position, one of my primary responsibilities is conducting sexual assault investigations and preparing detailed reports, often quoting witnesses. The investigation interviews require good listening skills and an ability to ask open-ended and targeted follow up questions about uncomfortable topics. I used these skills during my interviews with participants in my study.

Thoughts about equity continued throughout my life. During my senior year at college, I gave birth to a son, and just after my Master's graduation, I gave birth to a daughter. I temporarily discontinued my formal education to take care of them. I was determined to raise my children in a unisex environment. I bought them clothing and furnishing in primary colors, and toys that were not classified by gender. However, family and friends insisted on buying blue things, trucks, and guns for my son, and pink things and dolls for my daughter. It was no surprise when my son became a mechanical engineer, and my daughter became a doctor of physical therapy.

Once my children became adults with children of their own, I decided to go back to college to finish my education. At fifty-seven, I am completing this doctoral program, not to start a new career, but because I have always had a love of learning, and it was a promise I made to myself when I quit school to raise my family. When it came time to decide what to study, I reflected on my interest in college students and my early graduate work on gender equity issues. That got me to thinking about my son who became a mechanical engineer and my daughter who, despite extremely high math and science scores did not go into engineering, as her advisor recommended, chose to get a doctorate in physical therapy. This led me to researching gender equity and women in engineering, where I found that while there has been a lot of research on the issue of women's underrepresentation in engineering, the problem persists.

While reading for my literature review, it became evident that most research on gender equity in engineering has been quantitative, and of the existing qualitative studies on women in engineering, most researchers studied graduate students or those who already graduated with an engineering degree. The studies also mainly focused on factors related to attrition. One study caught my attention. Bilimoria, Lord, and Marinelli (2014) encouraged research on women who persist in engineering rather than focus on problems and why they leave. With my counseling history of working from a strengths-based perspective, I began to wonder about what women engineering majors would say if they were asked directly about why they chose to stay in a male-dominated major. It was then I realized this thought might be related to my bias that developed when I was told as a child to sit down and stay quiet until someone spoke to me. Or, when I found that time and again I was paid less than men who had less education and experience.

These experiences with gender inequity presented a challenge I knew I would need to manage at all phases of this study. However, I am confident that the skills I honed as a counselor and as an investigator transferred and supported my efforts as a qualitative researcher. These skills include not only setting aside my biases and putting the needs, thoughts, feelings, and beliefs of a client/student/participant first, but also establishing rapport quickly, asking open-ended questions to facilitate discussion, and knowing when to seek supervision or guidance. A counselor can never fully set aside personal issues or biases but must acknowledge them and address them if they arise. These skills served me well as they were similar to skills needed to conduct a phenomenological study.

During this study, I continued to be mindful of my thoughts and feelings as I interacted with participants and data emerging from the study. I documented reactions and possible conflicts during data collection and throughout the study process. This was imperative because I wanted to be present and focus on the women as they told me, in their own words, about their understandings of their experiences as engineering majors.

Limitations

A limitation that contributed to the findings of this study was the fact that there are so few women in engineering in general, and in engineering majors at the study site. At the time of this research, most students who attended Middle America University (pseudonym), the site chosen for this study, came from two states in the upper Midwest region of the U. S. (69 percent) and were White (87 percent). Additionally, 75 percent of women engineering majors at the site were White. These numbers contributed to the fact that eight of the nine participants were White women. This lack of diversity is a limitation as all women's voices need to be heard not just those from a single ethnic group. However, building on Loraine Gelsthorpe's (1992) observations of methodological and epistemological issues in feminist research, Millen (1997) cautioned about the complexity of power dynamics in women's experiences, "'women are never just women' – we have a class, a sexuality, an ethnicity, and all these affect our situations and views" (para. 7.5). Thus, focusing on all women, including all races, ethnicities, abilities, etc. in a single phenomenological study creates a methodological and epistemological risk of universalization of diverse participants' experiences of a given phenomenon (i.e. persistence in STEM) and rejection of a complexity of intersecting power dynamics in the essential meaning structures of participants' presumably shared experiences of a given phenomenon. To embrace inclusion of diverse voices in research and practice, future research should include a series of separate phenomenological studies with, for example, African American women in STEM, Hispanic women in STEM, first-generation women in STEM, and other groups of varying classes, ethnicities, and abilities.

Delimitations

The focus of the study was on women engineering majors' persistence and did not include women who persisted in other STEM majors. Students with fewer than 45 credit hours were not included due to a desire to learn about experiences that supported persistence. Participants were delimited to only SWE members. Distance and online learners were excluded because they likely had different experiences with engineering faculty and departments in higher education.

This study on women engineering majors' experiences did not include an exploration of privilege, inclusion, race, or class. The exclusion of these issues does not mean they are not important or are not worthy of study; however, they are beyond the scope of this study. The intention of this study was simply to capture participants' experiences from their perspective because a gap in the literature shows that voices of women engineering majors have not been heard.

Summary

This chapter explained the methodology used for this qualitative study. From a constructivist perspective, phenomenology served as the methodological framework for this study on women engineering majors' experiences. The phenomenological design gave women a mechanism through which they could describe their experiences and be heard and valued as members of the engineering community. Chapter IV includes an in-depth explanation of emergent themes and associated codes described in this chapter.

CHAPTER IV

FINDINGS

Women's historical underrepresentation in engineering continues today. This study's purpose was to learn about experiences of successful women engineering majors' and characteristics that support their persistence to graduation. The study included nine women who had stated an intention to graduate in one of four represented undergraduate engineering majors within a college that has six accredited engineering departments at Middle America University (pseudonym). Participants had completed at least one semester of campus-based engineering courses. All women participants were members of a student organization, *Society of Women Engineers*. I collected data through semi-structured interviews with women who verbalized an eagerness to participate because they were familiar with gender imbalances in engineering and wanted to support efforts of those working towards parity. The responses varied considerably as this method provided participants an opportunity to share experiences they found meaningful or believed might be beneficial in a study of women engineering majors.

Findings presented in this chapter are organized into four sections. The first section is on Research Question 1 and includes the six emergent themes with associated codes (with frequency of responses in parentheses) followed by a discussion of participants' experiences as engineering majors with supporting individual participant quotes. The second section presents findings on Research Question 2 and contains descriptions of 15 personal characteristics of participants using original quotes. The third section covers Research Question 3 and summarizes participant responses to the question of why they stay in an engineering major. The chapter ends with a summary of the findings.

Research Question 1

Research Question 1 asks: What lived experiences do women engineering majors believe contribute to their choice to persist to graduation? In researching this question, six themes emerged from the data.

Theme I

The first theme that emerged from the data dealt with ambition and desires of participants. They appeared to say, "As an engineer, I will build a better life for others and myself." Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Engineers Do Big Things (And I Want to Be a Part of That): (7 of 9 participants addressed this idea)

b. Engineers Make a Better Life: (7 of 9)

c. Enjoy Learning About Engineering: (9 of 9)

Most participants expressed a belief that engineering would lead to bigger things personally and professionally. They expressed a desire to use their talents, abilities, and degrees to create new products or processes to make life better for people and the world. All nine discussed their sense of enjoyment and satisfaction with learning new things and figuring things out on their own or in teams. Participants understood that while their coursework was challenging, and they sometimes struggled, engineers use math and science to solve problems to increase safety and quality of life for individuals and society. Women participants wanted to be a part of that industry so they too could make a significant contribution. Many women participants described this contribution as their way of saving the world. Quinn clarified that she “didn’t expect to save the whole world, but I want to help like people that need help, and maybe people don't even realize it now.” She added, “Saving the world is kind of a weird way to put it, but that's what I want to do.” Most women participants spoke of wanting to use their talents to make a difference in the world.

Continuing this line, Julie wanted to “do something big” and talked about growing up within a family that valued altruism: “My father always said that we should do well in school and so we could get a good job and make a difference and help.” Others focused on betterment of their own family. Angela valued her family and was willing to persist in a difficult major because she knew that it would help her make a good life for herself and others. She knew that finishing her degree would be difficult and would take her approximately 3 years, but Angela was confident that her actions would inspire her siblings to use their careers to benefit society. Angela described her confidence in her decision: “I know in the end it will be worth it . . . I know that my siblings will be encouraged to do something with their life outside of high school.” Quinn indicated she valued helping others. She recognized that she was an intelligent person and that her ability allowed her to do things others could not. Quinn described the importance of using her talents in service to others: “I feel like I can do something that a lot of other people can’t, so it’s best for me to go the direction that I can do the best that at, and I can give the most through.” These women all identified their values and abilities and wanted to use them to help others in their work as engineers.

Despite struggling with tough classes and homework at times, Rose’s social conscience was evident in her description of her underlying motivation to persist in engineering. Rose described being “driven towards the fact that someday I'll be able to create a device that will help people.” Rose also accepted that self-sacrifice was a necessary part of this goal. Her willingness to push through difficult times became apparent when she explained there had been times when she was feeling discouraged about a bad grade and wanted to quit but she would remind herself, “No, I'm too stubborn to quit. I'm sticking with this. I made a choice, and I'm going to stay with it because this is what obviously [I] am going to be able to help people with.” Similarly, to the other participants, Rose wanted to help others and was determined to succeed in her program so she would be able to do so in her future career.

In addition to helping others, participants described a genuine love of learning and were pleased with their majors because they were interested in the material. Michelle enjoyed her classes and enjoyed figuring out problems. She felt working to find solutions helped her learning process: “When I don't understand something, and I have to go in and either ask that instructor or read the book or look on the internet, then I'm learning something. I feel like I'm getting something out of it.” Jamie also found satisfaction in problem-solving and finding solutions when frustrated with difficult classes or coursework, but reported she enjoyed learning about math and science, so even though her classes were difficult: “It’s not like, unbearable . . . I genuinely love it.” She went on to add, “So I think that's what keeps me around . . . having to study all the time isn’t that fun, but it's interesting." The women recognized their struggles with difficult and massive quantities of coursework, but their love of learning and sense of satisfaction and accomplishment when they faced and mastered challenges made it worthwhile.

Participant experiences that emerged as Theme I varied but included a desire to help others, interest in the material, and a sense of enjoyment and satisfaction in an engineering major. To sum it up, I looked to Angela who wanted to make it known that, "It's a good group of people to be around; engineers are not a scary people. They want to make your life better. That's what they're there for."

Theme II

The second theme that emerged from the data dealt with confidence. Participants felt, "I have what it takes to succeed in engineering, even though others may not think so." Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Believe in Self: (9 of 9)
b. Challenging (Like the Challenge): (7 of 9)
c. Determination: (9 of 9)
d. Put Things Into Perspective: (9 of 9)
e. Self-Talk: (9 of 9)
f. Sense of Accomplishment: (7 of 9)
g. Strong Independent Woman (I Can Do It Myself): (8 of 9)
h. Validation: (7 of 9)

All participants talked about believing in their ability to succeed, but at times felt discouraged. However, the women showed a strong sense of resiliency as they reminded themselves of what was real, and what was important to them. Participants' use of self-reflection and their ability to reframe negative thoughts helped them feel better and more able to take on any challenges they were facing. Seven of nine participants enjoyed challenges and their sense of accomplishment when they mastered a problem. All the women talked about their desire to succeed and the fact that they did not see themselves as *quitters*. They also spoke about an on-going need to work hard to prove to themselves and others that they deserved to be in engineering. Regardless of the challenge, eight women voiced confidence in themselves and their abilities, and they knew they would be successful in future endeavors. Seven women described their success in engineering as validating they were smart enough, deserved or belonged in the field, and were capable of being successful in future careers as engineers. The women understood that engineering was a challenging field, and it would require hard work. At the same time, they were confident they could succeed. They learned how to deal with failure and celebrated large and small accomplishments.

Quinn set goals for herself and was determined to succeed: "I am very excited to reach this, like to accomplish this . . . I've seen my goal. I have pictured what I want from it, and I know if I put in the work, I can have it." Julie recognized that her strength in mathematics would support her goal of becoming an engineer: "I'm doing it because it's hard. And, um, it's challenging. I could have done something easier. But I knew I wanted to go into engineering because I'm really good at math." Ashley talked about her success despite knowing there would be tough times and situations. She was confident she could work hard and had the intelligence to solve problems as they arose: "I knew that even if I didn't get something, I'd be able to figure it out, and like, still make it through. And that's what really helped." Many participants could convey what they viewed as their strengths and how those strengths supported their desire to study engineering.

Also recognizing challenges, Michelle discussed the difficulties of being an engineering major and the rigor of engineering and noted it is not a good fit for everyone. She articulated that it is a lot of demanding work, "which isn't a bad thing," and she knew that when she declared engineering as her major. Nevertheless, "It's just a lot more work than I was expecting, which is fine." She stated, "Some people get intimidated, and so those are the people that don't have what it takes." Jamie also acknowledged how she managed the challenges of engineering at the time of her interviews, and how she planned to deal with them in the future. She articulated that she wanted to be a CEO, and you must be naturally intelligent and ambitious to go into engineering. She added that hard work and drive is necessary to keep motivated when you do not do as well as hoped, and "You have to be smart and . . . hard working to make it through especially with a high GPA." Equally important, Jamie added, "I just think I am very strong willed, so for someone to tell me that I'm going to fail, it makes me want to try harder and prove them wrong." She smiled and added that she would, "probably try to become their boss [if someone told her she was going to fail while on the job]." This quote from Jamie shows that, in addition to challenges she faces in her coursework, she also is aware of gender bias and is planning to manage it assertively should she encounter prejudice in her career.

While participants were confident they could be successful in engineering, they struggled with self-doubt at times. All nine participants described worry, stress, and times when they doubted their ability to succeed. There also was a realization that the self-imposed pressure was not necessary, and that everyone has weaknesses and will not excel in every area. Rebecca discussed how her feelings of insecurity were self-imposed: “The only thing that’s discouraging to me is, like, when I'm in my classes not able to perform as well as I would want to.” Ashley reflected on her uncertainty when she first started in an engineering major. She explained having a lot of self-doubt during her first semester because she thought since she was in the same class with others that they had had the same level of preparation. She soon learned that everyone had had different experiences and had varying degrees of abilities and skills.

However, not all self-doubt stemmed from introspection. Quinn described an all-female group in which one of the members took the lead and others went along with her as she dismissed or ignored Quinn’s ideas. Quinn looked sad as she related the following experience that occurred while working in a group of women. She thought she had a “good idea that would improve our project,” but they did not even consider it. This dismissiveness left her thinking, “Maybe I didn't perceive my own ideas the way I should be. Like I perceive them as better than they are.” Then, Quinn started wondering and doubting other ideas she had, and “It just, it made me doubt how well I can contribute to a group.” Julie also talked about doubts generated by outside sources as she discussed believing in herself when her family did not: “They [her parents] thought I wasn't smart enough . . . They didn't really, like, believe that I could do it. But, I believed I could do it, so it doesn’t matter what they say.” Julie's use of affirmative self-talk – “It doesn't matter what they say” – was an example of participants taking control to manage their responses to stressful situations. These affirmations contributed to Julie’s determination to succeed. To reach her goal of becoming an engineer, she took it upon herself to research careers and sought support outside her immediate family.

When dealing with self-doubt, all participants used positive self-talk to redirect responses to negative experiences so they could rise above those experiences and stay on track to graduation in their chosen major. For example, Quinn reminded herself, “I've made it this far, and not a lot of people make it that far . . . Hey, you're doing great. You should be proud of yourself.” Moreover, when Quinn failed a test she learned to tell herself, “I’ll just make it up on the next one. Yeah. I just work really hard at the next one and make it up and tell myself that one bad test isn’t going to kill the grades.” When Marge struggled with getting a bad grade and feelings of failure, she had to remind herself, “You don't need a 4.0.” Ashley explained how learning to look at situations more realistically helped her cope with trying times. She recalled in high school it was easy and common to get an “A.” Then in college, suddenly classes were challenging, and Ashley would beat herself up emotionally. Over time, Ashley learned to relax, and her thinking became more realistic and less filled with worry. Taking a different path, Jamie would celebrate successes to remind herself she could make it through tough courses. During trying times, she reminded herself of her accomplishments and the fact that, “If I can get an ‘A’ in that class, that almost killed me, like, I can do it.” The ability to recognize and reframe negative thoughts and experiences contributed to an increase in motivation and served as a reminder to participants of their choice and ability to persist.

While participants recognized they had what it takes to succeed, they also believed they would have to continue to fight to have their voices heard and respected, and to prove they belonged. While not defined directly, participants gave examples of a chilly climate, such as Rose’s description of younger peers having been more biased against women in engineering than older classmates or faculty were. She described her reaction to their biased behavior, “Your peers who are still, like, you know, just getting out of high school. They still have this mindset that, like, oh, you know, engineers are boys, like why are you here-type of a thing.” In response, she knew she would have to “stand up for myself and be like, ‘No, I'm here, I'm doing this, I'm still valued in this community. You don't get to have a say in how I run things.’” Rose went on to specify that a lack of respect had happened more when she had been enrolled in a different engineering major than her major at the time of her interview. She noted, “I found it certainly more of an issue when I was in Mechanical . . . They were more likely to not to talk to me, not offer me help . . . to be more like dismissive.” She also talked about not understanding why bias occurred with classmates in her previous major, and how relieved she was to find an atmosphere of mutual respect in her new engineering major.

Participants were determined to succeed and expressed a need to face and enjoy challenges in their learning experiences. Jamie recognized her need for challenge, and how it helped her in class: “I really do enjoy being challenged . . . I like that I am forced to pay attention . . . I think I’d be bored if they didn’t challenge me as much as they did.” Michelle also acknowledged academic challenges and felt having to figure things out made her a better student: “In class, I’m really interested in what the professors are talking about, and I am challenged, that’s what I really enjoy . . . It motivates me to learn more or to do better.” She went on to explain that she enjoyed having to talk to instructors for help, reading books, and searching the internet because it helped her comprehend the material better.

