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Grit and Female Graduates' Experiences in Engineering and Computer Science Programs

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Walden University
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Abstract

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MS, Walden University, 2010

BS, Houghton College, 1998

Dissertation Submitted in Partial Fulfillment

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Abstract

Institutions have implemented recruitment and retention initiatives in science, technology, engineering, and mathematics (STEM) degree programs; however, gender disparity of women in engineering and computer science programs persists. The purpose of this qualitative phenomenological study was to explore the lived experiences of female graduates from engineering and computer science programs. The conceptual framework was the theory of grit to explore how female students sustained their passion and perseverance through obstacles and adverse situations. Data were gathered through semistructured interviews with 17 female participants who graduated from engineering and computer science programs in the United States. Data were analyzed through a priori coding and thematic analysis. Six themes were identified: (a) resilience and perseverance through challenges, (b) finding passion to focus drive and determination, (c) build a support system, (d) confidence and belief in abilities, (e) advocate for self and other women, and (f) hard work is necessary for success. Findings may be used to develop equitable practices for all students, to reduce the presence of bias and stereotypes, and to promote targeted implementation of mentorship opportunities for female students in STEM programs.

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Dedication

This dissertation is dedicated to my husband and to our sons. Your sacrifice and support helped me to finish this doctorate. It's as much yours as it is mine.

I am also grateful to the Lord for helping me complete this journey. My sustaining faith and his care over me and my family are what made it possible to finish.

Acknowledgments

I would like to acknowledge my husband and my two sons. To my husband, you completed your doctoral journey only a short time before me, and your example was a deciding factor that I was not far behind and could do this too. To my sons, you often watched your parents study hard and sacrifice time to help make our family better. Your constant encouragement and care enabled us to complete our studies. Thank you.

I would also like to thank my parents and in-laws, family members, and friends for their ongoing support. Your encouragement helped me throughout this process.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

The demand for science, technology, engineering, and mathematics (STEM) graduates has increased; however, there are not enough STEM graduates to fill the open positions (Cheryan, Ziegler, Montoya, & Jiang, 2017; Rickels, 2017). Job projections indicated that there will be one million fewer graduates in STEM fields required by U.S. industries over the next 10 years (Handelsman & Smith, 2016; U.S. Department of Education, 2015). According to the U.S. Department of Labor (as cited in Jackson & Laanan, 2015), many of the fastest-growing careers and occupations will necessitate "significant science or mathematics training to successfully compete for a job" (pp. 132-133). Due to industry growth with foundations in science and technology, there are twice as many job openings as there are workers to fill the need (Jackson & Laanan, 2015). Exploring the lived experiences of women who have successfully navigated engineering and computer science programs may reveal supports that could lead to positive social change in the field.

For academic administrators and education leaders, there are two impending needs: to increase preparatory efforts to develop more students, teachers, and practitioners within STEM fields to educate and prepare the next generation's workforce, and to increase the number of workers to fill industry needs due to an aging workforce and competitive world market (Cheryan et al., 2017; Handelsman & Smith, 2016; Rickels, 2017). Enhancing STEM programs and degrees is essential to the development of the growth in the U.S. economy as future projections of job growth in most STEM fields have an above-average rate for future employment (Cheryan et al., 2017; Fayer,

Lacey, & Watson, 2017; National Center for Education Statistics, 2014). College leaders must educate and prepare the next generation's workforce to increase the number of workers industry needs due to an aging workforce and competitive global market (Cheryan et al., 2017; Handelsman & Smith, 2016; Rickels, 2017).

Fewer than 20% of the bachelor's degrees in engineering (19%) and computer science (18%) are earned by female students (National Science Board [NSB], 2016). The percentage of women in STEM fields remains low despite the many recruitment and retention efforts of women in STEM fields (Farrell & McHugh, 2017). Current research has indicated that for every five male graduates in a STEM degree, only one woman pursues and graduates with a STEM degree (Cheryan et al., 2017; Legewie & DiPrete, 2014). In the labor force, women represent less than 25% of STEM-related positions even though they make up almost half of the workforce (Cheryan et al., 2017; Kincaid, 2015; Rincón & George-Jackson, 2016).

Although some fields have decreased the gender gap and contain almost equal proportions of men and women, such as in biological sciences, chemistry, and mathematics, other fields, such as engineering and computer science, contain an ever-widening gender gap (Cheryan et al., 2017; Graf, Fry, & Funk, 2018). Of the 8.6 million STEM jobs available in 2015, 64% were in computer science and engineering (Fayer et al., 2017). These STEM fields also have the highest projections of future job growth and demonstrate the greatest need for qualified workers (Fayer et al., 2017). Furthermore, Fayer et al. (2017) stated that by 2024, computer information technology will have a job projection of half a million new jobs and engineering will have a quarter million new

jobs. However, women represent only 12-14% of the engineering workforce (Graf et al., 2018; Smith & Gayles, 2018). Also, women represent only 25% of the computer science workforce, and this percentage has declined from 32% in 1990 (Graf et al., 2018). Exploring the lived experiences of women who have been successful in STEM programs may reveal the supports and impediments these students encountered.

During a time of improved awareness of and focus on increasing females' interest and representation in STEM programs, the lack of parity in computer science and engineering is striking (Cheryan et al., 2017). The continuing gender disparity impedes potential contributions that talented women can provide through increased creativity, innovation, and intellect (Cheryan et al., 2017). Investigating factors that increase the retention of women in STEM fields, particularly in the fields of engineering and computer science, is necessary for impending industry needs (Smith & Gayles, 2017). From inclusive programing in artificial intelligence to cyber security representation, inclusion of women in these academic areas could enhance equity opportunities for future employment in these fields.

Background

As colleges and universities prepare students for the STEM workforce, research must focus on how to retain female students within computer science and engineering programs (Smith & Gayles, 2017). Researchers have found several factors associated with gender disparity in computer science and engineering (Smith & Gayles, 2017). One factor is the type of institutional or department environment, or school climate, which is a strong predictor of student achievement or student attrition (Incantalupo-Kuhner, 2015).

Departments communicate through implied and overt measures the expected structures, social norms, and values that guide the standards and policies in that field (National Academies of Sciences, Engineering, and Medicine, 2016; Rincón & George-Jackson, 2016). Because of this practice, the climate or culture of departments can influence a student's success or lack of success in that field (Rincón & George-Jackson, 2016).

Female students have reported that the cultures of computer science and engineering programs often contain systematic barriers through implicit stereotypes, expectations, and bias (National Science Foundation [NSF], 2016; Rincón & George-Jackson, 2016). This type of climate is particularly influential for female students as the cultural messages communicate a lack of ability to be successful in STEM fields (National Academies of Sciences, Engineering, and Medicine, 2016; Rincón & George-Jackson, 2016). Female students also reported that instructors show preferential treatment to male students, especially in the areas of math and science, which causes female students to feel a sense of isolation, invisibility, and not belonging (Incantalupo-Kuhner, 2015; Mau, 2016; Rincón & George-Jackson, 2016). In addition, female students reported an inability to connect socially and psychologically within the department's structural network (National Academies of Sciences, Engineering, and Medicine, 2016; Rincón & George-Jackson, 2016). Because of these experiences, women often change majors out of STEM fields (Mau, 2016).

Problem Statement

The problem addressed in this study is the gender disparity of female graduates in engineering and computer science programs. Even though women earn 57% of all

bachelor's degrees and 49% of science and engineering degrees, female participation across STEM fields is uneven and disproportionate (Cheryan et al., 2017; National Center for Education Statistics, 2017; National Student Clearinghouse Research Center, 2015). Less than 20% of the bachelor's degrees in engineering (19%) and computer science (18%) are earned by female students (NSB, 2016). A disproportionate number of male students persist to graduation within STEM degrees, and the imbalance has prompted national attention (Handelsman & Smith, 2016; Rickels, 2017). By examining the lived experiences of women who have successfully navigated engineering and computer science degree programs, it might be possible to identify retention strategies that could enhance persistence for female learners that would contribute to positive social change in the discipline.

Colleges and universities have instituted programs and STEM committees to enhance retention of female students, especially in degree areas with the highest percentage of gender imbalance, namely engineering and computer science (Carver et al., 2017; Cheryan et al., 2017; Denner, Werner, O'Connor, & Glassman, 2014). Despite the national urgency to balance gender disparity and increase the percentage of female graduates pursuing STEM degrees, little has changed over the years and graduation percentages of female students have remained at 1 in 5 graduates (Cheryan et al., 2017; National Student Clearinghouse Research Center, 2015; Smith & Gayles, 2018). Furthermore, research showed that the graduation percentages of bachelor's degrees earned by women has decreased 10% in computer science and 1% in engineering degrees since 2000 (NSB, 2016; National Student Clearinghouse Research Center, 2015). Studies

that address the lived experiences of female students in this field could provide academic leaders with new approaches to support this population.

The gender imbalance with STEM graduates affects the STEM workforce as well. Industry leaders have sought to increase diversity and inclusivity in the STEM workforce, but there have been too few STEM graduates to meet the demand (Doerschuk et al., 2016; Webster, 2018). Women occupy less than 25% of STEM-related positions even though they make up almost half of the workforce (Cheryan et al., 2017; Kincaid, 2015; Rincón & George-Jackson, 2016). In the field of engineering, women represent 14% of the population, and despite multiple institutional initiatives, this number has risen only 2% in the last three decades (Graf et al., 2018). The field of computer science is one of the highest-paying and fastest-growing STEM areas; however, women's representation has decreased by 7% in the past 30 years (Graf et al., 2018). Companies need gender diversity and inclusivity in the workforce because it is essential for a company's growth and profits (Webster, 2018). The persistent gender disparity merits investigation to determine the experiences of successful women graduates in the STEM degrees of engineering and computer science in an effort to increase retention of female students and meet the industry's demand for a gender diverse workforce.

Purpose of the Study

The purpose of this study was to explore the lived experiences of female graduates in engineering and computer science programs. I used the theory of grit (Duckworth, 2016) to explore the gender disparities of female graduates from engineering and computer science programs. *Grit* is defined as the ability to maintain

resilience through passion and perseverance to attain goals over a long period of time (Duckworth, 2016). *Resilience* can be defined several ways. Seligman (2006) found that resilience is the sense of optimism that is maintained in the face of adversity. Seligman stated that having a positive response toward hardships or failures helps to counteract responses such as learned helplessness and a victim mentality. Being resilient is an advantage that allows people to thrive under pressure as they are able to apprise situations without distortions and can determine necessary changes to overcome adverse situations (Seligman, 2006). Resilience and learned optimism increase a person's sense of control through adaptive measures that modify their actions and behaviors (Seligman, 2006).

Being resilient also means bouncing back from adversity or thriving despite difficult situations (Duckworth, 2016). According to Bandura (1977), resilience is a fluid process that includes the capacity to adapt to challenging circumstances. Additionally, a person's belief in their ability to persevere, which is known as self-efficacy, affects their motivation and behaviors that produce performance-specific achievements (Bandura, 1977). Although resilience and self-efficacy are traits of grit, being gritty is also about having uncompromised passion and perseverance over a long period of time (Duckworth, 2016). Grit is a commitment to sustained passions through determination and perseverance over the years (Duckworth, 2016).

Research indicated that due to systematic barriers and stereotypes, female students change majors that provide greater support for their academic endeavors (Mau, 2016; Rincón & George-Jackson, 2016). This rate of attrition creates high gender disparity in engineering and computer science programs (Mau, 2016; Rincón & George-

Jackson, 2016). Exploring the experiences of female graduates in engineering and computer science programs through the conceptual framework of grit may reveal strategies to mitigate this disparity.

Research Question

The research question addressed the experiences of successful women graduates in the STEM programs of engineering and computer science. As Ravitch and Carl (2016) stated, a researcher must "intentionally map [the] research methods into [the] research questions" as it is "the center of the research design" (p. 80). The following research question was used to guide the study: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

Conceptual Framework

The conceptual framework for this study was the theory of grit to explore how individuals sustain their passion and perseverance through obstacles and adverse situations (see Duckworth, 2016). The theory of grit is used to explain individuals' sustained interests as fueled by their passions and the power of perseverance to remain deeply loyal to their commitments (Duckworth, 2016). Duckworth (2016) described grit as qualities of passion and perseverance through sustained interest, practice, purpose, and hope. Included in this definition are resiliency and self-efficacy, which is a person's belief in their ability, but grit is not merely being resilient in the face of adversity or failure; it is an individual's deep commitment to a goal that surpasses all other priorities (Perkins-Gough & Duckworth, 2013). Grit fuels the passion to endure in difficult situations to bring to fruition a dream, desire, or goal (Duckworth, 2016). The theory of

grit provided the framework to explore female graduates' experiences that may have affected their persistence, coping behaviors, and motivational strategies through the lens of passion and perseverance, resilience, and self-efficacy (see Bandura, 1977; Duckworth, 2016; Dweck, 2006).

Nature of the Study

The design of this study was qualitative phenomenology. A phenomenological approach is used to describe the meaning of lived experiences of a group of individuals regarding a phenomenon and allows the researcher to explore differing perspectives and obtain a deeper understanding of the problem (Skervin, 2015). According to Van Manen (1990), phenomenology is the "study of the lifeworld" that "aims at gaining a deeper understanding of the nature or meaning of our everyday experiences" (p. 9). This approach provides the opportunity for interviewees to share their socially constructed reality and describe their perceptions of their experiences (Babbie, 2017). Conducting research from a phenomenological approach allows the researcher to explore how participants experience and view the world (Van Manen, 1990). This method involves the "principle of intentionality" and allows researchers through interpretation, self-reflection, and critical analysis to explain human nature as described by participants (Van Manen, 1990, p. 4).

In this study, I used a phenomenological approach to explore the female students' affective experiences that enabled them to process and contextualize their knowledge and understandings as an underrepresented population in engineering and computer science programs (see Merriam, 2009). Van Manen (1990) stated that phenomenology is a human

science that is used to explicate meaning of a phenomenon through lived experiences to understand the structure and meaning of that phenomenon. Exploring peoples' experiences allows researchers to gain knowledge and become more informed (Van Manen, 1990). Using this method, I explored the lived experiences of female graduates from engineering and computer science programs to understand the impact these had on their ability to be successful in these programs.