Marge appreciated intellectual challenges. She attributed this to her aversion to boredom and the sense of satisfaction she got when solving problems. “I like to have a challenge. I don't live life well without challenges . . . I'm very easily bored . . . When you have something difficult, and you can get past it, then you have this wonderful feeling of satisfaction." This sense of satisfaction helped her get through challenging classes and failures because she used it to motivate and remind herself that once she graduated, it would be worth all the pain and suffering.

Other participants addressed being challenged, but from a different perspective. These participants described experiences where they felt a sense of accomplishment after completing a new task or tackling a new experience successfully. Angela built a project with a team, and it worked. She asserted, "It works and that was a really good experience, and I don't think I'll ever forget." Quinn reported she would get a "huge confidence boost" and feel "invincible for a few minutes" when she completed difficult assignments successfully.

However, tackling challenges sometimes requires asking for help. For some participants, the issue of being independent and then needing to ask for help created conflict and seemed to be a potential barrier to persistence. However, participants soon learned that asking for help was necessary at times. It was a typical part of learning, and they began to view it as more positive than negative. Angela initially wrestled with the contradiction of having to ask for help while also needing to be self-sufficient and "the strong independent woman" who could figure things out and complete assignments on her own. Nevertheless, she understood asking for help is part of the learning process and would remind herself that it would foster future independence.

Ashley speculated that an aversion to asking for help could at least partially account for the loss of students from difficult majors, such as engineering where some students may not have the solid foundation of math and science that is important for success. Quinn also touched on the issue of students leaving engineering majors. She recognized that sometimes students go into engineering and do not know what to expect because engineering is so hard to define, and diverse engineering fields vary considerably. Quinn admitted she was one of those students: “I was 100 percent one of those people . . . It involved math and science and that was about it . . . I had no idea what else to expect other than the math.” She was fortunate she found a major interesting to her that provided her with a way to meet long-term goals. However, she indicated she understood how it could happen that people might leave. “A lot of people go in, and they have no idea what it’s going to be like . . . there’s a lot of people who do that, and then they realize that is not what they want.” Participants acknowledged that while they had succeeded in engineering, others had not. They had given the matter careful consideration and shared their thoughts as a way of contributing to the exploration of why the gender imbalance in engineering persists.

In summary, Theme II includes discussions of issues including belief in self and the ability to support oneself or to seek support when challenges are excessive. Despite those difficulties, participants rose to meet challenges and embraced them as part of their learning experience. Participants saw themselves as strong independent women and were determined to succeed, but sometimes experienced self-doubts. However, they could use self-talk to reframe adverse situations and put them into perspective. This coping skill and the ability to seek help when needed helped participants stay motivated and persist.

Theme III

The third theme that emerged from the data was, "Gender influences persistence." Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Educate Young Girls to Increase the Number of Women in Engineering: (8 of 9)

b. Faculty Sexism: (8 of 9)

c. Gender Imbalance: (9 of 9)

d. Gender Stereotypes: (9 of 9)

Participants enjoyed outreach activities and were interested in working together to help young girls understand and become involved in engineering, and they believed that their success would pave the way for other women in the future. A few reported sexist comments or behavior from faculty members; however, positive remarks about faculty support far outnumbered negatives. Sexist comments came from classmates more than faculty. Of note was participants' willingness to provide opinions and observations about faculty on faculty evaluations. Later, participants recognized the faculty members they complained about sometimes began to change in support of women students, so they knew their comments on faculty evaluations were read and their voices heard. Gender imbalance comments ranged from participants stating they knew there was an imbalance in engineering to surprise at how much of a difference there was when they entered the engineering programs. Sometimes, participants were the only women in class or one of only two or three women in a class. Other comments described how gender issues were more of a nuisance than an actual problem. Sexual stereotypes also were more of an issue with classmates than faculty. Most women just ignored them. However, women also spoke of having to work harder to earn respect than male classmates did. As discussed in Chapter II, gender stereotypes and chilly climates in classrooms have been the focus of many researchers who have sought to understand these issues in hopes of increasing equity in STEM classrooms. However, stereotypes are enduring and have a lasting impact on students. Jamie shared an elementary school experience that could have interfered with her engineering career.

> Our teacher said something about how women usually excel at literature and reading and, where men normally excel at math and science. I just assumed I'd never go into math and science. . . . I was excelling at math and science. So, to hear that, like, women excel in literature and then for me to be bad at literature, it made me feel even worse about it.

Jamie explained her early experience was discouraging, but she started to feel better about herself once she got to college and found other women who had similar interests and abilities.

Stereotypes and public perceptions have contributed to the gender imbalance in engineering, and before participants began their engineering classes, they knew there was bias and engineering was a male-dominated field. However, this knowledge did not prepare them for the extreme difference in some areas. Angela noted, "It's not normal for women to be engineers. . . . You know it's a one to five ratio even here at the university." She went on to explain that it was rare to see another female in class and gave the example of her Engineering 101 class that had "40 guys and two girls. You just stand out." She continued, clarifying: "It is just how it works. But it's not like they treat you any differently. They just, like, they recognize that you're a female and you're doing something that's not (pause) normal." When asked about her use of the word normal, Angela clarified that she was referring to the gender imbalance. She noted, "It was a pretty low number. So, we're trying to improve those numbers [by hosting outreach events with SWE]."

Jamie discussed her reaction when she realized the magnitude of the gender imbalance. She related she did not think about engineering as being male-dominated until she got into class and realized that instead of being about "a 40-60 thing . . . I got here, and it's like a 10-90 thing . . . And I was shocked. I didn't know that it was that, like, like the numbers were that bad." Contrarily, Marge's reaction was unique in that she came from a family where all members received the same treatment. She articulated that she was used to equitable treatment and did not connect that she was going into a major with so many men. She sighed as she said it was not much of an issue, but "I guess over time I sort of realized there's going to be a lot of guys . . . it became more of a kind of annoyance," meaning not having female peers who were going through the same experiences with her in the classroom.

However, Marge grinned as she said that being in a male-dominated field was not all bad, and she sometimes felt "kind of special when you are the only girl." She laughed and quickly added that she would love to have more women in engineering. Marge noted she did enjoy the feeling of being unique and knowing that it was because she made it when many women did not. She followed this statement with a discussion of feeling guilty about feeling good about persisting in engineering when others had left the major without graduating.

Addressing the issue of parity, Michelle talked about seeing an increase in the number of women entering engineering. “Yes, I've noticed that that has increased with the lower classes. Oh, there’s a lot more girls coming in.” However, Ashley recognized the gender imbalance in engineering as a long-term issue that would not go away quickly. She expounded, “I just don’t think we're ever going to get there . . . There would need to be so many changes in other majors too . . . giant shifts in every area of colleges, and I don't see that happening anytime soon.” Rebecca also discussed parity as she pointed to a shift in perception of engineering from being a male-dominated field to one that is more equitable. “You know, obviously engineering is great for anybody, but it’s even more like this battle we’re trying to win to get it equal you know. It's not stereotype; it's numbers.” Participants understood there were equity issues in engineering but were realistic as they described the problems that contribute to the continued imbalance, especially the fact that the margin is so significant in some areas that it may be quite some time – if ever - before there is a gender balance in engineering.

Quinn shared an experience that started her thinking about the significance of gender imbalance in engineering and what it meant for her.

> Our engineering building, the women’s bathroom . . . someone typed out, “women's restroom” and put it, like, stuck it on the door . . .. That caught me by surprise when I first got here. I was like, and they don’t even have a women’s restroom? . . . Well, it kind of felt, when I first noticed it, I was like holy, am I’m even in the right place right now? . . . I kind of felt unwelcomed. But, then again, it also felt good because it was like, oh not as many girls have been here, and I'm still doing it anyway.

Quinn described feeling as if men and women students were equal but described one male student who treated everyone as if they did not belong. He talked down to everyone, "He thinks he is the best," and the only one that deserves to be there. She added, "Every once in a while, it kind of feels like the women don't belong here type of vibe, but he also does it to men sometimes, too." Quinn went on to explain she felt she needed to prove herself to the men, but "I don't think there's anything that would, that's making me feel that way. It's just that I've been trained to think that men don't believe I should be there." She continued, "I have to prove that I'm smart enough and that I'm a smart enough woman, and yeah, that the intelligence is there to get through it, and that I belong there and not in any other major." She added, "I feel that way about both the students and the faculty. I don't think that they're directly making me feel that way. I think it's more that I have the idea that I turn to." Quinn went on to explain how she felt about inequity in engineering:

> I've been told again and again that it is a male dominated career. We've been told the statistics by our professors, like, this is how this is, the percent of women, percent of men. So, when you're with men, just in a very, very back of my mind, it's almost like they have more of a privilege to be there, whereas I am expected to work harder to be there. . . . I've just been taught to think that. I've never like no one's ever told me that directly, but . . . that's been kind of rooted into my thought system."

To illustrate the unspoken messages, Quinn gave the example of the handwritten bathroom sign and the fact that most of the faculty were men. Quinn continued to explain that these thoughts come from . . .

. . . the fact that a lot of the time, women are so highly encouraged to do things like this. To go out of their way to, like, go into *men's careers*, and you know, do what they want to do and no matter what. I think it's almost been like counterproductive on my thought process. Just the idea that they have to encourage it, and that they have to say, "You're good enough." Like it's almost like well, "Why do you have," like, "Why do you have to say that? Was I not good enough?" And obviously, you know in the past women had less rights and less or different expectations. It's almost like them saying, "Hey you can do anything a man can do," almost makes you, it almost makes me think that I still have to prove that. Which really, I don't. I don't feel that I need to at all, but the fact that they had to tell me that I can, makes me feel like I need to prove it if that makes sense.

Quinn's remarks illustrated explicit and implicit bias she and the other participants encountered on a regular basis as engineering majors.

Jamie recognized that one thing that contributed to her feeling as if she did not belong came from gender stereotyped roles and behavior in her family of origin. She explained that when she got to the point where she needed to be in the shop and start building things, "I was at like, a huge like, deficit almost, because like, I don't know a lot about . . . big power tools . . . I didn't grow up playing with them and building shit with my dad."

Marge also discussed the issue of belonging, and that no one told her directly she did not belong in engineering, but she had had experiences that left her feeling discouraged. She explained she had heard sexist comments from classmates, often men who had not had much interaction with women. Marge added that they did not say it aloud that she should not be there, but some of them had a way of making it known that "Oh, the girl's in charge." They implied that it was somehow a problem or inconvenience, something they were forced to endure rather than welcoming her as part of the team. Marge made a point to mention the fact that most older students and faculty were more accepting and welcoming of women. This acceptance was echoed by other participants who shared experiences about positive working relationships with people who had spent more time immersed in the professional atmosphere found in most if not all engineering departments.

Despite many positive experiences, some participants described encounters where they found themselves having to fight for the respect that male students received automatically. For example, Jamie described a group project (type of project changed for confidentiality reasons) that involved solving a sound quality issue with a high-end electronic drum set. Jamie was the only female in the group, and the only group member who had experience with drum sets as she had owned one in the past, but the male students did not know it. As the group talked about how to solve the problem, the males made suggestions, and Jamie told them why each would not work. She tried to explain things were the way they were for a reason, and that an engineer had designed the item because of it. They dismissed her repeatedly, not listening to what she was saying until, "I finally talked them into attaching the trigger sensor permanently to the cymbals, and it was, like, such a big fight to get them to listen to me as to, like, why we should put, do it that way." She noted it was frustrating having to fight to get her voice heard throughout the entire project, "even though I had, like, valid ideas, and like, valid reasoning." Jamie added that in the end, she felt that having to fight for her ideas was worth it, primarily because the instructor used her design on a real project.

Enduring dismissive comments and behavior, and having to fight for respect was a common occurrence. Rose described a situation where a male student in a different group was dismissive of her when she asked about his project, but when her male groupmate asked the same question, he explained the process in detail. Rose was shocked and angry, knowing that he had disrespected her even though she had done the majority of her group's work, and he did not think she was, "competent enough because I'm a girl." She confronted him later in class, and, "He didn't even remember that he'd done it . . . I was furious."

Right after the group incident happened, Rose told a female friend who was in the same major as the male who dismissed her, about the event. Her friend said, "You just treat it as a joke. Then, then you become one of the guys." Rose took offense, as she believed she, "shouldn't have to joke with them to earn their respect." Her friend told her it did not matter, and she should, "just play along."

Rose was dismayed but rationalized that her friend had grown up in a rural community, and her father had been an engineer in the same field she was entering. In her home, her dad and brothers did the outside work, and her mom and sisters did the housework. Her friend likened her male classmates to her male family members and said that when they were disrespectful or did not pull their weight, she just disregarded them until she needed to start nagging them to do their fair share of the work. Rose noted, "You should have to struggle as much as any other person in the class, and it [respect] should be based solely on that. And that's what I'm, like, trying to make us think." Rose realized that stereotyped behavior was inherent in her friend's culture, but still could not understand why her friend would continue to put up with disrespect. Rose stated a reason she participated in SWE outreach activities was so she could educate girls about respect and engineering.

Michelle also wanted to change stereotypes, especially after an instructor told her class that women would have to work harder than men to earn respect as an engineer. She added he told them it was because not everyone believes women are as capable as men are, and that they should just let it go and accept the fact that they will have to work harder for the same respect even when doing the same job. Michelle stated, "I know that some people are going to have that bias, not nearly as many, and that's their problem, not mine. But I can make, I can make a difference to change their minds." At the same time, Michelle admitted she had accepted the fact that she would have to work harder than men.

Jamie used a personal experience to illustrate how things have been changing for the better for women in engineering. She told a story about how, in a study group, Bill gave Bob a handwritten note sheet, but Bob forgot to whom it belonged. Bob looked at the handwriting and said, "If you're being sexist, it's kind of girly handwriting," and gave it to Jamie. She handed it to Bill. When Bob realized his error, he was visibly embarrassed because he had done, "that little minor sexist thing" of assuming it was Jamie's handwriting. He apologized immediately, "He's like, 'I'm so sorry that was sexist,' and I was like, 'Yeah, it kind of was.'" Conversely, Michelle lightheartedly gave two examples of how stereotypes persist. One male classmate asked her advice about color on a poster, "He said, 'Michelle, you're a girl, I need your feminine opinion.'

(Michelle laughed) And I said, 'Okay, but sure I can try to help you.'" Another classmate asked her what color belt would go with the outfit he was wearing to do a presentation. He said, "It's like I'm not a girl, so I don't know these things," Michelle said she had to laugh because they had asked her and she is "not very feminine." She then added, "It did look better the way I said it. So, they were right." These women were open about their experiences with sexist comments and the fact that they stood up for themselves and did not just ignore them.

In summary, participants spoke of various ways of handling stereotypes and bias-related situations, and their attempts to make a difference when faced with inequities. Participants reported recognizing gender issues – but did not identify them as microaggressions – and did not seem deterred by them. Instead, they noted there were pros and cons to being in a male-dominated educational environment. Commonly shared goals were to increase the numbers of women in engineering through outreach, mentoring younger students, and role modeling as successful engineering students.

Theme IV

Another theme to emerge from the data was, "Support factors contribute to student success." Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Ask for Support: (8 of 9)

b. Communication (General Soft Skill): (8 of 9)

c. Encouraged: (8 of 9)

d. Faculty Support: (9 of 9)

e. Family Support: (9 of 9)

f. Make Connections for Support: (9 of 9)

g. Study Groups: (7 of 9)

h. SWE Student Organization: (8 of 9)

i. Tutoring: (7 of 9)

j. Work/Life/Family Balance: (8 of 9)

Participants described the importance of asking for support and help as needed. They reported that family and most of their faculty and peers were more than willing to provide that support. The women valued mutually supportive relationships and finding balance with family, friends, faculty, and classmates. However, developing and maintaining support systems proved difficult at times, as participants described having to let go of friends who did not understand the long hours they spent studying to be successful. They learned to seek others who did understand and found support and new friendships with classmates and in study groups.

SWE was highly valued and regarded as a source of support, encouragement, camaraderie, and personal and professional growth opportunities. Tutoring received mixed comments as some tutors were helpful; however, others were sometimes more interested in dating them than helping them, and still, others viewed themselves as superior and would talk to women using condescending tones and explaining things the women already understood, as if the women were children. More than one participant described this as "mansplaining" (Solnit, 2014). Mansplaining is a term often attributed to Rebecca Solnit, even though she declined to take credit for it, in her book entitled *Men Explain Things to Me* (Solnit, 2014). Mansplaining has many definitions, but in general, it refers to an act involving a man explaining something to a woman that she already knows about, or a man saying a woman is wrong when in fact she is correct.

All participants valued community and camaraderie as sources of support. Rose summed it up by sharing her experience while on a campus visit that led to her attending Middle America University. She disclosed she "chose this school because of the community and how it feels . . . I knew that I wanted to stay here because . . . people were there to help . . . everyone's door was open." Rose remembered being impressed with the openness of the community.

Participants also described the need to ask for support and help as needed from faculty and peers. They reported the majority of faculty were more than willing to provide that support when requested to do so. In fact, the "faculty support" code included 143 significant statements, a considerably higher number than any other code. The code, "make connections for support" received the next highest number of statements with 101 statements. The high numbers of statements for these codes indicate participants discussed their interactions with faculty and peers more often than other topics. Findings showed most of these interactions were positive and students felt supported, and having that support was seen as a motivating factor for persistence.

Faculty provided support during and after office hours, and many helped through email. Michelle shared her appreciation for her faculty who made time to assist students. "It made the learning process so much more meaningful when they were there for us." Moreover, she was grateful, "They want us to be able to succeed now because if we can't succeed now, we're not going to be able to succeed when we're professionals." Angela credited faculty support with her continued success in engineering. She described using office hours and email. “They’re usually pretty flexible about it. You know I haven’t had any bad experiences with that if I need to talk to them.” She added, “There's people out there to help you that want to help you . . . I think that’s what’s been getting me through so far and will continue to get me through in my education.” Angela went on to explain, “Professors aren’t there, like, to judge you. Like, they just want to help you. Like, that’s what they’re there for . . . if you ask someone, they’re usually more than willing to help you.” She gave an example of a teacher who realized she had not done well on a test, and the teacher emailed her inviting her to come in for extra help.