Definitions

The following definitions were used in this phenomenological study:

Grit: The traits of perseverance and passion to accomplish goals through sustained interest, practice, purpose, and hope over a long period of time (Duckworth, 2016). Grit is not necessarily correlated with natural ability, talent, or a high IQ (Ris, 2015). Grit is defined by a belief system and action statement that grows talent and skills through sustained and prolonged effort through difficulties and challenges, and an unwavering belief system that persistence will bring to fruition the accomplishment of a highly valued goal (Duckworth, Peterson, Matthews, & Kelly, 2007).

Passion: An intense dedication of focused attention on goals (Duckworth, 2016). Passion, as defined by the theory of grit, encompasses continual practice and sustained purpose (Duckworth, 2016).

Perseverance: The continued effort to complete a goal despite challenges, difficulties, or failure. To persevere is to persist through setbacks and includes the determination, tenacity, and resolve to remain steadfast through continued effort to achieve an objective or to accomplish a goal (Duckworth, 2016).

Resilience: The ability to develop adaptive actions to adversity or challenging environments (Bandura, 1977).

Self-efficacy: A person's belief in their ability to achieve desired outcomes, or an individual's belief in their personal competence (Bandura, 1977).

Assumptions

The following assumptions were critical to this study. The first assumption was that participants would freely share their lived experiences in an honest, accurate, and forthright manner. I assumed that participants would critically reflected on their experiences in degree programs and provide factual descriptions of their experiences at the college, within the department, with their professors, and with other students. During the interview, participants described the factors that they utilized to complete their degree programs, and were open and vulnerable when communicating challenges that they overcame to be successful graduates.

I also assumed the participants had faced obstacles in obtaining their degree. STEM programs have high gender disparity and often have negative departmental climates in which stereotypes and prejudices discourage women from remaining in these programs (Mau, 2016; Rincón & George-Jackson, 2016). I assumed that participants who completed a degree in engineering or computer science, the programs that have the highest percentage of gender disparity, had to overcome barriers in their departments to graduate (Graf et al., 2018; National Student Clearinghouse Research Center, 2015; Rincón & George-Jackson, 2016).

In addition, I assumed that exploring the success factors of female graduates would contribute to positive social change by identifying factors that undergraduate programs could implement to promote female students' success toward degree completion. I assumed that revealing these success factors would be beneficial for departments and institutions in creating policies and procedures that would encourage the retention of female students in these programs.

Scope and Delimitations

The purpose of this phenomenological study was to explore the experiences of female students who had graduated from an associate's, bachelor's, or graduate program in engineering or computer science. Despite the initiatives for STEM opportunities for young girls, there is gender disparity in STEM programs (Smith & Gayles, 2018). During semistructured interviews, participants described their lived experiences of completing a degree program with gender disparity. The intent of this study was to provide a voice for female students who have graduated and to identify success factors that institutions could implement throughout their campuses and departments to support female students and increase their graduation rates in engineering and computer science programs.

Limitations

Limitations of this phenomenological study included conducting semistructured interviews on a limited number of female graduates. Current data showed that 1 in 5 STEM graduates are female (Smith & Gayles, 2018). Because this population is small, access to participants was limited. Another limitation was participants keeping their scheduled appointments for the semistructured interviews and providing accurate details

of their lived experiences. To address these limitations, I recruited a large enough sample to ensure data saturation, I provided reminders for appointments, and I followed ethical guidelines for social science research.

Participant bias can be a limitation if participants share what they think researchers want to hear or if they withhold information that could be useful for the study (Thomas, 2017). Researcher bias can also be a limitation if the semistructured interview questions lead a participant to the information researchers want them to share, thereby distorting the results (Thomas, 2017). I recorded aspects of possible researcher bias in a notebook to identify issues that could have influenced the study. I endeavored to remain as objective as possible throughout the data collection and data analysis process. Additionally, I remained impartial to participants' responses by understanding that they may not be divulging all pertinent information, and I allowed them to share aspects of their experiences through their degree program.

Significance

The research problem was a gap in practice to address the lack of female students in STEM programs. To fill this gap, I explored the lived experiences of women who had graduated in the STEM fields of engineering and computer science. Findings may contribute to positive social change by enabling institutions to increase women's success in STEM programs. A shortage of skilled workers in science, technology, engineering, and mathematics positions will become more pronounced as tenured employees retire (Cheryan et al., 2017; Kincaid, 2015; Zamudio, 2015).

Evidence suggested that women's underrepresentation in STEM-related careers is not because of lack of skill but because of factors that discourage women's success and resilience (Cheryan et al., 2017; Kincaid, 2015). Researchers referred to these factors as unfriendly climates and biased cultures that lack support for female students, but despite this knowledge more exploration was needed to understand female students' success (Cheryan et al., 2017). Through exploration of the experiences of women in the STEM programs of engineering and computer science, the results of this study may help institutions develop initiatives that could be used to retain female students and meet the industry's demand for a diverse workforce.

The implications of this study may be far-reaching. Sustainability for women in STEM programs enables women to earn a qualified income for them and their families (Brandt, 2014; Fayer et al., 2017). The behaviors and values of successful women in STEM fields can contribute to systematic, positive change within their environments and can serve as a model for those entering STEM fields (Cheryan et al., 2017; Kincaid, 2015; Rincón & George-Jackson, 2016). Investigating the experiences of female graduates in the STEM fields of engineering and computer science may assist institutions in developing a strengths-based framework to provide greater opportunities for recruitment, retention, and graduation of female students (Rincón & George-Jackson, 2016; Zamudio, 2015).

Summary

In Chapter 1, I provided an overview of the research problem and purpose, namely that engineering and computer science degree programs contain high levels of

gender disparity. Despite efforts to increase the representation of women in STEM programs, especially in the areas of engineering and computer science, the percentage of women in these programs is less than 20% (Cheryan et al., 2017; National Student Clearinghouse Research Center, 2015; Smith & Gayles, 2018). The purpose of this study was to identify the success factors that female graduates implemented to support their graduation. I explored participants' lived experiences by conducting semistructured interviews with female graduates of engineering and computer science. This study has the potential for positive social change as colleges and universities incorporate the success factors that female graduates utilized into their departmental campus programs to encourage the graduation success of female students. In Chapter 2, I review the relevant literature and describe the conceptual framework used in this phenomenological study.

Chapter 2: Literature Review

Female student retention rates in engineering and computer science STEM degree programs are low. Female students earn more than half of the bachelor's degrees, but in the fields of engineering and computer science women earn less than 20% of the bachelor's degrees (Cheryan et al., 2017; NSB, 2016; National Student Clearinghouse Research Center, 2015). The gender imbalance has prompted national attention, and colleges and universities have implemented programs to encourage retention of female students (Carver et al., 2017; Handelsman & Smith, 2016; Rickels, 2017). However, despite the national urgency to increase the number of female students in engineering and computer science programs, the average has remained the same in engineering and decreased in computer science (Cheryan et al., 2017; NSB, 2016; National Student Clearinghouse Research Center, 2015).