Ashley also shared an experience she appreciated where an instructor took the time to help her after hours. “I e-mailed him back and forth about homework . . . until 11:00 p.m. He was answering me. I don’t know why.” Rose understood that asking for help was essential for her success, so she disclosed to an instructor that she was struggling because she had test anxiety. The instructor took her at her word and made the necessary accommodations. Rose emphasized, “More of what it comes down to is asking for support from other people.”

Michelle appreciated her faculty and their assistance but recognized students needed to take ownership of their education. In describing how to manage the immense amount of homework engineering majors have, Michelle clarified, “It’s not so much that the instructors are bad, . . . just there’s so much to know that it’s good to teach yourself . . . if you don’t understand something, ask for help or teach it to yourself.” Participants were appreciative of faculty who made themselves available and who genuinely seemed to care about student success. At the same time, the women recognized that it was up to them to seek assistance and not be afraid to ask for help when needed.

Participants also shared the value of making peer connections for support. They sought classmates, student organization members, anyone who was going through or had gone through rigorous programs as sources of support because they understood the long hours of study that are necessary for success. Michelle explained that she sought assistance from her peer group when having trouble understanding something. “Well, it’s pretty simple . . . we’re pretty close-knit since we have spent so much time together, so it’s pretty easy to just say, hey so and so, could you explain this to me.” Angela extended the idea of using a peer group for help to include providing mutual support. “Find, like, a group of friends . . . anyone really, people in the dorms, find people of your same major . . . and get homework help . . . and . . . be that person.” Participants shared that they learned to seek support and they needed to be there for others, too; the women also recognized everyone benefitted when they worked together.

Other participants talked about the importance of belonging and having friendships for support. Ashley described feeling like an outsider until she arrived at the university. “Once I got to college, I found more people like myself. So, it was okay . . . why I happened to stay in engineering is I love the people that I’m with.” Julie also recognized that “It’s really important not to just, like, have friends, but then friends who can help you with just the basic classes that every engineering student has to take.” Marge described the loneliness she felt when she was the only woman in a class and how camaraderie changed her perspective. “When it’s just me I feel like I’m alone in, not the universe or anything, but alone in this, . . . But when you have the camaraderie, everything just feels . . . less everything . . . it’s pretty amazing.” The women recognized that in addition to study groups, friendships and a sense of community were important to their success in engineering.

In addition to finding support through friendship and feeling a sense of camaraderie with peers, participants explained that getting to know faculty and developing professional relationships with them helped them learn about networking and meant a lot to them. Jamie attended a conference with a faculty member who introduced her to recruiters. Jamie felt that her faculty member's support helped her establish credibility as a professional. Quinn shared her thoughts on a favorite professor's guidance. "He has a really good balance on being professional and being a good mentor to us." Rose also recognized value in networking and relationships in a professional community, as she described getting to know faculty and their willingness to support her career development and job search efforts. Participants valued relationships with and support of faculty as they grew professionally.

Participants shared about times when they felt encouraged and that these experiences energized them. For instance, regarding attending a SWE conference, Julie described feeling inspired by her interactions with attendees who were further along in their programs or working in the field and who were willing to share their experiences and advice. She shared that those experiences gave her confidence that there were opportunities in her area and that she could succeed as they had.

Participants also discussed finding support within their families, including parents and partners, and how important it was to them. Angela described feeling cared for when she heard her parents telling others about her studying engineering. "I don't think they [family] know that, but they keep me going a lot and they encourage me a lot." Others shared experiences when family helped them when they were struggling with the rigor of engineering. Marge recognized that school had always come easily to her, so she did not always know how to cope with feelings of failure. She was grateful that her parents were there to reframe her negative experiences so that she understood them better and could put things in perspective. For instance, Marge went to them once wanting to quit engineering and noted that some students who drop out might have parents who just let them quit. She, on the other hand, had parents who would listen to her then have a "solid discussion of why . . . By the end, they'd be, like, 'Do you still want to quit?' And I'm like, 'No, because you made me think about it.'"

Rose was appreciative of her engineer father's perspective, especially the time when she called him crying after failing a test. "He's like, 'Rose, here's, here's how it goes . . . once you get out of college, it's not going to matter." Jamie described mutual support she had with her partner and described hearing about how that support is important in dual-career families at a SWE national meeting. She recalled hearing from a power couple who were both in upper-level jobs. "It was kind of interesting to hear . . . how sometimes one of their careers got to take a back [seat] to the other one. And how they . . . leaned on each other when they needed help for different things." Participants understood the importance of family support and knew that leaning on each other in difficult times was essential for success.

Eight of nine participants discussed the SWE student organization and described ways in which it provided emotional and academic support, professional development, outreach opportunities, and networking. The ninth participant was also a member of a Greek Life organization. She described that organization as a source of support in much the same way as others who spoke of SWE as providing support, encouragement, growth opportunities, and a sense of camaraderie or family. Perhaps most importantly, SWE members felt welcomed, and they found they were not alone and that while members were struggling with the same issues, they were willing to help others succeed. Marge explained how SWE helped her grow as a person and as a professional, and how members support each other. She related a story about her first SWE trip. “I talked to no one . . . the entire trip . . . I said, oh, no one wants to talk to me . . . I'm a freshman.” She then described she felt empowered by the SWE members. “Every single one of them. It’s like, ‘You can do this, go and talk to these people. You're amazing.’” Participants explained the importance of SWE and ways in which the organization and other members had contributed to their continued success.

Angela admitted to having doubts about whether she had chosen the right major until she went to her first SWE meeting. She described her experiences with SWE members who encouraged her and what SWE meant to her as a woman going into engineering. “That was the first time . . . I’m not alone . . . there’s you know 30 other women around me that are trying to do the same thing, and in a world that’s not, it’s not discouraged, but it’s not normal.” Angela had already come to terms with the gender imbalance in engineering and the public perception that engineering is man’s work, but still, something was missing for her until she found SWE. Jamie also could relate to the feeling of being an outsider who was struggling to succeed in a traditionally male-dominated field until she joined SWE: “It felt like these were my people, and like, this is what I want to do with my life.” She added it was nice to learn that the women did not become CEOs at 20 years old; instead, she realized she had time to get there because they were in their 40s. She also appreciated hearing from them that they "struggled, too. that it all didn't just come overnight, and that I need to calm down some days, and that I need to take it one at a time." For Ashley, education was important, and she was impressed that, "There's a lot more people that value education, especially in engineering, and especially in SWE . . . that was the area that I really found my niche." Jamie shared a favorite quote from SWE that seemed to sum up SWE goals, "Girls compete with each other, women empower each other." These descriptions of experiences with SWE demonstrated the importance of the organization to participants and their interactions with other women engineering majors.

Tutoring, a formal support service provided by the university, received mixed reviews and depended on the type, location, and quality of the tutors themselves. Ashley stated that she had been a tutor in high school and found that there was "this really bad stigma around tutoring" that prevented some students, male and female, from seeking help. Nevertheless, Rebecca reported she used tutoring services occasionally and found them helpful. "Yeah, I've worked with tutors when I really need help. I haven't really gone to a tutor consistently . . . But, yeah it's good." Julie also indicated that tutoring was helpful, but found female tutors to be more professional than some of the male tutors were as, "The female tutors, they seem like it's their job, so they're going to help anybody." Whereas, some of the male tutors favor certain people and focus on helping girls because they are "more chatty, and so they would have, like, a better time, more fun time helping those girls out than like the guys."

Marge also noted a difference in her experiences with male versus female tutors. She felt as if some of the male tutors were condescending towards her. "People just talk down . . . I don't like it . . . Pretty much every tutor I've had . . . It's like, 'Now do you understand this?' And I'm like, 'You don't have to use a voice like that. I'm not a toddler.'" Rebecca shared a term her friend uses for condescending behavior from males, whether they were tutors or study group partners. She also found it frustrating. "Mansplaining, that it's actually so common that when a guy gets that tone and assumes a complete mansplaining something . . . It feels it's just, it is degrading." Rebecca added that she gets angry, and that, "Everything you just said means very little, like I have lower respect for you now." She went on to say, "You've got to pick your battles. You know, you just kind of have to move on and just kind of accept that they're, I don't know, they're dumber than you for thinking that." Rose mentioned a different issue with tutoring that she found frustrating. She noted that while tutors could be helpful, not every tutor could teach just because they were smart.

Contrarily, Angela praised the living-learning community for engineers located in a campus residence hall. Living-learning communities are programs designed to support students who live in residence halls – usually assigned to live together in a section of the hall by major or type of co-curricular activity – by bringing in tutors and mentors to assist with academics. She found tutors that provided services there to be "a great resource because we're taking the same classes, basically, and they are students my age. So, I can go over there and get help if I need it." Quinn also noted that tutors in the living-learning community were "pretty welcoming to new students and younger students . . . they're really helpful."

In addition to faculty office hours and formal tutoring, students sought help from teaching assistants (TAs) and peers. For the most part, students found teaching assistants to be helpful. Rose offered insight into her experience with teaching assistants and peers in classroom situations. “TAs, depending on how they, they’ll give more attention to the girls. And I can see the flip side being an issue for the guys.” She stated the males indicated that the TAs only help the females. Rose stopped them saying, “It's like huh, no. And first of all, this is the first time we’ve ever been given the priority in class, so calm yourself. This [ignored] is how we feel all the time.” The males responded that it was not true, to which Rose responded, “Oh, but it is. This [differential treatment] is what we go through. You see how it’s not so nice. And like I’m not saying this is how it should be. I’m saying we should both get equal.” The males responded simply with, “Oh.” Rose continued, “I'm not okay with him giving me more, that, that’s not the point of this here. I want equality. Do you know what that means?” Rose asserted herself and acknowledged that TAs did not always treat students equitably; however, she noted the practice was unfair. This conversation seemed to strike the males in the class as odd.

Jamie also shared her frustration with male peers, as some of them were socially awkward and intimidated by her, because of “the fact that I’m a girl, and the fact that I’m sometimes smarter than them, like, it’s very intimidating.” She also explained that it was harder for her to make friends in class because “I have to try harder to gain the same respect that a guy does . . . when I first meet someone, and they keep asking me like hang out and study, I don’t really know what their intentions are.” She added she was frustrated because, “Guys don’t have to go through that, and they don’t ever, like, question . . . ‘Why does he want to be my friend?’” Jamie went on to give an example of an experience that had occurred the year prior that was uncomfortable at the time and continued to be uncomfortable whenever they met unexpectedly outside of class. She explained she met a man at a student organization meeting, and he got her number. Jamie did not think much of it at the time, but then he would text asking to study, and then he texted and asked her to have coffee. She agreed, and he texted her, "'It's a date.' And I was like, 'You know this isn't a date, like, this is just friends, like, I have no intention of dating you,' and he's like, 'Yeah, I know.'" However, he then kept acting "really weird about it." Jamie clarified, "It was just so frustrating because I knew his intentions after he said that, but like, he wouldn't own up to them." Jamie expressed frustration and described feeling discouraged at times because some of the male students seemed to think that she was there to find a date and did not understand or respect her as another engineering student.

The final source of support participants recognized was their personal need to find balance in their lives to cope with academic, social, and personal demands. Marge understood that a lot of her stress was self-imposed because she tried to "get everything done, get the best grades possible, and be in all of these organizations . . . I get very stressed out." She maintained a healthy balance by reminding herself, "You know you're okay if you take a break. You don't have to be in everything. You're going to stand out on your own just by being you." When discussing balance and preventing burn out, Rebecca explained, "Weekends are very important to an engineer because you can't . . . go through a hard week and not have fun on the weekends . . . That's a critical component to it . . . it just gets you ready for the next week." Also, recognizing a need for balance, Ashley disclosed both her parents were in upper management, and that meant as they continued to move up in their careers, she spent a lot of time alone because she was an only child. She stated she did not want her future family life to be like that. However, Ashley was already finding that because of her high intelligence, people expected her to have big ambitions and thought she would likely be a CEO one day. She explained she had to set limits and would continue to work with supervisors in the future to ensure she maintains a healthy balance between career and family. Ashley also advocated for making time for social activities and taking some fun classes to create balance while in an engineering major. She noted, “Those were like the best classes . . . you need something to look forward to in your week besides the weekend.” Participants described learning to appreciate and practice balance as engineering students because they knew it would be important later in their careers.

On the other side of the spectrum, still seeing the need for balance, Jamie described herself as being “very ambitious, so I want to, my dream is to go work for a company and become like one of the leaders or a CEO someday.” Jamie was realistic as she noted that she would be living a, “pretty busy lifestyle,” so she planned to hire a nanny to help with her future children. She added it was because “finding that balance is important . . . He [partner] gives me good advice and tells me when I’m being a crazy person and overloading myself, but he tells me that he believes in me, which is nice. I need that.” Learning to create and maintain balance was important to participants, as they knew that their family lives and careers would be demanding in many ways no matter what their career goals were.

Theme IV provided insight into support factors that contribute to persistence. Participants described a willingness and ability to ask for help when needed as essential to their success. And one of the most, or perhaps the most, crucial support was having faculty who were there for students when they asked for help and who reached out when they noticed a student struggling with coursework but had not come in on their own. Participants also described getting support and encouragement from family and peers, tutors, as well as from members of the SWE student organization. Students also recognized personal responsibility for creating and maintaining balance in their lives so they could manage their personal, social, and academic commitments.

Theme V

The fifth theme to emerge from the data was, “Use your talents to do what you love in your engineering career.” Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Career/Do What You Love: (9 of 9)

b. Choice of Major Decision: (8 of 9)

c. Money/Income: (8 of 9)

All nine women discussed the importance of enjoying the work one does and connected it to future happiness and a positive future. Women participants explained they indeed wanted to go into engineering as a career field, but some were not sure what type of job might suit them best. Some looked towards management to avoid gender issues in a power structure. Eight women believed engineering would provide a level of income that would support them in their desired lifestyles. Participants recognized their intelligence, abilities, and interests fit well with engineering careers and knew they would be happier in their jobs if they could use their talents to do the things they enjoyed most. Jamie realized she loved, “math and science so much that I feel like if I wasn’t doing it every day that, like, it kind of would have been a waste . . . I always get to do what I really enjoy." She also knew she could have gone into another STEM field, but she preferred the "application of the math and science to, like, real life, and then testing and designing and fixing things like that" because it would be more fulfilling than just, "writing equations."

Similarly, other participants researched careers (often through discussions with family members who were engineers or faculty who were willing to explain the differences in the types of engineering and future opportunities) and found they enjoyed learning about engineering and practical applications of engineering. In high school, Julie thought there would be many opportunities in engineering, but her family did not know anything about it. Undeterred, she took it upon herself to do research, and she talked to engineering faculty and attended meetings where working engineers explained what their jobs involved. Rebecca also discussed her belief that engineering would provide a variety of career opportunities because with "engineering . . . you can be anything, but you can always fall back on a desk job . . . or have plenty of opportunities. You can be a business person and have an engineering background, too; so, it opens more doors."

In addition to job opportunities, participants were confident that engineering was a stable career field always evolving. Ashley described engineering as a profession that was "fairly recession proof," and Quinn was looking forward to having: "job security." Rose was happy and found comfort knowing she had a "stable future ahead of me." Angela also wanted a stable career, but noted she stayed in her major because "I want to do this for myself. . . . I know that it's going to set me up for a good future. Good job. . . . I also needed to do something that I love every day." Participants knew engineering would provide them with career options and opportunities, and they looked forward to stability in future careers. They knew their programs were challenging, but their efforts would lead to job security and an ability to do work they found exciting and meaningful.

Other participants explained they chose engineering as it would provide financial security as well as a stable career. Rebecca noted that a big part of her decision was "financial. . . . It's a promising major, and you never really know where you know the economy is going to go, but I always feel pretty confident that engineering is going to lead me to somewhere good." Marge noted that money was nice, and "It's one of the highest paid bachelor degrees getting out of college," and Ashley also researched salaries and reported, "I looked up highest paying four-year degrees, and I read engineering, and it just kind of clicked." In addition to finding steady employment in a field they loved, financial security was important to participants and a big reason some chose engineering initially.

Two participants described differing views on the issue of salaries and gender equity. Neither cited specific statistics such as a report by the American Association of University Women (2015) that indicated women made only 82 percent of what men earned in engineering. When asked to talk about her thoughts on wage equity, however, Rebecca indicated she believed in equitable pay in a career that was male-dominated. She noted her research showed there were a lot of men whose pay was more than women's pay. Rebecca went on to explain she sees herself as an activist, trying to make a difference, and at the same time wanting to make sure she gets paid fairly for her work. She then justified her comments. "You know it's not going to happen instantly . . . Right now, we see this gap, wage gap . . . It's not just going to go away because we asked [it] to. You have to do something about it." Contrarily, Michelle explained that it was okay if men made more money than women did because of societal expectations of men as the provider. She noted, “So to me, if guys and girls who work in the exact same job . . . I’m okay with a guy getting paid a few more cents an hour than I am and until society kind of changes that.” Unlike Rebecca, who had done research on salary inequities, Michelle noted, “I mean it’s not something I looked into, but at the same time, I think I’m very on the fence about the whole salary thing being equal.”

Theme V showed that participants chose and persisted in engineering because they believed a degree in engineering would lead to a stable career with an income that would meet or exceed their needs. They also liked the fact that an engineering degree would provide them with options as there are many opportunities in the various engineering fields, and they would be able to apply the knowledge learned in their engineering major in meaningful ways.