The gender imbalance affects not only the completion rate of female students, it also affects the STEM workforce as well. Although industry leaders have sought to increase diversity and inclusivity in the workforce, there are too few female graduates to meet the demand (Doerschuk et al., 2016; Webster, 2018). Women in the STEM workforce occupy less than 25% of STEM-related positions (Cheryan et al., 2017; Kincaid, 2015; Rincón & George-Jackson, 2016). In the fields of engineering and computer science, women represent 14% of the population in engineering and 25% in computer science, a drop of 7% in the past 30 years (Graf et al., 2018). Gender diversity is needed in the workforce because it has an impact on company growth and profits (Webster, 2018). The persistent issue with gender disparity warrants further investigation

to explore the successful experiences of women graduates in engineering and computer science, which could have a positive impact on the retention of female students and meeting industry's demand for a more gender diverse workforce. The purpose of this study was to explore the lived experiences of female graduates in engineering and computer science programs to describe their mindset and strategies for success.

Literature Search Strategy

The literature search strategies consisted of using Google Scholar and Walden University's Library. From Walden's library, I used several databases such as ProQuest Dissertations and Theses, ProQuest Walden's Dissertations and Theses, EBSCO, and Thoreau to search peer-reviewed journals. Key search terms included *STEM*, *science*, *technology*, *engineering*, *mathematics*, *computer science*, *women* or *female students*, *graduates*, *gender inequality*, *gender disparity*, *success*, *college* or *university*, *grit*, *perseverance*, *self-efficacy*, *mindset*, and *resilience*. Using Google Scholar, I searched phrases such as *women in computer science or engineering*, *experiences of women in engineering or computer science in college*, *STEM fields*, *female persistence in STEM degrees*, *women representation in STEM undergraduate degrees*, *gender gap in STEM degrees*, *gender disparity in engineering degrees*, *gender disparity in computer science degrees*, and *degrees with gender disparity*.

Through ProQuest, I searched several combinations of terms. For topics, I searched terms such as *STEM* OR *science* OR *computer science* OR *engineering*. For population, I searched terms such as *female* OR *women* OR *students* OR *graduate**. For institutions, I searched terms like *college** OR *university** OR *higher education*. For

terminology, I used *success* OR *factors* OR *lived experience*, *gender inequality* OR *gender disparity*, *resilience** OR *grit* OR *mindset* OR *coping*. For methodology, I used *qualitative* OR *phenomenology**. This literature review contains the theories that provided the foundation for this study, as well as the sources that indicated a gap in practice of female graduates in engineering and computer science.

Journal articles and dissertations were saved into Mendeley literature review software and into folders on my computer hard drive. Folders were also backed up on an external hard drive and in Google Drive. Articles were sorted according to different topics such as STEM, engineering, computer science, grit, mindset, resilience, self-efficacy, qualitative, or phenomenology. Through a review of literature through books, peer-reviewed journals, research articles, and dissertations, I identified the themes shown in Figure 1.

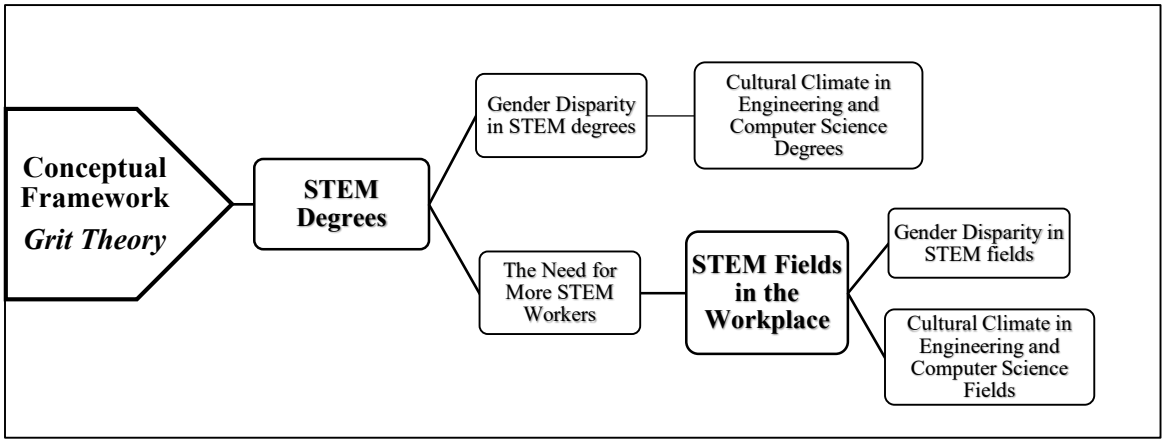

Figure 1. Themes of the literature review.

Conceptual Framework

The purpose of this study was to explore the lived experiences of female graduates in engineering and computer science degree programs. Companies need gender

diversity and inclusivity in the workforce because lack of gender diversity can affect a company's growth and profits (Graf et al., 2018). Duckworth's (2016) theory of grit was used as the framework to study the lived experiences of female graduates in engineering and computer science programs. The framework includes factors of grit, passion, and perseverance through adversity and how they contribute to people's persistence and motivational strategies (Duckworth, 2016; Dweck, 2006).

Introduction and Development of Grit Theory

The theory of grit did not become relevant until the past decade, and it evolved from several well-known psychological theories. Bandura's (1977) social cognitive theory, with an emphasis on resilience and self-efficacy, is linked to learning theories in which personal belief systems exercise a measure of control over cognitive, affective, and behavioral constructs. Through thoughts, feelings, and actions, a person has the ability to regulate emotions and behaviors and to engage in self-reflection, which influences the association between the individual's belief system and environmental factors (Bandura, 1977). This learning systems provides rich opportunities in the development of mindsets, perceptions, and self-regulation (Pajares, 1996). Bandura established that human behavior and action are influenced by the correlation between a person's internal locus of control and external factors of the environment.

Seligman (2006) began researching aspects of optimism and learned helplessness from which the field of positive psychology emerged. Prior to the emergence of positive psychology, clinical psychologists treated patients suffering from mental illnesses and trauma through psychotherapy and medications (Seligman, 2006). Although

psychologists were helping those in need, happiness was not a result of these prior treatments (Seligman, 2006). According to Seligman, "curing the negative does not produce the positives" (p. iii). Through Seligman's research, the development of knowledge and skill sets evolved to strengthen a person's belief system and sense of personal control to overcome adversities. The theory of positive psychology has three forms in the development of happiness and optimism (Seligman, 2006). The first is the development of skills to increase and amplify positive emotions (Seligman, 2006). The second is the identification of strengths and talents for self-improvement and well-being, and for applying these skills in situations at work, friendships, personal relationships, and all aspects of a person's environment (Seligman, 2006). The third is the development and use of a person's highest strengths and abilities for serving a purpose that is larger than themself (Seligman, 2006). This positive psychology movement has become known as learned optimism and human flourishing (Selgiman, 2006, 2011).

Duckworth (2016) began to see that talent or aptitude did not necessarily ensure high levels of achievement. Duckworth began to hypothesize the relationship between talent and effort and how these aspects related to students' successes. Duckworth began developing the theory of achievement, which explained how talent, effort, skill, and achievement are interrelated.