Theme VI

The last theme to emerge from the data was, “Discouragers must be overcome in an engineering major.” Examples of codes used to build this theme are as follows, and numbers of participants whose statements contributed to the code are shown in parentheses:

a. Challenging (Frustrating): (8 of 9)

b. Discouraged: (9 of 9)

c. Engineering Major Is Hard Work: (9 of 9)

d. Isolation: (7 of 9)

Participants occasionally felt challenged or discouraged to the point of frustration, but often, later, found they were harder on themselves than needed. Some described how the “woman card” was both positive and negative, as it could open doors and opportunities, but it also might be an unfair advantage, and they feared being questioned in future jobs about whether they were good enough or if they were hired solely based on their gender. The *Urban Dictionary* defines *women card* as “a term used to describe women who are taking advantage of the fact that they are women and therefore the minority who are getting extra benefits than men” (A Shotbow Player, 2016, para. 1).

Participants talked about the rigor of engineering but were confident in their abilities to figure things out and to ask for help when needed. The loss of friends who were not in engineering was painful, but participants described how they tried to keep ties with important people and how they developed close friendships through engineering classes and SWE. Participants were occasionally discouraged to the point of frustration but found ways to succeed despite challenges. Discouragers were outside the scope of this study on why women choose to stay in engineering majors. However, discouragers were included in findings as participants shared relevant thoughts and concerns about the woman card, the imposter syndrome [formerly known as the “imposter phenomenon” (Clance & Imes, 1978, p. 241)], isolation, rigor in engineering, intimidation, and lack of respect.

Woman card and the imposter syndrome. Ashley described being a woman in engineering as “challenging. And not just because the classes are hard . . . me and two other girls are currently going through it right now, where you feel like impostors.” She added that they knew they would be getting jobs and because “we're minorities, sometimes we feel like we didn’t deserve what we got. We got it because we’re females . . . We’re all, like, top of our class . . . but we’re just waiting for someone to call us out.”

Additionally, she noted, “I think it’s really common right now for females in engineering . . . It’s really talked about, the fact that females are a minority.” Ashley stated that she and other women engineering students have often wondered, if they got a job when qualified men also applied, would it be because they are female.

> And in the end, like, I know, that’s not the case, but it’s something that you can’t get out of your head. And it’s really just because we are surrounded [by] guys, and you look, and then you always wonder, well if there’s 50 of them here, and I got this job, why me? Like, there’s so many others. Because instead of just looking at all their qualifications, we’re just looking at our genders, and we all just look at that one thing, and we go back to it every time.

Ashley went on to explain, “We look at our gender as almost being that extra thing on our resume. And the thing is, though, is because we know it can be an extra perk, it’s almost kind of seen as a disability.” She added that companies are working to develop an equitable workforce, trying for “50/50”; but she knew, for example, her college was only about 13 percent female. As such, she reasoned that with a pool of only 13 percent women, companies trying to achieve parity would be compelled to hire less qualified women. Ashley took her thoughts on equity a step further, “I just don’t think we’re ever going to get there, because . . . there would need to be so many changes in other majors too . . . giant shifts in every area of colleges. And I don’t see that happening anytime soon.” Ashley talked about the conflict she experienced. “I mean, as a woman it’s nice knowing that, technically, I have that extra woman card in my deck. But it’s also a factor too, that I know someone can throw that back in my face.” In addition to coursework, women were compelled to deal with gender issues their male classmates did not.

However, participants indicated some of the men did express knowledge of and concern for equity issues and supported gender equity in engineering.

Isolation. Most participants also reported isolation as a concern they found discouraging. Marge spoke about gender imbalance and that sometimes she was the only female in class, and divulged, "It's that when you're alone in a class, it just feels wrong because you don't have the people there to help you." Isolation also stemmed from exclusion, as Ashley recounted, with so few women in her classes, she found the male students excluded women, but it was not always intentional. Instead, she explained, "It's because they're kind of awkward and don't know how to talk to females. Found that a lot. It's pretty common." Jamie described similar experiences in her classes. "I was kind of isolated like I was the only girl . . . all the guys were like, afraid to talk to me like engineers are." Jamie also stated that her isolation as the only female in her class carried into other areas, such as not being able to find study partners, and to student organizations. She would attend functions but found it hard to break into what she called the "inner circle" because all the other girls knew each other already from shared classes.

The amount of time required to be successful in engineering also contributed to feelings of isolation. Michelle described feeling disheartened when she could not spend time with friends or participate in social events because she had so much homework and chose to study. She noted that it was difficult to find balance, especially early on in college. Michelle reported her friends who were not engineering majors did not have the massive amount of homework that she did, and so she ended up losing friends along the way. However, because of spending many hours studying with engineering classmates, "I ended up . . . pretty much just friends with engineering majors"; even so, she added that she "learned how to make time for the important ones. And I guess the less important got left behind." The gender imbalance in engineering directly affected participants because it was sometimes difficult to find support through the limited number of women in classes and organizations. The women also expressed sadness at the loss of friends who they were unable to maintain relationships with due to their choice to focus on coursework and persist in engineering.

Rigor in engineering. Participants described confrontations with the rigor of engineering but were confident in their abilities to succeed. Rebecca shared that before going into engineering, people told her it was an extremely difficult major. "I mean no definitely everyone tries to scare you, 'It's going to be hard.'" However, she described herself as a positive person and accepted the fact that engineering required a lot of work. However, she noted that "the hardest part is the fundamentals of engineering are very boring, . . . [and] just the amount of work it takes . . . you have to really want it, or else you're not going to want to do it after a year." Jamie explained she had to get past the "first initial shock of, like, how difficult the classes were." She noted that to persist in such difficult classes, she had to work hard and have, "that drive to keep going when like, you get an exam back, and you didn't get it as well as you wanted to. . . . Engineering's really hard."

Marge shared an awareness she developed after dealing with tough classes. "I've had my fair share of crying at night . . . I've never had to study for a test in my life . . . It's very hard to go from being very smart to realizing you aren't the smartest person on earth." Rose also struggled to take "lots of heavy workload classes" at the same time. She failed two of her three toughest classes during one particularly difficult semester.

However, she got past her feelings of failure when she realized she was not alone, "and it's nice to have that shared sort of, it's not necessarily an upset-ness, but a shared, like, understanding of how tough it can be sometimes." All participants described the difficulties of their coursework, and the sheer amount of work required for success in their engineering majors. However, over time they learned to manage their coursework and failures by using personal strengths and external supports for assistance.

Intimidation. Ashley revealed she felt awkward in social situations with other women. "I look like a normal human being, but I never could talk to girls for some reason." Ashley further disclosed that being one of only a handful of women in engineering meant she was around mostly men, and this was where she was comfortable. She did not have much practice interacting with women, and this presented as problematic when she went to SWE conferences. Ashley described feeling terror at conferences when among and competing with highly accomplished women, primarily because she had no experience being in that position. Ashley felt intimidated at SWE conferences without the advantages she had at her university where being female she stood out as a minority and as one of the best students in her class. Likewise, Michelle described feeling disheartened when instead of having a sense of mutual support with her female peers, she found females to be more intimidating than males. She noted it was because males were more supportive and did not judge her as harshly as females did. "[With] girls . . ., if I ask a dumb question, they're . . . 'Oh, she's so stupid. . . .' [With] guys, if I ask them a dumb question, they're like, 'Oh, ha ha ha . . . let me help you try to understand." Participants found their interests and abilities in a field historically known to be male-dominated, and being among mostly men all the time in classes left them ill prepared at times to interact with females. They expressed feelings of awkwardness and intimidation at times when dealing with women.

Lack of respect. Along with feeling intimidated and judged, a lack of respect was discouraging. As Rose pointed out, "I think the hardest thing is . . . peers not necessarily respecting your input, like in a group project type thing." Rose gave an example of a group experience where her male group members told her she was "too commanding of the group sometimes" when she pushed to get everyone to do their fair share and on time. She noted that she was a "sort of very Type-A personality" and tried to keep to a schedule to get the work done. When Rose noticed her group members not doing their work [as she believed they had planned together], she called them on it, and they responded with, "Yeah, yeah, okay, we'll get it done" then did not follow through. When she again confronted them and showed them they had not done as they had agreed, "they're like frustrated with me . . . and they're like, and she's like nagging so much." Rose took this to mean they thought she was not being a good group member and did not understand it because she felt she was, "just the only one who seems to care about the project . . . I am trying my hardest to be a team, inclusive member." Other participants shared similar experiences and expressed frustration with male group members putting things off to the last minute or not doing anything and so women had to do the men's work in addition to their own to get the assignment done on time.

To conclude, Theme VI included discussion of participants' experiences feeling discouraged as engineering majors and how they responded to that discouragement to persist in their majors. The main points participants shared included the woman card and the imposter syndrome, isolation and other issues related to being in the minority as women engineering majors, the rigor of the coursework, feelings of intimidation by other women, and lack of respect.

Research Question 2

Research Question 2 asks: What characteristics do women engineering majors believe contribute to their choice to persist to graduation? Findings for the second research question included fifteen personal characteristics that emerged during data analysis. Characteristics are presented in alphabetical order as no one characteristic is any more important than another and included: ambitious, collaborative, committed, competitive, confident, creative, determined, focused, hardworking, independent, intelligent, organized, persistent, prepared, and resourceful. In addition, sense of humor was evident across participants as they sometimes shared rather intimate details of their lives as engineering majors. For instance, Rebecca joked, saying, “I'm like, ‘Of course, I’m changing the world’,” then got serious and explained, “It’s nice, on your worst days, is to know that you’re actually helping or putting something positive into the world.” Other participants shared this sentiment, as they also were anxious to use their talents and abilities in their careers to help others.

Ambitious

Most participants viewed ambition as essential for success in an engineering major and future career. Rebecca explained that students must be ambitious to continue to complete an engineering degree, “Just the amount of work it takes, you need to, you have to really want it, or else you’re not going to want to do it after a year.” Jamie also described needing ambition when she had not done as well as she had hoped on classwork, had copious amounts of unfinished homework, and had two or more exams in one week. She noted, “You *can’t* [emphasis added] study as much as you want for both of them [exams] . . . you need ambition to like, make it through.” She also discussed meeting a professional engineer and stated, “I thought she was so ambitious and so intelligent, and I wanted to be like her,” especially when she learned that the woman had struggled, too, “and it doesn’t just come naturally to her.” Jamie added that ambition had helped her in difficult times, which was important because “I want to be a CEO of a company someday. Like, that’s my dream.” Ashley, on the other hand, had recognized that her intelligence and natural leadership abilities tended to lead people to, “assume I’ll be a CEO one day, and they kind of forget that I actually don’t have very high career goals.” Ashley then explained she knew from experience with parents who were always working, that it would not be possible to have the balanced family/career life that she wanted if she moved higher than middle management. Participants recognized the need for ambition to persist in their major and knew that it would be essential as they moved into careers. However, the women had also considered their values and desires as they thought about and made plans.

Collaborative

Participants described many experiences working in groups and came to value collaboration. Quinn recognized that she had strengths in some areas and weaknesses in others, and that “the whole point of working in teams is because everyone can do things differently and at different strengths and levels.” Angela shared that she worked on a group project early on that was successful; and afterwards, she felt pride and noted that she would always remember it as a fun experience. Jamie also enjoyed working on a team and appreciated the fact that engineers work in teams because “you have to get a lot of different ideas going to, like, make sure that it's the best idea for the company or the project." Michelle supported working in teams as well. She noted that group work provided "a good lesson for us to learn because when you were out in the field, it's going to be group work for the most part, not individual; so we have to learn how to deal with other people." She added, "Having that dependability on each other is a lot nicer." Rebecca revealed that group work taught her how to be "comfortable enough to, like, question each other and question each other's ideas and not get offended by it." She went on to share her excitement with the thought of working with "a team of smart people where we can bounce off big ideas each other and, like, make things happen and come up with really cool design and cool fun things like us. Okay, that's where I want to be." Participants acknowledged teamwork as being essential to engineering as the women described a need to work together to hear as many voices and creative ideas as possible during the innovation process inherent in engineering.

Committed

All participants were committed to persisting in an engineering major. However, they did not talk about it much for themselves as they seemed to accept it as a given that they had made the decision and that was what would happen. However, several did discuss a difference in commitment between their female and male classmates. Michelle reported that unlike her male classmates, "The girls in engineering programs, they tend to have the same mindset of homework and school or want to work on getting more knowledge." Ashley offered an observation of how her female classmates' commitment to academics, "They know that they need to do well. They know they need to get it done. And then socializing is something that they also do off on the side." However, for her male classmates, “Socializing is the top priority . . . doing the homework, the day before is what they kind of go with. So really, I think it's just a difference in priorities.” While male classmates may have been just as committed to succeeding and persisting in engineering, participants often wondered about their level of commitment when males put off tasks until the last minute or did not work together on completing tasks as scheduled by group members. The real or perceived difference in priorities between males and females became an issue for women at times, as they reported occasionally having to complete one or more of the male group members’ tasks to get an assignment completed on time.

Competitive

Participant comments about competitiveness varied. Rose described herself as “a fairly competitive person” and stated that when she was “told that, you know, ‘Oh look,’ like, ‘There’s not many women.’ Oh, I'm like, ‘I'm going to change that. Watch me do this.’” She made it clear that “once I set my sights on something . . . I’m very hard to let go of it, very hell-bent to get me to stop doing something.” Julie stated competitiveness was not an issue for her, but, “They’re [older female engineering students] definitely competitive. But, they do want to help you.” However, Angela explained that while the women do help each other, “It’s more of this like silent competitiveness between us. It’s like almost like a tension thing. You can like feel the tension . . . but it’s not like we don’t get along. It’s not like we don’t help each other.”

In contrast, Jamie noted that at SWE meetings, members did not compete, but worked to empower one another. Regarding the issue of competitiveness, Michelle disclosed that she believed that it “depends on the person’s attitude. . . . It varies person to person. So, to me, I view us all as equals, so everyone is my rival, everyone is my friend, and everyone is my rival regardless of gender." She also stated that men compete more with other men; and women, with other women. However, she believed, "When someone like me, who sees us all as equals, um, sees one of my classmates excelling, I'm like, 'I want to be that classmate regardless of who they are.'" Competition existed among participants; but often, they viewed it as a driving force or motivator. The women asserted directly or indirectly that they were supportive of one another and that success for one woman was a success for all women.

Confident

Participants described confidence as being important to them, but recognized they also had moments of doubt. However, participants explained that they worked hard to restore their confidence during those times. Angela gave an example of how she communicated her confidence assertively. She laughed as she recounted one of her first times in the shop. Some male students did not know what to make of a woman being in the shop, but she stood her ground, and said, "Yes, I am a female, and I am in the shop with you, and I guarantee you I know what I'm doing." Bolstering her confidence by preparing herself to be assertive after interactions with sexist male classmates who had treated her disrespectfully, Rose told herself, "No, I'm here. I'm doing this; I'm still valued in this community. You don't get to have a say in how I run things."

Most participants expressed confidence, but for some, it seemed fluid and was something they worked on maintaining. For instance, Julie explained her parents did not think she was smart enough for engineering, but she believed she could do it, and she told herself, "It doesn't matter what they say." At other times, she had doubts but found support from friends. She noted that she was working on internalizing feelings of confidence, and “I think I’m getting better at it [self-confidence], definitely. I’m slowly getting there.” Jamie also reminded herself after a failure that had damaged her confidence, that she could do it. “But, you got an ‘A’ in differential equations when you thought you were going to have to drop that class. . . . It’s stuff like that . . . keeps you going.” Rebecca stated that it builds her confidence when she reminds herself, “I don't need to be 100 percent confident” when working on a difficult problem. Ashley remembered that early on she “used to be one of those that . . . graded my self-worth based upon what my GPA was, which is not healthy in the slightest. I’ve gotten so much better than that.” Since then, as she found successes along the way, she noted, “I knew that even if I didn’t get something, I’d be able to figure it out, and like, still make it through. And that’s what really helped.” Finally, Michelle shared that she thought, “Women need to believe in themselves more and not let their own preconceptions determine what they are or are not capable of doing.” She went on to explain that she had done it herself and had seen it “in other girls that I know that are in sciency fields.” She noted that she thinks they are “a lot harder on themselves than they need to be” but did not understand and could not articulate why it was that way. However, she then added it might be because, “We have higher expectations of ourselves . . . because we’re in fields that not a lot of women are in, so we think that we have to be really smart.” While participants described self-confidence, they also admitted to feeling doubt at times. However, upon reflection, they understood that doubts were fleeting and could reframe negative experiences or emotions to boost confidence or seek support when needed. They also recognized that being women in engineering in and of itself was challenging and learned to be kinder to themselves once they realized they were doing something that many women could not.

Creative

In addition to appreciating the analytical and practical application side of engineering, participants looked forward to using their creativity. Jamie wanted to become a CEO and saw herself "continuing to work hard and pushing my company in a direction where they're more innovative and more creative." Rebecca excitedly shared that using her artistic abilities in engineering was important and would be a source of pride for her. She explained, for example, "I'm fascinated by just anything . . . a well-designed pen or a chair and I can't stand bad design . . . I like good design . . . I want to see . . . myself working in . . . something I could be proud of in an artistic way." Jamie shared that, "I've always been pretty creative, . . . loved art . . . I guess it's not really like going into applied engineering, but . . . I like the creative aspect and being able to try new things and seeing them come together." She noted that creativity would help her as an engineer to solve problems, "There's just so many different ways that you could solve it . . . So, I think creativity is . . . necessary . . . a lot of times, if you can be more creative, then it is easier to solve."

Participants had an appreciation for and valued creativity and knew this would serve them well as engineers. They knew their originality and resourcefulness would make them productive members of future teams who would rely on creativity for innovation.

Determined

Determination served as a foundation for participants, provided motivation, and supported persistence efforts, as noted by Angela. "If you are not determined to do something, you're not going to get anywhere." She went on to discuss her motivation to persist, "There is a wide range of things that . . . keep you going . . . I'm here for a reason. I'm going to do this no matter what it takes even if I'm here for 10 years." Her determination was evident as she explained her reason was her family, "That's what keeps me going. My family, I think, is my main, and I say that I want to do for myself, but my family, that's more important sometimes." Rose described herself as, "stubborn and determined" and she said she was, "just really determined to get this done." She stated her reason was "my goal to help people, so [I am] going to do it . . . no matter how hard it gets . . . that fuels me to keep going." She added that it also helped to remind herself, "I can do it. I'm smart enough. I got this. Like, I totally got this." Marge took a different approach in describing her determination to succeed, "I don't know if I'm proving something to myself or other people. I have never backed down from a challenge. I refuse to back down from challenges." All participants described being determined to succeed for themselves and for their families. They were confident they had what it took to succeed, and their talents and abilities would support their persistence in school and in future careers.

Focused

Many participants described the importance of focusing on goals to support their persistence efforts. Michelle described her observations of women in her previous major (non-STEM and female dominated) versus women in engineering majors. "A lot of the girls in my class [previous major] were very dramatic, and that really bothered me, because I like to focus more on work and homework and school, and they wanted to focus more on personal issues." In contrast, she noted, "A lot of my classmates, the girls in engineering programs, they tend to have the same mindset of homework and school or want to work on being, getting more knowledge." Julie mentioned that she has had to take summer jobs for financial reasons, but has learned that she does not enjoy them because they do not present a challenge and are boring. As a result, she would rather look for engineering related opportunities for summer employment instead of something like a retail job. "I get bored really easily, and I really don't enjoy, like, summer jobs [non-engineering related] . . . they're necessary, but . . . I don't want to do that, and I don't want to be bored, because then I will lose focus." Participants understood the need to concentrate on completing day-to-day assignments and tasks as they knew that staying focused was essential to keeping them on track to graduation.

Hardworking

Participants described the rigor of engineering and a need to put in long study hours and work hard on a consistent basis. Jamie explained that in addition to being intelligent and ambitious, "You have to be hard working to make it through, especially with a high GPA." Angela acknowledged hard work was required to succeed in engineering. "Yes, it is hard, and yes, you had to put the time in it, but it's not like you don't have time to do everything else. You just have to manage your time really well." She noted that as she progressed in her program, she still had to work hard, but the work got easier to manage and stated, "I know it, it's going to be very hard . . . but I know in the end it will be worth it." The women all described the rigor of engineering and were determined to put in the hard work they knew would help them succeed, especially when faced with challenges or failures.

Independent

All participants projected a sense of independence and some described themselves as being or striving to be strong independent women. Independence, however, meant different things to participants, and they described various aspects of being independent. One aspect was being able to be self-sufficient and able to provide for one's physical needs. Another meant the ability to figure things out for oneself without help from anyone. Yet another meaning was related to emotional strength, not needing anyone to feel content. This idea could be difficult as some women believed if they did not behave in a totally independent manner, they would be viewed as weak and not capable.

Angela explained her family was "really supportive [of her independent nature/trait], especially my mom. She wanted me to be that strong independent woman that, you know, society has kind of knocked down a little bit over the years." Angela acknowledged that societal views of women and independence are changing making it possible for her to go into a field that was and continues to be male-dominated. As Angela thought about a career as an engineer, she recognized that asserting her independence would allow her to, "support myself later in life, not having to worry about the money . . . being able to look into the future and be all right." This thought was comforting to her and confirmed that she had chosen the right major. Michelle explained that being a woman and a minority in engineering "gives you a sense of almost independence because you have to do so much yourself." She was appreciative of the fact that because she had to do so much on her own in engineering, she learned to think critically and felt she knew how to make informed decisions. She stated, “The independence part comes in . . . because now you’re not so influenced by other things.”

In contrast, other participants noted that independence could be problematic at times. Ashley pointed out that independence could be a barrier to success. “I really think that the independence factor has really kind of made it that people aren’t as willing to go and ask for help and ask for questions, and email professors.” Rebecca explained, the “typical female engineer is an independent person and two independent people aren’t typically, like, going to bond right away.” She then described a situation where she and another female engineering student worked together on several projects, but “It’s just like we don’t need each other . . . I don’t need anybody. You know, I can do this on my own.” However, she admitted, “Okay, at the end of day, kind of what you do want [is] someone with you.” Participants wanted to be strong independent women but recognized that independence can present challenges. They discussed the need to develop a balance between independence and asking for support when needed. They explained they had learned to appreciate working with others and seeking assistance was not a weakness.

Intelligent

Participants understood that their intelligence was one of the factors that enabled them to succeed in engineering. Marge discussed her intelligence in terms of mental stimulus and challenges presented in engineering. “I like this mental stimulus of being in engineering, being a female in engineering. I, I really like being mentally stimulated.” Along the same line, Rose described herself as a “fairly curious and want to do things type of person,” and she enjoyed engineering because, “There are always new and changing projects. It’s never just something that stagnant. It’s an industry that’s always changing. It’s always new. So there [will] always be something that will keep me interested.” Other participants described feeling as if they had to go on the offense to defend their intelligence and right to be in engineering. Jamie explained, “I don’t ever want to, like, have that persona of ‘I’m like, oh, I’m the smartest, and like, you have to listen to me because I’m smarter than you.’” She went on to clarify, “I feel like I’m pretty naturally intelligent, and like, I am good at engineering, and that I, I deserve to be there just as much as the guys, and uh, more some days.” Quinn recognized her natural intelligence and the fact that not a lot of people could do some of the things she did. However, Quinn also described her frustration with having to justify her abilities because she was a woman in engineering. “Well, I have to prove that I’m smart enough and that I’m a smart enough woman, and, yeah, that the intelligence is there to get through it, and that I belong there and not in any other major.” The women knew they were intelligent and had a capacity for learning and succeeding in engineering. However, some noticed that because they were women in engineering, they sometimes felt they had to prove their intelligence and right to be in their major.

Organized

Participants discussed how being organized kept them on track and prevented stress. Participants described using organization tools such as calendars, to do lists, filing systems, white boards to process and organize thoughts, etc., to manage their large amount of coursework and other responsibilities and stay on task to meet deadlines. When discussing her frustration with tendencies of male group members’ to put things off to the last minute and not follow through on a plan or schedule, Rose explained, “I like to keep things structured, so I don’t do them last minute, because it causes me stress.” Michelle was another participant who discussed male versus female organizational styles, “Girls tend to be more organized . . . guys kind of just go with the flow . . . and are more adaptive to change . . . I think guys tend to procrastinate more on average. Obviously, not true for everyone across the board.” Organization was a key component to participants’ ability to stay on task, complete assignments, and participate in organizations they viewed as necessary for professional development.

Persistent

Participants had committed to completing their engineering majors. Regarding her goal of graduating with a degree in engineering, Jamie described herself as, “very headstrong” and noted that it would take a lot to make her think, “Maybe I don’t want to do this.” Rebecca used a marathon analogy to explain her choice to persist. “I’m already signed up. So, already wearing the numbers, halfway there. So, there’s no turning back now. We’re all; we’re running. I’m too far into it. I don’t want to waste my time like that. I want to see it out at this point.”

Others shared personal experiences with persistence. Ashley related an incident from her first year at the university where she went into a class and found out because she had tested out of lower levels of math, she had not learned some foundational material necessary for her class. Rattled by the thought of being unprepared and failing, she noted she “went back to my dorm room, and I cried. And I thought I was going to fail out, and I decided I was going to be terrible.” However, she decided failure was not an option, and she “ended up studying a lot, and I ended up getting an ‘A.’”

Rose disclosed that during one especially difficult semester, she remembered sobbing during tests, then failed two classes and began to doubt her abilities. She noted that she would study for hours but not feel capable, “Like no matter how hard I tried, I couldn’t do it . . . that was the worst I’ve ever felt, like, entirety of school like . . . That was the most defeating thing I’ve ever been through.” Michelle also struggled but described negative experiences as empowering. She explained, “There’s not a lot of female engineers in it. I was able to stick through it and do something that not really everyone is capable of . . . there’s a lot of people who drop out.” Michelle summed up her thoughts by describing the sense of empowerment she felt knowing she had succeeded despite hard times. Participants described being persistent despite difficult challenges. Some women had considered dropping out of engineering, but sought support and made the decision to persist to reach their personal and career goals.

Prepared

Participants described putting in long hours studying and preparing for classes, because they knew that doing so would keep them focused and help them learn their material and help them manage the large amounts of homework they were assigned. Rebecca understood that because she wanted to succeed, she knew she had to prepare. She stated, “Well . . . I want to be the best. I don’t want to show up to something if I’m not prepared. I don’t want to show myself if I’m not prepared” because she believed lack of preparation was unprofessional. While Ashley agreed that preparation was necessary for her success, she shared her observation that it is “different than guys . . . I’ve usually found, like, socializing is the top priority and then like doing the homework the day before is what they kind of go with.” Conversely, Marge explained that the people in her study group, males and females, work together to prepare for classes. “It’s pretty amazing. You’re all just here working on homework together . . . We all just go from class to class to class helping each other out and staying afloat and doing all that stuff." Without exception, participants described a need to be prepared for classes, exams, and their activities with student organizations. They understood preparation was a key component to their success and persistence in engineering.

Resourceful

Participants understood the need to be resourceful because students needed to take responsibility for their learning. They took advantage of formal academic services provided by their university, such as tutoring and instructors' office hours. Additionally, Angela found that she needed to look for other resources, and learned to ask upperclassmen for help. She noted, "It's going to be a lot harder if you stay in the shadows, in a sense, there's people out there to help you that want to help you. You should take advantage of those resources while you can." She added that using resources outside the classroom, "that's what's been getting me through so far and will continue to get me through in my education."

Julie found that proactively reaching out and studying with classmates and upperclassmen was mutually beneficial and provided the "opportunity to meet new people . . . and they're going through the same troubles with you because . . . they're just like one year ahead and . . . they have some wisdom to pass down." Jamie found SWE to be a valuable resource because she would listen and learn from women who were successful in their careers but shared their struggles as students. Jamie explained that she took notes after hearing speeches or talking with these women so that, "If I was ever going through a hard time and felt like dropping engineering, like, I could go back and read through it and be like, these powerful, amazing women have struggled too, and I can't just give up."

Participants recognized the need to seek and utilize existing resources for support. They knew that as future engineers they would need to continue being resourceful to take advantage of all available means to complete projects as efficiently as possible.

Research Question 3

Research Question 3 asks: How do participants explain why they stay in an engineering major? This final section includes a summary of reasons participants gave for staying in an engineering major. See Appendix G for an overview of reasons participants stayed in engineering and a showing of frequencies participant responses corresponded to each given reason. Within each of the three following sub-sections, reasons were listed alphabetically to avoid implying any level of importance.

Strongest Showing – Responses Given by Four of Nine Women

When asked directly what their reasons were for persisting in an engineering major, the top responses (given as code) by four of nine participants were: (a) engineers make life better/help others/make a difference, (b) good income, (c) love learning/challenges with engineering, (d) outreach/want to see more women in engineering, and (e) SWE/campus support.

Engineers make life better/help others/make a difference. Angela shared her admiration for engineers as a reason she chose her major, "It's a good group of people to be around; engineers are not a scary people. They want to make your life better. That's what they're there for." Rose described a lifelong aspiration to "help the most amount of people with what I have . . . give back to other people who need help more than I do."

Quinn focused on a desire to use her degree to help others. She gave an example of a problem from the medical field, and excitedly added that with her degree in engineering, "I can solve that [medical problem], and I don't know how, but I would really want to solve that."

Good income. Participants were concerned about future earnings potential. Ashley noted she debated between teaching and engineering, then realized, "Engineering definitely made more money, and . . . was more recession proof," which would give her and her family security. Jamie and Julie decided on engineering in part because they believed they would be making a good income.

Love learning/challenges with engineering. Ashley asserted she chose engineering because she liked, "chemistry and math, and I was smart." Jamie emphasized, "You have to be pretty ambitious to go into engineering." She went on to explain that many people do not understand how hard it is, that students must be good at math and science, that they need to be hardworking, and have natural intelligence and ambition. If they don't have these skills, "They drop out." That said, Jamie noted, "I genuinely love it . . . I genuinely enjoy what I'm learning, so I think that's what keeps me around." Michelle discussed her appreciation of the knowledge and skills she learned in her engineering classes. She explained, "Even if you don't get this super high paying job when you're out, you have these other knowledge and skills that you gain that you can apply to a lot of other things in life." Quinn mentioned her interest in course material and attributed her persistence to having "oddly fallen in love with it."

Outreach/want to see more women in engineering. Ashley reported she loved outreach and had good management skills, so she might get into an engineering management job and find ways to get into, “engineering outreach-based programs.” She highlighted outreach was “one of the main reasons I stay is just because I see what’s important.” Julie noted that she enjoyed outreach activities and having fun with participants. Jamie saw herself as a role model and stated one reason she stayed in her engineering major was she would “love to see more girls in engineering.” Along the same line, Michelle stated, “I just would like to see more women in engineering because they want to be, not because they’re women.”

SWE and campus support. Outreach is one of the primary activities of SWE, and Ashley recognized she could continue her relationships with women in SWE and do the outreach programming she loved. Specifically, “members in SWE, like, they really are kind of like a family to me.” She continued, “no matter where I go . . . there might not be a lot of females, and so I’ll probably stay friends with those that I’m currently friends with in SWE.” Jamie credited SWE members for supporting her persistence. “I am pretty strong willed, and I would like push my way through this degree, but they help a lot.” She added, it was because there was a strong sense of community and members shared tough times and acknowledged they struggled, too, so she did not feel so alone. Beyond SWE, Rose stated one reason she stayed in her major was the community she had become a part of as an engineering major. She indicated she decided to enroll at this institution “because of the community and how it feels” and added she knew she “wanted to stay here because . . . people were there to help . . . I’ve only run into one professor who had their door closed.” Marge also felt supported in the engineering community at her university and noted, “So, I really like that in engineering because you aren’t really trying to beat each other you’re just trying to float, and you do that together.”

Second Strongest Showing – Responses Given by Three of Nine Women

The next highest set of responses given by three of nine participants were: (a) good job/successful future, (b) in too far to quit/I'm not a quitter, (c) know not many can make it/use strengths.

Good job/successful future. Angela explained that she stays in her major, "because I want to do this for myself, [as] opposed to anyone else. I know that it's going to set me up for a good future, good job." Ashley was confident engineering was "a good path for me" but added she does not know where she will end up. She noted she plans to stay in engineering and management, but with her interest in teaching, thinks she may end up as a professor. Julie explained in addition to the money she will earn; she believes "you'll be happier because engineering can be like, you could do anything with it. . . . You're just not stuck at a desk job or like doing the same thing forever."

In too far to quit/I'm not a quitter. When feeling discouraged about the challenges in engineering, Rebecca reminded herself, "Just got to wake up. You have your coffee, and you just gotta go. You have no choice. . . . I'm too far into it now. You know I can't really, you can't really look back now." Regarding her persistence, initially, Quinn reported, "I'm not a quitter." Additionally, she had seen her goal and pictured what she wanted from it. She noted, "I know if I put in the work, I can have it. I can do it, and I know that I can make it if I, if I put in the effort that it deserves." Quinn then mentioned she has "a lot of friends and family supporting me, and I don't think I could quit." Later, Quinn explained she liked engineering and stayed in her major "because I have a little bit of pride, and I wouldn't, I don't think I would be able to, especially since I know I've gotten this far, I don't think I would be able to stop." Ashley described the support systems she developed through engineering and declared the main reason for staying in engineering was the people she was with and enjoying her classes, "I wouldn't want to leave . . . I'm very much attached to the people that I work with."

Know not many can make it/use strengths. Michelle described feeling empowered "because there's not a lot of female engineers in it. I was able to stick through it and do something that not really everyone is capable of." She added, "There's a lot of people who drop out, so it's kind of empowering to know, like, I stuck it through. I worked through the hard times and the good times." Along that line, Julie explained how there are not many female engineers, and "It's only because we don't know about the opportunities, you know, and we could probably do a better job or just as good as the males do." She went on to discuss how little she knew about engineering before entering college and the fact that she was not encouraged to consider engineering, "I didn't know that much. I just knew what I liked, and it just happened to drive me into engineering. Other people didn't get that opportunity because they weren't good at math." Quinn explained wanting to use her intelligence, her "maximum capacity" to make a difference in people's lives and believed engineering was an area where "I can use strengths that I have that people don't, that some people don't, and I want to put it towards that."

Responses Given by Only One or Two Women

The remaining reasons given by only one or two participants were: (a) confident I can make own decisions, (b) don't want to let family down, (c) help parents later, (d) industry always changing/variety, (e) job security, (f) know there is bias but I can make a difference, (g) prove I can do it, and (h) role model for siblings.

Confident I can make my own decisions. Thinking about benefits of her engineering education, Michelle described feeling liberated because "I have that sense of, like, I can make my own informed decisions and know how to make them. And, I don't have to worry about being as influenced by everyone else or society or anything like that."

Don't want to let family down. Angela's secure connection with her family supported her desire to stay in her major. She disclosed, "I'm reminded daily of my family back home. That's one of my biggest things . . . It's also one of my biggest fears, and so I don't want to let them down. That's what keeps me there." Julie felt privileged to be able to attend college because her siblings and others had not. She recognized she had an opportunity to "do better and make a difference because . . . of my race, and there are people who are of my race who are living in refugee camps in like third world countries." She attributed her sense of duty to family and to her race, to her father who reminded the family that "We should do better because we're given opportunities they weren't, and we were given opportunities that he wasn't given." She added, "I don't want to let him down. I don't want to let myself down."

Help parents later. Quinn reported her success in engineering was important to her and that even though she knew she did not need to, she felt "responsible for my parents, especially after I graduate . . . I'll be making over double what they've made. And so, both, it's both responsibility and excitement to be able to, like, give back to my parents." She noted, "That's a huge [persistence] factor as well. I really want to help them out." Angela also hoped engineering would provide enough of an income for her to be able to help her family financially in the future.

Industry always changing/variety. Quinn shared her excitement about going into engineering because, "The industry is always changing and always advancing, and so I know that I'll never be bored at something, that I'll always keep learning."