Grit Theory

Duckworth's (2016) theory of grit encompasses both a personal belief system in a person's abilities, as well as the actions and behaviors necessary for goal achievement. Grit is characterized by the components of passion and perseverance through interest,

practice, purpose, and hope for long-term goals (Duckworth et al., 2007). Grit is the sustained interest and effort over many years despite adverse circumstances, challenges, discouragement, failure, and stagnation of progress (Duckworth et al., 2007). Individuals who are gritty view accomplishing their goals "as a marathon" and "his or her advantage is stamina" (Duckworth et al., 2007, p. 1088). Seligman (2011) stated that the "underlying rational for grit [is] the never-yielding form of self-discipline" and encompasses the "personal characteristic of extreme persistence" (p. 121). The more grit a person has, the more discipline they demonstrate; the constant dedication to the task "multipl[ies] your progress [toward] the goal" (Seligman, 2011, p. 121). According to Seligman (2011), an individual can attain greater achievement through increased effort as time spent on task increases achievement in two ways: It increases an individual's existing skill set and knowledge, and directly increases skills and knowledge generally. Additionally, there is a direct correlation between effort and self-discipline; a person can choose through free will how much time to devote to their endeavor, which requires positive character traits that relate to self-control and grit (Seligman, 2011).

The theory of grit encompasses four factors that develop in phases: interest, practice, purpose, and hope (Duckworth, 2016). The first stage or phase is interest, which includes passion. People who are gritty are interested in what they do; they enjoy it and will put forth sustained effort even in the areas that they do not enjoy as much because it gets them closer to their larger goals (Duckworth, 2016). Second, people who have grit develop discipline in their particular area (Duckworth, 2016). They are wholeheartedly devoted and focused on that practice, along with the smaller goals through self-control

and aligning actions that support that practice, to develop mastery of their long-term goal (Duckworth & Gross, 2014). Third, when passion and perseverance are combined, individuals begin to understand the purpose of their goal (Duckworth, 2016). They have the "conviction that [their] work matters" (Duckworth, 2016, p. 91). This conviction that their work is personally interesting and essential for the well-being of others, leads to sustained practice and achievement (Duckworth, 2016). Lastly, hope is not the summative part but rather an incorporating part of each of the first three stages (Duckworth, 2016). Gritty people maintain hope through the stages of interest, practice, and purpose that sustain them through periods of doubt and difficulty (Duckworth, 2016).

Duckworth et al. (2007) acknowledged that their results only determined grittiness and did not correlate how achievement is related not only to grit but also to self-efficacy, learned optimism, and mindset. Duckworth et al. further stated that more research was needed to explain how individuals' behaviors and achievement are related to grit as well as other plausible factors. Seligman (2011) found that grit was a predictor of grade point average, military performance, and retention at West Point. The power of grit, through passion and perseverance, helps a person achieve their potential (Duckworth, 2016).

Is Grit the Same as Resiliency or Self-Efficacy?

The theory of resilience and self-efficacy are defined in social cognitive theory (Bandura, 1986), which emerged in the 1960s as a social learning theory. Bandura's social cognitive theory states that learning occurs within a social context through observation and external and internal reinforcement. Bandura argued that individuals

possess a self-system of analytic and reflective ability that enables them to control their thoughts, feelings, and actions (Pajares, 1996). The self-system encompasses the cognitive and affective structures that enable a person to self-regulate emotions and actions, develop motivation, learn from others, plan alternative strategies, and engage in self-reflection (Bandura, 2006).

Through concepts of reciprocal determinism, observational learning, reinforcements and expectations, behavioral capabilities, and self-efficacy, there is a codetermination of construction of causal situations within personal and environmental systems (Bandura, 2018). People are not solely autonomous agents or solely dependent on situational instances but are able to regulate their behavior and influence their actions for goal-directed results over a sustained period of time (Bandura, 1986). Through human agency by self-regulation and motivation, an individual can regulate between their internal environment and their external environmental influence (Pajares, 1996). Additionally, learned helplessness and pessimism are not fixed and unchangeable matters; rather, individuals can learn a new set of skills that can change how they view their circumstances (Seligman, 2006). Seligman (2006) argued that if a person can understand and identify their sense of personal control, it can determine their fate.

Self-efficacy. Through the theory of social cognition or self-awareness, Bandura (1977) hypothesized that the personal expectations of a person's ability to perform or meet the expectations determines their ability to cope in the face of obstacles or aversive experiences. Persistence in the face of adversity, even when circumstances are perceived as threatening but are relatively safe, produces feelings of self-fulfillment and mastery

(Bandura, 1977). This persistence, or resilience, encourages greater self-efficacy (a person's belief in their ability to complete or perform a task), by enhancing their self-perceived ability in the next trial and reducing their reactionary, defensive behavior (Bandura, 1977).

Several factors are instrumental in influencing cognitive processing of efficacy. Particularly, "the strength of people's convictions in their own effectiveness is likely to affect whether they will even try to cope with a given situation" (Bandura, 1977, p. 193). Bandura believed that the higher self-efficacy a person had, the more likely that a person would persist in the face of challenges and be successful at completing them (Pajares, 1996). On the other hand, those who lack confidence in their abilities are less likely to engage in tasks and will give up in the face of difficulty (Pajares, 1996). Bandura argued that a person who has confidence in their ability to perform tasks was rather a collective agency in which "a group's shared belief in their capabilities" would actualize "given levels of attainment," meaning that self-efficacy is both a "personal and social construct" (Pajares, 1996, p. 567). Additionally, in prejudicially structured systems, no amount of skillful effort may bring about the desired outcome, even though they may be highly confident in their abilities as social rejection may have negative consequences reinforcing a personal belief system that their abilities are "fixed" (Pajares, 1996, pp. 568).

Resiliency. Resiliency refers to the ability to cope well with high levels of change, constant pressure, to bounce back after adversities or setbacks, and to do this without a dysfunctional mindset or behaviors (Siebert, 2005). Seligman's (2006) definition of resiliency is the idea of positive or learned optimism; that a person can have

an honest appraisal of situations without added distortions and how to adapt or change for a positive outcome. Learned optimism is the antithesis to a victim mindset (Seligman, 2006). A resilient person can thrive in at-risk or high-risk situations even if the odds are against them (Perkins-Gough & Duckworth, 2013). Siebert (2005) stated that people have an "inborn predisposition to become resilient and change-proficient" (p. 8). Resiliency efforts and skills are developed through self-motivated, self-managed efforts (Siebert, 2005). According to Siebert (2005) there are five levels in the development of resiliency skills.

In these levels, several factors are essential for being resilient. The first level which is maintaining health and well-being, allows a person to remain flexible, less stressed, and more in tune with their emotional and mental state of health (Siebert, 2005). The second level requires a person to look outward to the problem instead of internalizing and self-blaming for the challenge during problem-solving situations, thereby bypassing a victim mentality (Siebert, 2005). The third level of resiliency involves maintaining inner gatekeepers that involve mind and body connections such as a "strong self-esteem, self-confidence, and a positive self-concept" that lead to higher-level abilities (Siebert, 2005, p. 11). The fourth level relates to the development of resiliency (Siebert, 2005). Siebert (2005) hypothesized that curiosity and self-managed learning, correlated with mental and emotional stability, and balanced with social responsibility, lead to advanced development of resiliency skills.

In the fifth level of resiliency development, Siebert (2005) reported that individuals have reached an advanced stage of resiliency. By living in an environment of

constant change and flux, a person at this level does not fight constant disruptive change (Siebert, 2005). Instead a person has learned how to accept new realities and mastered the art of detaching from the action, as well as accepting and being involved in the solution (Siebert, 2005). They have learned how to view new circumstances through a lens of positive attitudes, how to quickly align the new circumstance to a lucky result, and thereby turning a possible misfortune into good fortune (Siebert, 2005). This type of resiliency leads to personal effectiveness by knowing what is necessary to accomplish a task as well as maintain the motivation to complete it (Siebert, 2005).

Incantalupo-Kuhner (2015) questioned whether grit produces resilience or resiliency produces grit and positive perceptions in adverse circumstances. Perkins-Gough and Duckworth (2013) argued that a person who is resilient in the midst of failure or adversity has grit. Hochanadel and Finamore (2015) stated that "grit is not just having resilience in the face of failure, but also having deep commitments that you remain loyal to over many years" (p. 48). Resilience, passion, and perseverance are all components of theory of grit, and a person who has grit is an explanation for how they are able to attain high levels of goal achievement through persistence and tenacity (Duckworth, 2016).

Literature Review Related to Key Concepts

STEM fields are often defined as degrees and occupations that include science, technology, engineering, or mathematics (STEM) domains (National Center for Education Statistics, 2012). There is often debate as to what constitutes a STEM field. According to the Unites States Immigration and Customs Enforcement (U.S. ICE), there are over 400 degrees and occupations listed as pertaining to STEM fields (U.S. ICE,

2016). Additionally, the U.S. Department of Education Integrated Postsecondary Education Data System (IPEDS) states that STEM fields can be further categorized by a specified career or work focus (U.S. ICE, 2016). For example, even though the acronym for STEM includes fields in science, technology, engineering, and mathematics, several other clusters of fields, which may not be thought of as a STEM field, are also included in the definition of STEM, such as psychology, social sciences, life sciences, and materials research (NSB, 2018). Generally, a STEM field or related field includes fields that contain aspects of "research, innovation, or development of new technologies using engineering, mathematics, computer science, or natural sciences (including physical, biological, and agricultural sciences)" (U.S. ICE, 2016, para. 1).

In secondary and post-secondary programs, a STEM degree can be hard to define (Siekmann, 2016). Institutions must delineate the necessary educational pathways that would best serve that field (Siekmann, 2016). Educational STEM programs can be broad and encompass a multidisciplinary and integrated approach to solving real-world challenges through critical and creative thinking (Siekmann, 2016). This broad definition of what constitutes a STEM education, along with an even broader definition of STEM fields, contributes to an overall lack of agreement with what constitutes a STEM occupation (Graf et al., 2018; Siekmann, 2016). One of the factors that may be inhibiting the population growth within STEM occupations is that the definition for fields within STEM education is not straightforward and can be defined in many ways (Siekmann, 2016). This perplexity complicates communicating what is needed within educational and

industrial areas and how to solve the issue of balancing a gender representative population within STEM fields (Siekmann, 2016).

There are two impending and immediate needs affecting STEM fields (Cheryan et al., 2017; Handelsman & Smith, 2016; Rickels, 2017). First, to increase efforts to educate students, teachers, and practitioners in specific STEM fields through secondary, post-secondary, and graduate levels (Cheryan et al., 2017; Handelsman & Smith, 2016; Rickels, 2017). Secondly, to increase recruitment efforts for workers to fill industry needs due to an aging workforce and competitive world market (Cheryan et al., 2017; Handelsman & Smith, 2016; Rickels, 2017). As of 2012, there were twice as many job openings in STEM fields as there were available workers to fill those jobs (Jackson & Laanan, 2015). Future industry growth projections, especially in fields with foundations in science and technology, have estimated that in the next 10 years there will be one million fewer graduates in STEM fields (Handelsman & Smith, 2016; U.S. Department of Education, 2015). The demand for STEM graduates has grown and increased; however, there are not enough STEM graduates to fill this need (Cheryan et al., 2017; Rickels, 2017). Advancement in STEM programs and degrees is essential to the development and growth of the U.S. economy (Cheryan et al., 2017; National Center for Education Statistics, 2014).

Science, Technology, Engineering, and Math Degrees at Postsecondary Institutions

In postsecondary institutions, almost 60 % of the baccalaureate degrees are earned by female students (NCES, 2017). Overall, female students earn approximately 50% of the science and engineering baccalaureate degrees, however, on average in within the

realm of STEM degrees, only 1 in 5 female students earn a baccalaureate degree (Cheryan et al., 2017; Legewie & DiPrete, 2014). Throughout the varying STEM fields, womens' representation in the fields is uneven (Cheryan et al., 2017). Gender disparity in STEM degrees has prompted national attention and generated STEM committees to institute initiatives within postsecondary educational levels to increase female graduates (Handelsman & Smith, 2016; Rickels, 2017). However, despite the national urgency to balance gender disparity and increase the percentage of female graduates pursuing these degrees, little has changed over the years (Cheryan et al., 2017; National Student Clearinghouse Research Center, 2015). Industry demands for a diverse workforce have increased but the available pool of qualified STEM workers has decreased (Cheryan et al., 2017; Farrell & McHugh, 2017).

Need for STEM workers

Gender disparity affects industry needs as well. According to the national average, most jobs in STEM fields (93 out of the 100 STEM occupations) report annual wages above the national average and have an above-average rate in growth for future employment (Fayer et al., 2017). However, the percentage of women in STEM fields remains low despite the many recruitment and retention efforts of industries and employers (Farrell & McHugh, 2017). Overall, women represent less than 25% of STEM-related positions even though they make up almost half of the workforce (Cheryan et al., 2017; Kincaid, 2015; Rincón & George-Jackson, 2016). Disproportional representation of women in STEM fields contributes to a lack of diversity and denies valuable contributions that talented women can bring through creativity, innovation, and

a diverse intellect (Cheryan et al., 2017). Additionally, gender disparity in STEM fields can impact global markets (Kincaid, 2015; McGrath, Gipson, Perrakos, Nagel, Pappas, & Peterson, 2013).

Gender Disparity in STEM Fields

Women are not equally represented in the STEM fields. Additionally, some STEM fields have a greater disproportion of females than other fields (Cheryan et al., 2017). Although some fields have balanced the gender inequity issue such as biological sciences, chemistry, and mathematics fields, other fields have not and continue to experience an ever-widening gender gap (Cheryan et al., 2017; Graf et al., 2018). Of the total 8.6 million STEM jobs that were available in 2015, 64% of them were in the areas of computer science and engineering occupations (Fayer et al., 2017). The field with the largest projected future growth is in computer information technology (with half a million new jobs by 2024) and the second largest projected growth is in the field of engineering (with a quarter million new jobs by 2024) (Fayer et al., 2017). However, women's representation in engineering has only risen 2% and has decreased in computer science by 7% in the past three decades (Graf et al., 2018). More research is needed to examine why there is a widening gap in female representation of engineering and computer science fields, especially when these fields are experiencing the greatest projection of growth and need.