Job security. Ashley described a need for security in her future career for her and her family and added her research showed engineering was one of the more "recession proof" fields. Rose saw engineering as a viable career because, "There's always need for engineers."

Know there is bias, but I can make a difference. Michelle explained she knew about gender bias in engineering but did not see it as a deterrent. "I know that some people are going to have that bias, but not nearly as many. And that's their problem, not mine, but I can make, I can make a difference to change their minds."

Prove I can do it. Referring to her persistence in engineering, Marge indicated, "I don't know if I'm proving something to myself or other people. I have never backed down from a challenge. I refuse to back down from challenges. I'm going to prove something wrong." Quinn also described looking forward to achieving her goal, "I'm excited for the day I graduate to prove to everyone that I am, I can do this, and I'm excited to prove it to myself." She added with a laugh, "It's going to validate that I am intelligent, and I am professional, and I can be an adult."

Role model for siblings. Angela wanted to be a role model for her siblings and hoped that seeing her doing something she loved would inspire them to do what they loved.

In summary, participants cited many reasons for their persistence. The most common reasons women gave for staying in an engineering major were a desire to help others and make a difference on a large scale, the potential for a higher than average salary, a love of learning and challenges in engineering, a desire to use outreach strategies to educate young girls and decrease the engineering gender gap, and a sense of community and support they developed as engineering students and members of SWE.

Summary

Participants shared their experiences as women in engineering majors. These experiences were explored in-depth within six themes that emerged from interviews. Next, fifteen personal characteristics were identified during data analysis and illustrated using participant quotes. Finally, a summary of participant's responses to direct questioning about their choice to stay in an engineering major with supporting quotes was presented according to the frequency of participants who spoke on each issue.

It became apparent that participants, despite the rigor and massive quantity of homework reported, enjoyed learning about and challenges presented in their courses. They also described positive working relationships with faculty whom participants saw as being very helpful and willing to guide and mentor students who were willing to ask for help. Participants looked forward to future careers when they could use their skills and talents to help others. They believed jobs in engineering to be relatively recession-proof and counted on a level of income that would allow them to support themselves and their families. There were some discussions about being minorities as women in engineering that they had not expected the percentage of women in their classes to be so low, at about 13 percent. Participants found most interactions with classmates and faculty to be respectful. They did note that younger males, usually right out of high school, seemed to be the most biased and dismissive of them in labs and during group projects. However, they found support and encouragement with their peers and especially within SWE. Participants also enjoyed outreach activities with SWE and were determined to work towards equity. They saw positive changes occurring but knew that equity might never happen in engineering.

CHAPTER V

DISCUSSION

The purpose of this qualitative study was to explore lived experiences of successful women enrolled in engineering majors as they persisted to graduation. Departing from a line of research existing at the time of this study that primarily examined why women leave engineering, this phenomenological study sought to understand participants' experiences and to identify characteristics of participants and how they supported their choice to persist to graduation in engineering. The following research questions guided this study:

1. What lived experiences do women engineering majors believe contribute to their choice to persist to graduation?
2. What personal characteristics do women engineering majors believe contribute to their choice to persist to graduation?
3. How do participants explain why they stay in an engineering major?

Methodology

For this qualitative study, I used phenomenological methods to explore the meaning women engineering majors constructed from their experiences in undergraduate engineering programs. Semi-structured interviews facilitated discussion as participants, and I delved deeply into their lived experiences as engineering majors. Through thematic analysis of participants' experiences, I identified six themes: (a) as an engineer, I will build a better life for others and myself; (b) I have what it takes to succeed in engineering, even though others may not think so; (c) gender influences persistence; (d) support factors contribute to student success; (e) use your talents to do what you love in your engineering career; (f) discouragers must be overcome in an engineering major. Exploration of themes led to insights into the essence of experiences that led to a participant's choice to stay in a field that has historically been male-dominated.

Summary of Findings

Six themes emerged from the interviews and data analysis process. Also, fifteen characteristics were identified as important for women to persist in an engineering major. Last, reasons participants stayed in engineering were explored. Chapter IV included an in-depth description of the themes with supporting participant quotes. Chapter IV also presented fifteen characteristics identified in women participants who were successfully enrolled in engineering majors, and reasons they stayed in engineering and showed supporting evidence for these findings in quotes by participants. This section contains a summary of the findings organized by research question and is followed by a discussion of the results.

Research Question 1

Research Question 1 asked: What lived experiences do women engineering majors believe contribute to their choice to persist to graduation? In researching this question, six themes emerged from the data.

Theme I: As an engineer, I will build a better life for others and myself. Participants shared their excitement about entering the work world and using their engineering degrees to help others as well as creating secure futures for themselves.

Quinn expressed this desire as wanting to "save the world," and Julie explained she wanted to "do something big." Both were confident that while working as engineers, they would be able to build a career helping others and make the world a better place for themselves and others. The women understood engineering was a demanding major but welcomed the challenges and looked forward to contributing to efforts to make the world a better place through their work as engineers.

Theme II: I have what it takes to succeed in engineering, even though others may not think so. Participants were determined to succeed and were confident in their abilities to meet challenges from interactions with faculty and classmates, difficult and copious amounts of coursework, and navigating the professional world of engineering. Participants explained that engineering curriculum is a struggle for most students but the women attributed their persistence to their determination, perseverance, and strong math skills. Rebecca explained the struggle for her included sacrifices: "It's a full time, it's not a college degree where you're going to, you know, go and find yourself and be able to do all this stuff, like it's, *you're in engineering, and it's like all in* [emphasis added]." Others acknowledged challenges, but they believed in their abilities and resourcefulness when faced with obstacles or barriers. Ashley was confident in her ability to rise above challenges when struggling with coursework, "I knew that even if I didn't get something I'd be able to figure it out." Several women discussed their intelligence and the notion that some women get intimidated as not everyone has what it takes to succeed in engineering. For example, Jamie explained engineering majors needed to be "naturally intelligent and ambitious to go into engineering . . . you have to be hard working to make it through especially with a high GPA." Duckworth, Peterson, Matthews, and Kelly's

(2007) research on grit contradicts this idea, and their findings showed that while intelligence and conscientiousness are important in determining success, perseverance might be just as important. Buse, Billmoria, and Perelli (2013) suggested that career challenges and self-identifying as engineers motivated persistence, and Marra, Rodgers, Shen, and Bogue (2009) reported that strong self-efficacy beliefs could help women persist when they are in the minority in classes. The *Why So Few* (Hill, Corbett, & St. Rose, 2010) report recommended educating students about bias and helping them understand that intellectual and spatial skills are not innate, rather they can be developed over time.

Participants also voiced a common understanding that they would have to continue to work harder to earn respect of current classmates and future colleagues because of seemingly unshakable gender stereotypes. They recognized and were proud of progress towards parity; but as Michelle stated, "You're going to have to work harder to gain the same prestige as the guy doing the same job as you because you're a girl in that person's eyes."

Working harder meant increased stress for participants. However, they learned to set limits and developed strategies to maintain as balanced a lifestyle as possible. This finding corresponds with Grossman and Porche's (2014) research regarding women developing resilience as they encounter and manage microaggressions during interactions with others in their engineering departments. Participants' stated desires to persist despite bias-related reflections. Miller et al. (2015) found only two percent of women in their study reported being deterred by gender discrimination, and Bella and Crisp (2016) suggested women in STEM fields developed a higher level of resilience to negative stereotypes than did women from non-STEM fields.

One finding in this study paralleled those of Vogt's (2003) quantitative study that used Bandura's (1986) SCT to measure factors related to the self, behavior, and the environment. Vogt found women were about as confident as men were, but had a slightly less sense of self-efficacy. In this study, personal agency supported participant self-efficacy as shown in their ability to reframe self-doubt and put things in perspective using affirmative self-talk. Comparable to Vogt's results, women in this study also described expending considerable effort and organizational skills to complete assignments and get good grades.

Theme III: Gender influences persistence. At the time of interviews in this study, women interviewed were fully aware of the gender imbalance in engineering, and they all discussed gender issues they encountered, some even before entering college. Jamie described a teacher in elementary school who might have deterred her from pursuing a career in engineering when Jamie's teacher informed her class that girls were good at literature and boys were good at science and math; however, Jamie excelled in science and math, but struggled with literature. Women in this study recognized there were gender stereotyped roles in their families of origin and in classroom settings that also had contributed to their wondering at times if they had a right to be in engineering. They gave examples of stereotypes, such as: not learning how to use tools from working with their dads, and being ignored by or putting up with sexist comments from younger male classmates. Most participants saw these issues as more annoying than anything else, but these interactions were not something they could ignore entirely as subtle signs arose occasionally. This data mirrored Vogt's (2003) findings that gender biases existed but appeared to be a lesser issue; the women from Vogt's study recognized gender bias in their departments, but did not see it as a barrier. This finding is reminiscent of Mickelson's (1989) Pollyanna hypothesis, which posits that as young women leave high school, they have an optimistic view of the world. They also have an awareness of gender biases but believe "the women's movement" drove away such issues and cleared the path to gender equity as the realities of a chilly climate, or leaky pipeline have not yet interfered with their dreams. Participants were indeed aware of historical biases, but perhaps did not recognize implicit biased behavior they encountered in their engineering departments as barriers.

Unlike the other women participants who viewed themselves as advocates and role models, Angela talked about women in engineering as being not normal, referring to the gender imbalance. She and others, however, were shocked when they walked into their first engineering classes and realized the disparate ratio of women to men in their classes. She added that in one class there were forty men and two women, so the women stood out. However, participants reported instructors and most their male classmates did not treat them any differently, and some acknowledged feeling special because they had succeeded where other women had not. Then again, there were times when participants had experiences that left them uncomfortable, feeling unwelcomed, and wondering if they had made a mistake declaring an engineering major. One example was shared by Quinn, as she explained there was no women's restroom when she started, just a typed sign taped on a door that declared the room to be the "women's restroom." On one hand, she reported feeling a sense of pride because she chose to persist and many others had not. On the other hand, that feeling was not consistent for her, as she explained that women are often highly encouraged to go into STEM fields, and society tells them they are good enough to do so. However, she noted it seemed odd that if members of society truly believed women were good enough, they should not have to verbalize it. Quinn concluded that this issue led her to believe she had to prove herself to men and that was disconcerting.

Women participants addressed the issue of gender imbalance numerous times during interviews and indicated the gender equity issue in engineering would not be resolved for a long time. Ashley noted, “I just don’t think we’re ever going to get there . . . There would need to be so many changes in other majors too . . . giant shifts in every area of colleges, and I don’t see that happening anytime soon.” However, the women were hopeful as they had observed more women entering engineering than they had seen in the past, and they viewed the increase in numbers as an indication of progress.

Participants most often viewed faculty as helpful and encouraging, and they appreciated faculty sharing their professional development experiences, especially those related to bias and disrespect due to gender. Faculty members sharing of early experiences as students and recent experiences as faculty gave participants hope as they demonstrated changes were occurring in engineering and women’s persistence contributed to gaining ground regarding respect. However, not all faculty members were of the same mindset regarding women belonging in engineering. Participants also described interactions with faculty who treated them as children or discouraged them because of their gender. While bothersome, once again, these experiences were not viewed as significant barriers and participants found ways to manage them or sought assistance from other faculty who were supportive in a professional manner. Another finding that supports Bella and Crisp's (2016) research.

In summary, most participants did not realize the extent of the gender imbalance in engineering until they arrived at college but learned to accept it as a fact and developed ways to manage experiences, so they did not become insurmountable barriers. Of interest was participants' minimization of many instances of gender bias they reported having experienced as women engineering majors. While the women did encounter gender stereotypes and bias at times, reporting only a few experiences they found to be discouraging, the women most often discussed positive experiences with faculty and peers, male and female, who supported their efforts to persist. The women were determined to succeed regardless of challenging experiences and kept focused on their goal of becoming engineers.

Theme IV: Support factors contribute to student success. Participants talked about faculty support more than any other topic, expressing appreciation for various types of professional support provided by most faculty. Participants identified several other support factors including help from classmates, SWE members; and other support systems they built for themselves. Participants developed a strong sense of self-awareness that allowed them to seek assistance as needed; and they created a balanced lifestyle to manage the stress of engineering. Michelle explained there is a lot to learn, and students need to be self-reliant and take ownership of their education. Contrary to other participants, however, Michelle took it a step further as she explained her belief that students should teach themselves their material, and ask questions only when necessary to ensure they comprehend the material. Michelle did not appear to want or need as many support factors as other participants.

Most participants were open about needing to ask for help and encouraged the use of supports as needed. They often used faculty office hours and email for help with homework and study groups to keep on top of assignments, projects, and prepare for exams. For instance, Michelle appreciated faculty having an “open door policy,” and Angela suggested students ask for help and use services, as “any engineer would tell you to use your resources to your benefit.”

Participants encouraging faculty support echoed findings of Amelink and Creamer (2010) who showed that regular communication outside the classroom and interaction with faculty supported persistence. That said, Ashley observed that even though she asked for help, she felt conflicted at times because when she asked for help, she did not feel like the independent woman her parents had raised. Nevertheless, even with this internal conflict, she advised seeking faculty assistance as needed and noted that when she did ask for help, her instructors appreciated the fact that she cared enough to know every single problem on assignments.

Participants also advocated seeking assistance from peers. Marge expressed her appreciation for peer support as the students worked through challenging coursework together. “So, I really like that in engineering because you aren’t really trying to beat each other; you’re just trying to float. And you do that together.” Additionally, participants got emotional support from faculty, friends, and family, especially when discouraged. The women also shared appreciation for faculty who mentored them professionally and helped them in various ways outside their classrooms such as introducing them to professionals in the field or writing letters of recommendation.

Results of this study support other research including the following studies. Amelink and Creamer (2010) encouraged faculty engagement with students outside a classroom. The American Association of University Women's *Why So Few*? (Hill, Corbett, & St. Rose, 2010) report suggested supporting girls' interests and persistence in STEM fields by increasing visibility of female role models and educating students about bias. The AAUW's report, *Solving the Equation* (Corbett & Hill, 2015) encouraged colleges to develop a sense of community to support retention. Bossart and Bharti (2017) recognized the importance of engaging women early during their first year of college by showing them real life engineering applications to solve societal challenges. Litzler, Samuelson, and Lorah (2014) explored factors related to self-efficacy and recommended schools work to support students and build confidence and self-efficacy beliefs to increase retention. Geisinger and Raman (2013) reported successful engineering programs focused on improving retention efforts. Last, Shapiro and Sax (2011) emphasized a need: for strong pre-college math and science preparation, for explanation of connections between STEM careers and real-world applications, for faculty support and mentorship; and for collaborative learning.

To summarize, participants recognized challenges inherent in engineering courses and departments but learned to identify supports and seek assistance when needed. Interaction between students and faculty who were aware of gender issues and supportive of equity efforts inside and outside classrooms was viewed as essential to student success, as was collaboration with peers and developing support networks.

Theme V: Use your talents to do what you love in your engineering career. Participants recognized that being in a field they enjoyed helped them deal with challenges. They knew themselves well enough to use their strengths to their advantage, especially their strengths in math and science. For instance, participants loved mathematics and found joy in taking on challenges and solving problems. As Julie explained, she felt fortunate having had the opportunity to go into engineering because she had not been encouraged to do so, but "I just knew what I liked, and it just happened to drive me into engineering." The women were eager to continue their engineering education and begin careers that would provide stability. Participants also shared thoughts on future income and desires for job security. For instance, Rebecca explained she chose engineering because it would provide a decent salary, and it was a promising major. She noted that the economy may fluctuate, but there will always be a need for engineers due to the ever-changing nature of the field.

Theme VI: Discouragers must be overcome in an engineering major. Participants described overcoming frustrations and discouragements they faced as women engineers, such as sexual stereotypes, challenging coursework, isolation from friends and family, and the ongoing gender imbalance in engineering despite their efforts to educate future women engineers through SWE outreach to young girls. Throughout their time as engineering majors, participants were disheartened at times and most expressed some feelings of self-doubt. Nevertheless, they learned to use positive self-talk to reframe negative experiences, and in difficult times, they reminded themselves of their abilities and goals. Participants also learned to ask for academic and emotional support when needed and saw this as essential to their success.

Participants described a *vibe* they got at times that left them feeling they did not belong. Exploring this further, I discovered they were talking about aspects of a chilly climate, including explicit and implicit bias. When asked directly about any possible discouragers, participants gave a variety of answers. In addition to struggling with coursework, initially, the women described feeling disheartened with the realization that the gender imbalance was something that would not go away anytime soon. Participants recognized they would have to learn to manage gender-based issues, even though most believed they had not encountered many gender-based issues personally, or had not experienced explicit comments made directly to them. Angela did not describe it as implicit bias but explained she just did not like the feeling she had or chilling looks she got from male peers when she entered the shop. "No one's told me that, like, you know, but you get, you get looks, sometimes, especially when you're, like, in the shop." Respect by peers was another issue discussed repeatedly. For instance, Jamie reported having to come to terms with feeling as if she had to "fight a little bit harder than like they did to get their ideas heard" and while most described gender-based biases as annoyances rather than barriers; they still left participants wondering at times if they truly belonged. These comments are evidence of a chilly climate that persists in engineering at Middle America University.

In short, all the women had experiences with feeling discouraged. However, they believed in themselves and did not allow others or negative experiences to deter their progress. They all had a strong sense of self-efficacy and personal agency that supported their efforts to persist. This finding echoes those of Marra, Rodgers, Shen, and Bogue (2009) who reported results that showed self-efficacy was related to women student's plans to persist in engineering, a male-dominated field. This study supported Marra et al.'s (2009) results in that the women described their belief in their ability to succeed, or self-efficacy, despite difficult challenges and failures.