To explain underlying reasons for gender disparity in engineering and computer science fields, researchers have implied several motivational factors (Rickels, 2017). One factor suggested that women did not pursue STEM degrees because a lack of interest in

those fields (Rickels, 2017). Rickels (2017) research seemed to confirm this belief as women received more degrees in humanities, social sciences, and life sciences and attributed this factor to women's stronger interest in non-STEM fields. Jackson and Laanan's research (2015) suggested that women chose non-STEM degrees due to a lack of confidence in their mathematical abilities or lack of academic preparation since STEM degrees tend to contain a larger portion of mathematics and science requirements than non-STEM degrees. However, female students performed equally or better on math test performance scales and earned a higher proportion of mathematics degrees than male students (Cheryan et al., 2017). This research demonstrates that female presence in engineering and computer science is not due to academic preparation or mathematical ability but to possible other factors (Cheryan et al., 2017).

Culture of Engineering and Computer Science in Postsecondary Institutions

The degree programs of engineering and computer science at postsecondary institutions contain the highest percentage of gender disparity (Cheryan et al., 2017). Since academic preparedness may not necessarily be the fundamental reason for gender disparity in engineering and computer science, researchers examined other possible causal factors (Cheryan et al., 2017). Through various studies, researchers examined institutional climate and sociocultural challenges of engineering and computer science degree programs.

Barriers Women Face in STEM

One explanation for gender disparity is a negative institutional environment, also known as academic or departmental climate, and is a strong predictor of female student's

achievement and completion levels (Incantalupo-Kuhner, 2015). Research has identified that the environments that contain the highest percentage of gender inequality are those that report higher rates of gender harassment, a “chilly” or “hostile” departmental climate, and the presence of implicit and explicit gender bias (Rincón & George-Jackson, 2016, p. 742). Mlambo and Mabokela (2017) stated, “the hostility of STEM spaces towards women remains evident today” (p. 274). In other qualitative studies, female students reported that instructors showed preferential treatment to male students especially in the areas of math and science, which caused women to feel invisible (Incantalupo-Kuhner, 2015; Mau, 2016; Rincón & George-Jackson, 2016). Additionally, female underrepresentation can be particularly damaging as lower numbers equaled a lack of collegial support for female students (Rincón & George-Jackson, 2016; Smith & Gayles, 2018). Continued lack of support made them feel isolated and that they did not belong (Rincón & George-Jackson, 2016). In this environmental lens over time, female students acceded to biased stereotypes and expressed a lowered self-confidence, lowered self-perception of their abilities, and lowered probability of their success in that program (Rincón & George-Jackson, 2016; Smith & Gayles, 2018).

Another factor of gender disparity in engineering and computer science degrees is a negative sociocultural environment (Smith & Gayles, 2018). Sociocultural norms dictate the structures, social norms, expectations, and values that guide the standards and policies within that field (National Academies of Sciences, Engineering, and Medicine, 2016; Rincón & George-Jackson, 2016). Prevalent and subtle cultural messages can affect a person’s self-perception and undermine their academic identity. Female students

reported the need to work hard at overcoming messages that demoralized their persistence in their program (National Academies of Sciences, Engineering, and Medicine, 2016; Rincón & George-Jackson, 2016). Moreover, school climate is a strong predictor of student achievement (Incantalupo-Kuhner, 2015). Further research indicated that efforts to equalize the gender disparity within engineering and computer science are often undermined and sabotaged by systematic barriers through stereotypes and bias (NSF, 2016; Rincón & George-Jackson, 2016).

DiBella and Crisp (2016) found that women in STEM within male-dominated fields often face a double bind, in that women need to perform well academically as well as they need to devote cognitive resources to withstand particular challenges that are associated with their gender (such as resilience, adaptation, and self-reliance). Smith and Gayles (2018) found that a cultural atmosphere of sexism, power disparities, and power dynamics cumulatively compounds barriers in an environment already present with rigorous academic requirements. Social identity threat is present for women in STEM when a combination of two environments occur: (a) an environment that is almost solely comprised of male peers, and (b) an environment in a technical sector where women are often negatively stereotyped (Van Veelen, Derks, & Endedijk, 2019). Van Veelen et al. (2019) research indicated that women's performance is "negatively affected by activation of negative gender stereotypes" (p. 2). This environment is a situational predicament when prejudice or bias is prevalent often settings that contain gender inequality (Van Veelen et al., 2019). Oftentimes, these sociocultural pressures can cause female students to change out of their current STEM major into either a more culturally accepting STEM

major or a non-STEM major, thereby decreasing female students' retention rates within gender unequal STEM degrees (Mau, 2016).

Older students are less likely to persist than younger students which may be contributed to financial factors or academic skills as barriers to completion (Mau, 2016). In the past ten years, college tuition and fees for universities and colleges has risen faster than the median household income (NSB, 2016). Additionally, although levels of debt vary between students, institution type, and state, overall students have higher levels of debt for degree completion than in years past (NSB, 2016). Other barriers may include lack of flexible hours, family obligations, and family expectations that relate to child care and family responsibilities that may conflict with obtaining a degree (NSF, 2019; Rickels, 2017).

Mau (2016) suggested that more programmatic support should be offered to develop curricula that is unbiased and culturally sensitive to female and minority needs as this will assist with persistence. Cadaret, Hartung, Subich, and Weigold (2017) reported that negative stereotype threats of women in engineering affects their confidence and self-efficacy in their academic beliefs and with their group identity so that they develop a consciousness around the stigma. Continued instructional support, informal support groups or mentoring, and encouragement may prove beneficial to address problems that women face in non-traditional programs and coursework and may help to lessen these barriers (Mau, 2016).

Indicators of Success Factors

Despite these barriers that women face, studies indicated success factors of women graduates. Successful indicators included strong academic preparation and high levels of self-confidence (Brandt, 2014; Incantalupo-Kuhner, 2015). Female students whose motivation is supported by a belief system which includes fulfilling one's purpose in life tend to be more committed to completion of their degree (Incantalupo-Kuhner, 2015; Zamudio, 2015). Self-efficacy and persistence lay the groundwork for maintaining grit through female student's programs (Incantalupo-Kuhner, 2015). They demonstrated resilience strategies by establishing supportive relationships and maintaining positive perceptions of their abilities (Incantalupo-Kuhner, 2015; Zamudio, 2015). School climates that encouraged a supportive atmosphere showed to impact women's perception of their value and contribution to that particular field (Rincón & George-Jackson, 2016). More research must be conducted to identify ways to support women in engineering and computer science, and how to incorporate factors that contribute to their success (Rincón & George-Jackson, 2016).