Research Question 2

Research Question 2 asked: What personal characteristics do women engineering majors believe contribute to their choice to persist to graduation? By conducting interviews and working through the data gathered over the course of many months, I identified 15 characteristics prevalent in the personalities of participants, all successful women engineering students. Detailed descriptions of these characteristics were provided in Chapter IV, and they were listed alphabetically so as not to suggest any order of importance. Characteristics that surfaced while scrutinizing data and emergent themes included: ambitious, collaborative, committed, competitive, confident, creative, determined, focused, hardworking, independent, intelligent, organized, persistent, prepared, and resourceful.

Reflecting on my interactions with participants during interviews, this list came as no surprise as these characteristics were evident in our conversations. Analysis of these characteristics resulted in the following assertions. These women were impressive and came across as *strong independent women,* a phrase that was used by more than one woman. Participants were assertive in their presentation and discussed successes and failures openly and honestly. They described how their commitment to altruism and success, as well as their determination and focus, drove and maintained their desire to persist. They also explained they felt a need to be organized and to work hard to manage challenging coursework and succeed in their chosen majors.

Research Question 3

Research Question 3 asked: How do participants explain why they stay in an engineering major? At the end of interviews, I asked participants directly why they stayed in an engineering major, but there was no one specific answer to that question. Responses were as varied as the women themselves, meaning there were some similarities, but they each were unique unto themselves. There was no apparent correlation among individuals having an engineer as a family member, completion of AP classes, or to participation in co-curricular organizations. The most consistent responses across participants were that engineering is a field that is always changing, it offers job security with good pay, engineers make life better for people, and SWE provides essential supports and opportunities for members. Participants believed that engineers do "big things" that can help many people in many ways, from developing medical supplies and medications to creating products and devices that make life easier, to designing and building safe buildings and bridges.

Other common responses included a love of learning, challenges engineering provides, a desire to do outreach to help increase the number of women in engineering, and a need to prove to themselves and others that they could be successful in engineering. Less frequent responses included being in too far to quit, a desire to not let parents or themselves down, and a desire to give back to their family, financially, after graduation. An overview of participant responses to the question of why participants stay in engineering was included in Appendix G with a breakdown by participant.

Discussion

One of the most striking findings from this study was that when a participant's usual high level of confidence was damaged by a situation or comment that left them feeling doubtful of their abilities or worth as a woman in engineering, they worked hard to restore their confidence. Angela described an experience in which she had communicated her confidence assertively when she encountered male students who appeared to be bewildered as she entered a shop to work on an assignment. She did not back down, as it seemed they expected; rather, she stated, "Yes, I am a female, and I am in the shop with you, and I guarantee you I know what I'm doing." Publicly standing one's ground was not always as easy as Angela made it look. Finding herself unsettled after a particularly disrespectful interaction with sexist male classmates, Rose withdrew to privately recover and reboot her confidence. She told herself, "No, I'm here. I'm doing this. I'm still valued in this community. You don't get to have a say in how I run things."

For some participants, confidence was something they had to develop and work to maintain. As Julie described an experience with her parents, she noted she had had to remind herself, "It doesn't matter what they say," because she believed in her ability to succeed despite her parents telling her she would not be successful in engineering. Julie admitted to having doubts at times, but stated she received support from friends and worked on internalizing feelings of confidence, "I think I'm getting better at it [self-confidence], definitely. I'm slowly getting there." And Jamie reminded herself that "she could do it" after a failure had damaged her confidence, "But you got an 'A' in differential equations when you thought you were going to have to drop that class . . . It's stuff like that . . . keeps you going." Rebecca stated that it builds her confidence when she reminds herself, "I don't need to be 100 percent confident" when working on a difficult problem. Finally, Michelle shared that she thought, "Women need to believe in themselves more and not let their own preconceptions determine what they are or are not capable of doing." She went on to explain that in the past, she let preconceptions interfere with her progress towards goal attainment and she saw the same thing happening "in other girls that I know that are in sciency fields." Michelle had witnessed how preconceptions influenced women to think they could or could not do something. She noted that she thinks some women are "a lot harder on themselves than they need to be" but did not understand and could not articulate why it was that way. However, she then added that it might be because "we have higher expectations of ourselves . . . because we're in fields that not a lot of women are in; so, we think that we have to be really smart."

When participants failed, or things did not go as planned or hoped for, participants put things in perspective and rose above a given incident or failure. For example, Rebecca described self-imposed feelings of insecurity and noted she would remind herself of this when she faced difficulty in classes; and Ashley described dealing with "uncertainty" and "self-doubt" as a first-year engineering major, but soon learned to put things in perspective when she found out that others felt just as unprepared at times. Along this line, some participants described a high level of self-confidence but also admitted to feeling doubt at times. Upon reflection, however, they understood that doubts were fleeting, and they could reframe negative experiences or emotions to boost confidence or seek support when needed.

Participants also recognized that being women in engineering in and of itself was challenging and learned to be kinder to themselves once they realized they were doing something that many women could not. What participants did not acknowledge, or perhaps even recognize, was the possibility that microaggressions could have contributed to those negative experiences. This finding supports Bella and Crisp's (2016) report that women in STEM develop resiliency when faced with repeated negative stereotypes and microaggressions. Participant reports of use of coping strategies supports Grossman and Porche's (2014) findings that found resilient behaviors in participants who had learned to cope with microaggressions. Could it be this hard-earned resilience is at the heart of Miller et al.'s (2015) report that gender discrimination did not deter female participant's persistence in engineering as indicated by less than 2 percent of women's responses? Miller et al. suggested this finding might reveal that structural interventions such as those listed above could signal a change in historically chilly engineering environments to ones that are more welcoming and supportive of women.

Participants in this study advocated for reaching out to young girls in middle school or even earlier when possible. Angela highlighted the issue. "The more people who become aware of or/and get aware, especially at a young age, it is very beneficial to us." Ackerman, Kanfer, and Beier (2013) also encouraged support for STEM education before students reach high school. Jamie encouraged "telling girls at a very young age, like, that math and science is a woman's field . . . well, not necessarily a women's field, but it is open to women, too" and that it is not just for men.

Participants also suggested educating parents along with young girls about engineering, as many people do not understand what engineers do. Jamie observed parents at SWE outreach events who also showed interest and excitement as their daughters participated in activities. She felt including parents in engineering outreach activities was important to recruitment efforts, “They seem more engaged in, like, pushing their children into STEM fields, too.”

In a conversation with the dean of the engineering college at the study site (personal communication, October 13, 2015), the dean made it clear that the college supported working towards gender equity and noted faculty were actively working on changing “the conversation” (National Academy of Sciences, 2008). The faculty’s efforts had not gone unnoticed by participants who, to a person, remarked about the encouragement and assistance faculty provided them in a gender equitable manner. Along the same line, Geisinger and Raman (2013) reported attrition is costly, and retention efforts are an essential part of changing the imbalance in engineering. Geisinger and Raman concluded that results of their literature review showed successful programs focused on changing at least one of the following factors known to contribute to attrition: classroom and economic climate, grades and conceptual understanding, self-efficacy and self-confidence, high school preparation, interest and career goals, and race and gender. Data from this study appeared to support this conclusion by Geisinger and Raman, as evidenced by the dean’s comments and the fact that participants talked about more women coming into classes behind them.

In summary, while participants gave a variety of responses as to why they chose to stay in an engineering major, it became evident that a strong sense of personal agency and self-efficacy supported persistence efforts. Also significant was the need to support outreach efforts to young girls, especially through organizations such as SWE, as SWE members in this study indicated a genuine interest and willingness to work towards parity. Reported gender issues reinforced the need to work systemically to create policies and programs that will continue to encourage gender equity in engineering classrooms.

Implications for Theory

The goal of this phenomenological study was not to test Lent, Brown, & Hackett's (1994, 2000) Social Cognitive Career Theory (SCCT) or measure factors related to women's persistence in engineering, rather the SCCT model simply provided the frame for understanding women's choices to stay in an engineering major. This qualitative phenomenological study's findings contribute to existing, mostly quantitative research by providing deeper insights into career development factors associated with SCCT such as interests, choice, and success. More specifically, participants described self-efficacy and outcome expectations, identified by Lent, Brown, and Hackett as "central mechanisms through which learning experiences are translated into interest, choice (or commitment), and persistence" (Miller et al., 2015, p. 60). Self-efficacy was demonstrated through discussion of participants' belief in their intelligence, confidence, and abilities to succeed despite challenges faced as engineering majors. Outcome expectations were revealed in participant discussion of their beliefs and hopes for the future. They were confident that engineering would provide them with a career in a field they were interested and invested in, a solid income, a vehicle to help others by making the world a better place, and chance to make a difference for themselves, their families, and other women.

Implications for Practice

Women participants spoke about their experiences in hopes that someone would hear their voices and continue to work towards gender equity in engineering. One of the most meaningful experiences reported by all participants was the incredible faculty support they found within their departments. As such, faculty should be encouraged to continue to be accessible as much as possible and reach out to students they see struggling. Something as simple as answering a question via email after office hours, or emailing a student asking them to come in for help after a particularly rough exam demonstrates that faculty care about an individual student's success and strengthens a students' resolve to persist. Angela encouraged the use of office hours and noted, "I think that's my biggest thing for me, and if I can't, then I'll e-mail them . . . they're usually pretty flexible about it. You know I haven't had any bad experiences with that."

Participants recognized that students sometimes are not as prepared in math as they should be and may be embarrassed or afraid to ask for help, leading to attrition. Faculty should teach students that asking for help when struggling or failing is part of the learning process and necessary for academic attainment. Angela spoke in support of this issue. "But she [instructor] actually e-mailed me. She was like . . . I want to help you out, like come into my office hours . . . she was able to sit down with me and explain things different ways. Make sure I understood." Ashley described a need for faculty to encourage students to ask for support, and the fact that "professors don't bring [it] up nearly as much" as is needed. This idea was supported in the *Why So Few?* report (Hill, Corbett, & St. Rose, 2010) as Hill et al. encouraged faculty to help students understand that intellectual and spatial skills can be developed. Students need to hear this message as early as possible, and know the act of asking for help is not a weakness or a sign of a lack of independence; rather, it is important to support the learning process.

Faculty can also facilitate or encourage students to use tutors and create study groups early on, so students have additional support as they move through a program. Angela supported using tutoring services at a Living Learning Community (LLC) for engineers. She added tutors at the LLC were a good resource because they were about the same age as she was and took the same classes. Participants found peers to be an invaluable resource as they too were struggling with difficult material, and they could help each other. Specifically, Angela suggested students find others and form study groups so they could mutually support one another.

One faculty member was reported to have said that in engineering programs, students were viewed and treated equitably, but explained women would face bias in future careers. However, participants more often described bias in classmates, not faculty. They noted bias was usually evident during group work when a faculty member was not present. Amelink and Creamer (2010) also reported disrespectful behavior occurred in the absence of faculty supervision. Perhaps faculty should make it clear on their syllabi that biased comments are not acceptable and encourage students to report such incidents to faculty or the campus Title IX Coordinator, especially if a pattern of such behavior emerges. Education on "implicit bias" should take place in high school to prepare all students to recognize and counter such behavior.

Another area where participants sometimes saw biased behavior was in tutoring labs. Participants observed some tutors focusing on female students because they were more fun to talk to than male students. Providing such selective assistance is problematic because male students may not get the assistance they need, and according to one participant, some tutors used their positions to try to find dates. Participants also explained that just because someone is smart, does not mean he or she can teach. Tutors should be educated about professional behavior and screened to ensure they can convey material concepts in an understandable way and not in such a way as might be construed as mansplaining.

One participant shared an experience from elementary school because she wanted to make sure teachers do not give biased messages to their students. She related an incident where a teacher told her girls are good at literature and boys are good at math and science. However, this participant excelled in math and science and did poorly in literature. As a young student, she thought there was something wrong with her, so she shied away from math and science for a while even though she loved them. Jamie advised:

> So, I would really like to see teachers never tell their students that [girls are good at literature and boys are good at math and science] and to just kind of let each individual find themselves. Instead of forcing those gender roles on so young . . . because like the earlier you force them [stereotypical gender roles] on, the more they just kind of accept that. And, that's the way things are, and that's how they're always supposed to be, and that is not necessarily true.

Unfortunately, Jamie's situation was not unique, and research has shown that teachers continue to perpetuate stereotypes in classrooms (Morrissette, Jesme, & Hunter, 2017). Understanding Jamie's experience is essential, and teachers should consider her advice to facilitate changing classroom cultures to be more gender neutral. This is important as Blickenstaff (2005), and Gayles and Ampaw (2014) showed that undergraduate women become dissatisfied with biased academic environments and leave at higher rates than men.

Future Research

Data gathered through interviews with participants indicated their engineering departments were becoming more welcoming and supportive of women engineering majors despite an overall pervasive gender imbalance in engineering majors that showed an average female enrollment of about 13 percent. However, some women described incidents where they had to endure sexist comments and behaviors by some younger male students, whom they portrayed as being dismissive and disrespectful towards their female peers. I recommend exploration of this phenomenon with first-year students to gain a better understanding of the behaviors and underlying dynamics involved. Along this line, internalized sexism (Bearman, Korobov, & Thorne, 2009) could have contributed to participants' limited recognition and reporting of gender bias. Therefore, future research should investigate undergraduate women engineering majors and the role internalized sexism plays in their interactions with classmates and engineering faculty.

Another potential avenue to explore is with faculty. What do they see as being necessary outside of class support for students? What strategies have they tried that have been successful in helping students struggling with course material? What forms of communication do they prefer, such as office hours or email? I suggest an increase in administrative support for faculty professional development, especially in areas such as work-life balance, interpersonal communication, and implicit bias, just as the authors of the *Why So Few?* report (Hill, Corbett, & St. Rose, 2010) recommended.

Participants discussed concerns related to the "woman card." They saw it as both a positive as it could help them in their careers, but also feared having to wonder if, when they got a job, they were the most qualified applicant or did they get a job because of their gender and a companies' desire to balance their workforce. Ashley clarified that women in engineering majors look at gender as an extra item on their resumes; but at the same time, she said because they know it gives them an advantage, they sometimes see gender as a disability. Ashley explained further that it is nice to have that extra woman card, but it is also a source of concern as she knows someone can throw that back in her face. How does this concept affect male and female engineering students as they approach graduation and begin their engineering careers?

Finally, participants described isolation due to the amount of work required and their choice to study versus spending time with family and friends. What impact, if any, does this have on attrition, and if so, what are some possible strategies to minimize any negative effects. This might be another good area for further research.

Conclusions

Women engineering students who believed in the importance of sharing their experiences openly and honestly, and who wanted to have their voices heard made this study possible. They viewed their participation in the study as a contribution to on-going efforts to create a more balanced workforce in engineering. Themes and findings that emerged from data collected during personal interviews with participants add to existing research on gender equity in engineering.

The purpose of this study was to understand women's experiences as engineering majors as they persisted towards graduation. A quote from Angela captured a sentiment expressed by all participants. “There is a wide range of things that kind of keep you going or keep you motivated.” During interviews and data analysis, it became apparent most participants genuinely loved engineering coursework and challenges and were looking forward to financially secure careers that would allow them to help themselves and their families and make life better for others. The women recognized their abilities in math and science and acknowledged privileges their intelligence afforded them. They wanted to utilize their attributes to their maximum capacity. A desire not to let themselves or their families down supported persistence, and some admitted that having made a commitment to their major their pride motivated them to continue. The women were committed to doing outreach programming and to serving as role models in hopes of attracting more women to the field. Finally, the women felt a sense of camaraderie and community with classmates who encouraged their persistence.

Study findings were encouraging as participants found their programs and faculty to be helpful, supporting their success. No one shared experiences about explicit bias in classrooms other than in labs with peers who made inappropriate comments in the absence of faculty. The limited reporting of bias may indicate that engineering classrooms at this university may be seeing a shift from a historical chilly climate to a more equitable one. There were only a couple of comments about faculty bias, but the women put them in perspective. They explained that the faculty who had made the comments were either older males or from countries where gender equity values differed from those in the U.S. The women stated they did not let the comments bother them; instead, they viewed them as more of an annoyance. Were the incidents of bias and these comments merely annoying or a function of something along the lines of Mickelson’s

(1989) Pollyanna hypothesis? Regardless, Angela spoke less like Pollyanna and more like Wonder Woman as she summed up her hopes and her beliefs about why women engineering majors persist, “That’s why we push through and do all these challenging things, and get involved. So other people are aware, and hopefully, that trend just keeps going and going, and we’re able to have more females.” If the caliber of the women in this study was an indication of what we can expect in the future, perhaps there is hope for gender balance in engineering after all.

APPENDICES

Appendix A
Recruitment Letter

My name is Vicki Morrissette. In addition to serving as a university employee, I am a doctoral student in the Department of Educational Leadership. It is in my role as a graduate student that I am sending you this invitation to participate in my dissertation research on women engineering majors at Middle America University (pseudonym). During this study, I hope to learn about and develop an understanding of women's experiences as engineering majors at Middle America University, and I would greatly appreciate your participation. Participation is voluntary and you may opt out at any point.

If you choose to participate, you will be asked to meet twice. During the first interview, participants will be asked about their experiences as a woman engineering major. During the second interview, participants and the researcher will review the interview transcription for accuracy, discuss any feedback or additional thoughts, and the researcher may ask follow up questions for clarification. Both interviews will be audio recorded and transcribed, and will take about 60-90 minutes each.

As a token of my appreciation, participants will be entered in a drawing for one of four $25 gift cards at the end of their participation interview process. All participants who participate in both interviews will be entered in a second drawing for one of two gift cards (one $25 gift card or one $50 gift card). Participants will be able to select their preferred type of gift card to a local retail or dining establishment.

This research will help us understand participants' experiences and may lead to increased support for women in engineering majors. Please let me know if you have any questions about participating in the study. Thank you for considering participation in my study.

Vicki Morrissette

Appendix B
Pilot Study

Background

The purpose of the pilot study was to ensure interview questions elicited adequate responses to my research questions. I received IRB approval to conduct a pilot study in December 2016, and completed it in February 2017. Due to a limited number of possible participants in engineering, I used mathematics majors for the pilot study, as they are also STEM students and may have had similar experiences as engineering students. Four individuals responded to my request for participants. However, two declined after receiving the study information and consent form, and only one other person met the selection criteria. I met with the one participant and conducted two interviews following the pilot interview protocol below. I transcribed audiotaped interviews and reviewed them for accuracy.

I am grateful that I took the time to go through the pilot process. Not only did I achieve my stated goal of testing interview questions, I also learned firsthand about IRB and Institutional Research processes, and that I need to relax and more fully engage with a participant, rather than focusing on the next question to be asked. As I reflected on the interview, member checking, and transcription process, I realized I needed to simply ask open-ended questions and then wait for a participant to describe their experiences, prompting only if needed until a response is as complete as possible. This strategy required me to sit in silence at times and to allow participants time to reflect and to give responses that were more descriptive. After conducting the pilot study, I simplified and reduced the number of original interview questions. For clarification purposes, I revised the demographics question for class status to number of completed credits and year in school. I found that the interview protocol in the pilot study worked well to structure the overall process so I followed it during my final study. Transcription of pilot interviews proved to be more difficult and cumbersome than expected, so I hired a professional, on-line transcription service to transcribe the full study interviews verbatim, then reviewed transcripts and made corrections while listening to audio tapes to ensure accuracy.

Interview Questions for Pilot Study

It is common knowledge that STEM fields have traditionally been male dominated. While this is changing in some STEM areas, women continue to be underrepresented, or outnumbered, in classrooms and later on the job. I would like you to feel free to share any thoughts you have as we talk so I can develop an understanding of what it is like for you as a woman who has chosen to persist in a STEM major.

1. I would like to start by hearing about how the values and beliefs you developed as a child may have influenced your decision to go into STEM.
    a. Think about sitting around the dinner table with family, participating in class discussions, or hanging out with friends reading magazines, watching TV, or using social media as a girl, what messages about career opportunities for men and women did you hear growing up?
    b. Was there a gender difference in division of labor between mom and dad, brothers and sisters? If so, what was it and how do you feel about it now that you have grown up?
    c. As a young girl, how did you learn about STEM and the work people do in STEM fields?

d. When you told your parents you were going to go into STEM, what did they say, or in what ways did they react?

2. Now, I would like to get a picture of your daily life as a woman in STEM, so please think about your weekly schedule of classes and course work and walk me through what a typical week would look like.

3. Think back to when you first knew that you were going to go into a STEM field, how did you know it?

    a. What were some of the pros and cons you considered as you moved forward to declaring your STEM major?

4. Tell me about a person in a STEM career who may have been a role model in your life.

    a. What about that person and their work do you admire most?

    b. In what ways did they influence your decision to go into STEM?

5. There is research that indicates that there has been an unwelcoming environment in STEM education. This situation is known as a "chilly climate" that has led to women feeling less than welcome and at times, they have been discouraged from entering or persisting in a STEM field.

    a. In what direct or indirect ways, if any, have you or female classmates been discouraged from entering or persisting in STEM?

    b. What was your emotional reaction to the discouraging comments or behavior?

6. I would like to know more about what it has been like to be a woman in a STEM program.

a. Please think back from when you first started in your STEM major to now, and tell me about your most memorable experiences in your program.

b. What educational challenges have you faced as a woman STEM major?

c. What social challenges have you faced as a woman STEM major?

7. Now, I would like to hear about your experiences with your classmates in and out of the classroom.

a. Please describe 2-3 examples of your best STEM classroom or lab experiences.

b. Please describe 2-3 examples of your worst STEM classroom or lab experiences.

c. Please describe the dynamics you have observed or experienced as part of STEM related group assignments.

d. Please describe the difference and similarities of the out of class interactions with male and female classmates.

8. Shifting gears, a little bit, I would like to talk about your experiences with your faculty members. (You do not need to identify the individuals or the classes they teach. If you inadvertently identify someone or a class during the interview, I will assign the person or class a code for use on the interview transcript.) You have taken classes from and perhaps worked on projects with your faculty members.

a. If I had been present during classroom experiences with your favorite instructor, what would I have seen or heard?

b. How would classroom experiences with your least favorite instructor differed?

c. Please, describe any professional experiences you may have had with faculty outside of the classroom.

d. What have these interactions meant to you?

9. Suppose you had a favorite little sister that was thinking about going into STEM, what three points would you share with her.

10. If you could sum up your experiences as a woman STEM major, what three words would you use?

11. Is there anything else you would like to tell me about your experiences as an STEM major?

12. As we are coming to the end of our time today, I would like you to take a moment to reflect on this interview experience. What have you learned about yourself today?

13. Do you have any questions about the study?

Appendix C
Interview Protocol – First Round of Interviews

Participant Code: _________________ Date of Interview: ___________________

Interviewer: Victoria Morrissette Place of Interview: __________________

Day of Interview Procedure

1. Greet the participant at the agreed upon place as scheduled.
2. Explain consent as detailed in the consent document sent to participant prior to meeting and answer any questions.
3. Remind participant that participation is voluntary and they can decline to answer any questions(s), take a break, or end the interview and exit the study entirely at any time without penalty.
4. Review confidentiality and data security measures. Explain that the interview will be recorded and I will take brief notes as we talk.
5. Explain that participant does not need to identify classmates or faculty members. If they inadvertently identify someone or a class during the interview, I will assign the person or class a code for use on the interview transcript.
6. Have participant **sign the consent form**. Offer to either send a scanned copy of the consent form to participants via email or give them a copy at second interview as they prefer.
7. Warm up question(s) - START the tape recorder:
   A. Please, tell me a little bit about yourself, such as where are you from and how you chose Middle America University (Pseudonym).
   B. What do you hope to do with a degree in Engineering?

8. Check the tape recorder for sound and ensure it is working properly.

Interview Questions

1. When you told your **family and friends** you were going to go into engineering, what did they say, or how did they react? How did you feel and what did you think about it?

2. What were some of the **pros and cons you considered** as you chose an engineering major?

    a. Have you encountered these in your program? (If so, what did you do? How did you feel?)

3. a. Please describe an experience when you **felt encouraged** about going into engineering.

    b. Please describe an experience when you **felt discouraged** about going into engineering.

4. Please think your life as an engineering major and tell me about your **most memorable experiences** in your program.

5. What **challenges** have you faced as a woman engineering major?

6. Tell me about your experiences with your classmates individually and in groups.

    a. Describe any similarities or differences in your interactions with male and female classmates.

7. Please, describe any academic experiences you may have had with faculty or tutors outside of the classroom, and what have these interactions meant to you.

8. Suppose you had a little sister who was thinking about going into engineering, what three bits of advice would you share with her?

9. If you could sum up your experiences as a woman who has chosen to persist in an engineering major, what three words would you use and why.
10. Is there anything else you would like to tell me about your experiences as an engineering major?
11. Do you have any questions about the study?

Exit Statement

Thank you for meeting with me today. I have enjoyed visiting with you and hearing about your experiences.

As we previously discussed, I would like to meet with you again to review the transcription and make sure I captured your experiences accurately. I may ask additional questions for clarification and you can add any experiences that you think would be helpful. Would that still be okay? I will contact you (phone or email) as soon as the transcription is done to schedule a time that is convenient for you. Thank you again for participating in my study.

* Researcher will ask participant to complete an optional demographics form.

* When the interview has been transcribed, I will contact the participant to schedule the second interview.

* Prior to the second interview, researcher will check the transcripts by reviewing them while listening to the taped interviews.

Appendix D
Interview Protocol – Second Round of Interviews

Day of Second Interview Procedure

1. Greet the participant at the agreed upon place as scheduled.
2. Remind participant of consent issues, including the fact that participation is voluntary. Participant may decline to answer any questions(s), take a break, or end the interview and exit the study entirely at any time without penalty. Review confidentiality and data security measures; and finally, remind participant that the interview will be recorded and researcher will take brief notes as during the first interview.
3. Participants will be given a copy of the consent form if they did not choose to receive it by email after the first interview.
4. START the tape recorder.
5. Researcher will review transcript from first interview with participant and discuss any emergent themes.
6. Researcher may ask follow-up questions for clarification and the participant may add information or thoughts since the first interview.
7. Researcher will ask: As we are coming to the end of our time together, I would like you to take a moment to reflect on this experience and tell me what you have learned about yourself.
8. Researcher will answer any questions the participant asks.
9. Researcher will give participant preferred gift card as a token of appreciation.
10. Researcher will thank the participant for their participation in the study.

Appendix E
Atlas.ti Code Book With Final 32 Codes

Code Info	Comment
Ask for Support	Ask to get needs met *** Merged Comment from: Ask Questions (2017-09-25T20:25:40) *** Ask for help when needed
Believe in Self	*** Merged Comment from: worth getting to know-have something to offer (2017-09-25T20:30:38) *** Have to explain I have something to offer to get respect/equitable treatment
Career/Do What You Love	Do work that you enjoy doing and makes you happy//Foresee positive future lifestyle for self, future family, career//Won't have to worry about money or employment
Challenging (like the challenge)	Enjoy the challenge, need to be stimulated intellectually
Challenging (frustrating)	Discouraged by people/comments/actions that interfere with choice/progress to graduation
Choice of Major Decision	Researched different majors before selecting this one, comments related to how/why chose major
Communication (general soft skill)	Comments regarding need or importance of communication with others to work well together or complete a project
Determination	*** Merged Comment from: Goal Oriented (I'm Not a Quitter) (2017-09-25T20:39:33) *** I'm Not a Quitter, I am determined to finish this degree *** Merged Comment from: Ambition (2017-09-25T20:41:16) *** Desire to succeed in career/move up in ranks to level you want *** Merged Comment from: Prove I can do it (2017-09-25T20:50:18) *** Statements made about the need to prove they could do it to themselves or others

Code Info	Comment
Discouraged	Experiences where someone's behavior or words have felt discouraging (intentional & unintentional)
Educate Young Girls to Increase the Number of Women in Engineering	Comments regarding actions taken to support, or belief that educating young girls is important to increase the number of women in engineering
Encouraged	Description of instances where participant felt encouraged about going into, staying in engineering
Engineering Major is Hard Work	Comments about the rigorousness of engineering majors
Engineers Do Big Things (and I want to be a part of that)	A desire to make a difference, help people in a significant way
Engineers Make a Better Life	[no entry]
Enjoy Learning About Engineering	Enjoy academic subjects/classes related to future engineering career (includes math, chemistry, engineering major's required classes)
Faculty Sexism	*** Merged Comment from: Faculty Discouragement (2017-09-25T20:26:43) *** Comments or behaviors that are dismissive or blatantly discouraging regarding participants success as an engineering major or future engineer
Faculty Support	Actions and words that show faculty members care about the participant and their success
Family Support	Actions and words that show family members care about the participant and their success
Gender Imbalance	References to fewer women in engineering than men *** Merged Comment from: Male Dominated Thing ("The") (2017-09-25T21:13:32) *** The message that is conveyed repeatedly that engineering is a man's field

Code Info	Comment
Gender Stereotypes	Stereotype of it not being okay for a woman to be strong or independent; do historically male dominated job *** Merged Comment from: Engineering is Not Normal for Women (2017-09-25T21:05:47) *** Stereotype verbalized or otherwise conveyed to participants that they are not in the right field and that there is something wrong with it
Isolation	More hours spent studying means less contact with friend group / family / classmates
Make Connections for Support	*** Merged Comment from: Camaraderie (2017-09-25T20:28:58) *** Connecting with others, supporting efforts, don't feel alone *** Merged Comment from: Peer support (2017-09-25T20:34:01) *** Comments regarding getting support from classmates/peers in engineering
Money/Income	Future salary will be enough to support desired lifestyle/independence
Put Things into Perspective	Reports of instances where participant had to reframe their thinking to avoid feeling discouraged
Self-Talk	Self-reflection; Any comments participant mentions about what they have said to themselves to feel better, get motivated, encourage persistence, or remind self of accomplishments when struggling or having self-doubt *** Merged Comment from: Patience (With Self) (2017-09-25T21:15:29) *** If you're not patient with yourself, you get frustrated then you can't figure things out and won't succeed at the task *** Merged Comment from: Self-doubt (2017-09-25T21:15:30) *** Comments about doubting ability to succeed in classes/major
Sense of Accomplishment	Participants reports of special/meaningful accomplishments – validates that they are good enough to do this

Code Info	Comment
Strong Independent Woman (I can do it myself)	Description of instances or belief that one is capable of doing something on their own *** Merged Comment from: Independent (2017-09-25T20:30:00) *** Can take care of self/do things on my own
Study Groups	[no entry]
SWE Student Organization	*** Merged Comment from: SWE Opportunities (2017-09-25T20:36:57) *** Conferences, leadership skill building *** Merged Comment from: SWE Members Support One Another (2017-09-25T20:36:58) *** Members encourage others to do their best, take on new experiences/challenges *** Merged Comment from: SWE Outreach (2017-09-25T20:37:03) *** SWE outreach activities and reactions to participation in or creation/marketing of SWE outreach programming *** Merged Comment from: SWE Sense of Family (2017-09-25T20:37:05) *** Members look after one another as if in a family
Tutoring	[no entry]
Validation	Engineering major will validate that I'm intelligent, professional, worthwhile, belong in engineering
Work/Life/ Family Balance	Comments about need or suggestions for balance to reduce stress

Appendix F

32 Merged Codes With Categories, by Participant

(*All 9 Participants* = *Italics* / 7-8 Participants = All Others)

Code	Code Families (Categories)	Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Ask for Support / Ask Questions / Office Hours	Advice Faculty Personal Supportive Factors	X	X	X	X	X		X	X	X
Believe in Self / Worth Getting to Know-Have Something to Offer	Advice Personal Supportive Factors Why I Stay	X	X		X	X	X		X	X
Career/Do What You Love	Career Personal Supportive Factors Why I Stay	X	X	X	X	X	X	X	X	
Challenging (Like the Challenge)	Personal Supportive Factors Why I Stay	X	X	X		X	X	X		X
Challenging (Frustrating)	Discouragers Faculty Gender Group Personal	X	X	X	X	X	X	X	X	
Choice of Major Decision	Engineers Personal Supportive Factors	X	X	X	X		X	X	X	X
Communication (General Soft Skill)	Advice Supportive Factors	X	X	X	X	X	X		X	X

Code	Code Families (Categories)	Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Discouraged	*Discouragers Faculty Gender Group Personal*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Educate Young Girls to Increase the Number of Women in Engineering	Engineers Personal Supportive Factors SWE Why I Stay	X	X	X	X	X	X		X	X
Encouraged	Faculty Personal Supportive Factors SWE	X	X	X	X	X		X	X	X
Engineering Major Is Hard Work	*Engineers*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Engineers Do Big Things (And I Want to Be a Part of That)	Engineers Personal Supportive Factors Why I Stay	X		X	X		X	X	X	X
Engineers Make a Better Life	Engineers Personal Supportive Factors Why I Stay	X		X	X		X	X	X	X
Enjoy Learning About Engineering	*Engineers Personal Supportive Factors Why I Stay*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*

Code	Code Families (Categories)	Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Faculty Support	*Faculty* *Gender* *Supportive Factors*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Family Support	*Personal* *Supportive Factors*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Gender Imbalance	*Discouragers* *Gender* *Personal*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Gender Stereotypes	*Discouragers* *Gender* *Personal*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Goal Oriented (I'm Not a Quitter)	Personal Supportive Factors Why I Stay		X	X	X	X	X	X	X	X
Isolation	Discouragers Personal		X	X	X	X		X	X	X
Money/Income	Career Supportive Factors Why I Stay	X	X	X	X	X	X	X	X	
Peer Support	*Advice* *Group* *Supportive Factors* *SWE*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Prove I Can Do It	Personal Supportive Factors Why I Stay	X	X	X		X	X	X	X	X

Code	Code Families (Categories)	Angela	Jamie	Rebecca	Ashley	Michelle	Quinn	Marge	Rose	Julie
Put Things into Perspective	*Personal Supportive Factors*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*	*X*
Self-Confident	Personal Supportive Factors		X	X	X	X	X	X	X	X
Self-Talk	Personal Supportive Factors	X	X		X	X	X	X	X	
Sense of Accomplishment	Engineers Group Personal Supportive Factors	X	X	X	X		X	X		X
Strong Independent Woman (I Can Do It Myself)	Personal Supportive Factors Why I Stay	X	X	X		X		X	X	X
Study Groups	Supportive Factors		X	X	X		X	X	X	X
Tutoring	Discouragers Supportive Factors	X		X	X		X	X	X	X
Validation	Engineers Faculty Personal Supportive Factors SWE Why I Stay		X	X	X	X	X	X		X
Work/Life/Family Balance	Personal Supportive Factors Why I Stay	X	X	X	X	X	X	X		X

Appendix G

Overview of Responses to: Why Do You Stay in an Engineering Major?

Reasons to Stay in Engineering	Participants								
	Angela	Ashley	Jamie	Julie	Marge	Michelle	Quinn	Rebecca	Rose
	Credits								
	55	110	76	60	120	140	78	60	100
Don't Want to Let Family Down	X			X					
Good Job/ Successful Future	X	X		X					
Engineers Make Life Better/ Help Others/Make A Difference	X			X			X		X
Role Model for Siblings	X								
SWE/Campus Support		X	X		X				X
Good Income		X	X	X			X		
Outreach/Want to See More Women in Engineering		X	X	X		X			
Love Learning/ Challenges with Engineering		X	X			X	X		
Job Security		X						X	
In Too Far to Quit/ I'm Not a Quitter		X					X	X	
Know Not Many Can Make It/Use Strengths				X		X	X		
Confident I Can Make Own Decisions						X			
Know There Is Bias but I Can Make a Difference						X			
Prove I Can Do It.					X		X		
Help Parents Later	X						X		
Industry Always Changing/Variety				X			X		

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