Culture of Engineering and Computer Science in the Workplace

Overall, women who work within STEM fields tend to perform better than their male peers (Rickels, 2017). However, women tend to face additional difficulties as they are often viewed as less competent as their male-counterparts unless evidence is presented within the workforce to contradict this perception (Rickels, 2017). Additionally, instead of workplace cultures adjusting their environments to be more supportive and welcoming, female employees are expected to their behaviors to fit into

the sexist cultural norms of the environment (Smith & Gayles, 2018). Saxena, Geiselman, and Zhang (2019) found that women more so than men are the targets of workplace incivility which leads to negative outcomes such as poor performance, frequent turnover rates, and higher levels of stress.

Summary and Conclusions

In this chapter, a review of literature, the nature of search strategies, and an examination of the conceptual framework outlined the basis for this research study. While articles espoused the importance of development of grit, resiliency, and self-efficacy as foundational for achievement and success, there was a gap in practice that applied these theories to the negative climates relating to gender disparity in the degree programs of engineering and computer science. Additionally, a review of the literature did not contain factors that female graduates employed to sustain them through challenging and adverse situations related to unequal gender environments. A study that explores the lived experiences of female graduates who were successful in adverse environments throughout their degree program was necessary for influencing positive social change in postsecondary institutions where gender disparity is rampant. In the next chapter, I outlined the design of the study, the methodological research approach, and provided details of participant selection and setting to obtain information on how female graduates were able to persist through postsecondary programs of study that contained gender disparity.

Chapter 3: Research Method

The purpose of this qualitative phenomenological study was to explore the lived experiences of female graduates in an engineering or computer science field. Participants included female students who completed a STEM degree from engineering or computer science programs. The research question addressed the lived experiences of female graduates from engineering and computer science programs. The phenomenological approach was used to explore their experiences as females in departments with low female representation to identify key factors that enabled their success toward graduation. In this chapter, I describe the research design and rationale for the study and my role as the researcher. I also explain the methodology for participant selection, recruitment, instrumentation, and data analysis. This chapter concludes with a review of the trustworthiness of data and the ethical procedures that I followed.

Research Design and Rationale

Although studies have addressed the barriers that female students face in STEM programs, researchers have not investigated the success factors of female students in STEM programs that contain the highest levels of gender disparity. To address the gap in the literature concerning the lived experiences of female graduates from STEM programs, I used the following research question to guide the study: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

In social science research, there are three common purposes for conducting research: to explore, to describe, and to explain (Babbie, 2017). The research design for this study was exploratory in nature with a phenomenological design to explore the lived

experiences of female students who graduated from STEM programs with high gender disparity. Phenomenology is considered a research method and a philosophy (Ravitch & Carl, 2016). Husserl (as cited in Cibangu & Hepworth, 2016) argued that phenomenology addresses a phenomenon through humans' lived experiences of that phenomenon.

A phenomenon also refers to a circumstance that can be explained from a person's perception and is not bound by space or time (Falconer & Scott, 2018; Ravitch & Carl, 2016). A phenomenon could be an emotion, such as fear, anxiety, or joy; a construct, such as a theory or area of study; a set of complex experiences, such as a period of time in history; or a person's experience during a period of time (Falconer & Scott, 2018).

Phenomenology is the "philosophical approach to the study of experience" (Smith, Flowers, & Larkin, 2009, p.11). Phenomenology involves the study of an experience of an individual or group of individuals through their consciousness and as explained through their perceptions (Falconer & Scott, 2018; Ravitch & Carl, 2016). Phenomenological studies address what humans are like, what aspects of life matter to people, and what makes up their lived world through their lived experiences (Smith et al., 2009). The phenomenological approach is used to explain an occurrence or series of occurrences through the perceptions of people who had experienced the phenomenon to give meaning to the phenomenon (Burkholder, Cox, & Crawford, 2016; Tight, 2016). This design is used to understand the human factors involved in the phenomenon and to place the phenomenon in context (Burkholder et al., 2016).

Meaning is filtered through interpretation of events and information to reach an understanding that enables individuals to transfer knowledge to similar situations (Burkholder et al., 2016). Van Manen (1990) referred to this type of explanation as hermeneutic phenomenology. Hermeneutic understanding refers to interpreting the phenomenon to give meaning, and phenomenology is the descriptive methodology that provides a name to the phenomenon (Van Manen, 1990). Phenomenology enables others to name the phenomenon and describe how it was experienced (Van Manen, 1990). Hermeneutic phenomenology addresses "the meaningfulness of people's interaction with the world around them" (Cibangu & Hepworth, 2016, p. 151). Although researchers try to identify a phenomenon, it is necessary to remember that lived experiences are always more complex and intricate than can be revealed through any explanation of a research design (Van Manen, 1990).

Role of the Researcher

My role as the researcher was as an interviewer. In my experience as an instructor in higher education, I have observed the lower percentages of female students studying in STEM degree programs. I have mentored and advised female students as they have worked to identify their career path and have often wondered why, with all the initiatives at the federal and state levels, there are still so few women completing STEM careers. When mentoring female students, I have explored the barriers they face as female students in their programs, as well as the institutional support mechanisms they can utilize to be successful in their programs.

Because of experiences that I have had as an observer of female students in STEM programs and as a participant (a student choosing a degree), it was necessary for me to use the phenomenological method of epoche to bracket my preconceived ideas and possible biases (see Van Manen, 2016). I approached this study with an open minded and a nonbiased perspective (see Van Manen, 2016). Van Manen (2016) stated that "phenomenology does not try to develop conceptual schemes or prove a preconceived idea" (p. 222) but rather the idea of epoche reduction focuses on the experience as it was and is lived. To engage in researcher reflexivity, I used journal entries to conduct a "systematic assessment of my identity, positionality, and subjectivities" (see Ravitch & Carl, 2016, p. 15) to establish an ongoing awareness of my role and possible influence on this study.

To recruit participants for this study, I contacted women I have known in professional and personal relationships. In a previous professional position, I maintained contacts with other higher learning institutions to establish connections between their institution and my institution. I contacted several possible participants through that network for participation in this study. These professional contacts are women who are faculty members, departmental chairpersons, and administrators who have graduated with a degree in engineering or computer science programs. Because I was no longer working in that position, there were no power dynamics or institutional relationships between me and the participants.

Methodology

The phenomenological approach involves three concepts: intentionality, intersubjectivity, and reduction (Cibangu & Hepworth, 2016). Intentionality refers to consciousness as it is directed and purposeful for understanding and acquiring knowledge about the world (Cibangu & Hepworth, 2016). Van Manen (1990) referred to intentionality as an oriented, thinking activity that depicts a person's world through retrospection. Intentionality is not a mental representation of the world, but rather a responsiveness and engagement with the world (Cibangu & Hepworth, 2016).

Intersubjectivity refers to the communal understanding of the world, in that people, systems, and things are combined to create the world (Cibangu & Hepworth, 2016). Understanding and actualization of human thought is related to social systems in the lived human world (Van Manen, 1990). If a researcher is unaware of the interrelatedness of people and systems, the research will result in "skewed and shortsighted assumptions" (Cibangu & Hepworth, 2016, p. 150).

Reduction is the process by which the researcher's subjective and latent feelings or understandings of the phenomenon are put aside to prevent preconceived biases from influencing the acquisition of knowledge regarding the phenomenon (Van Manen, 1990). Reduction is the process by which researchers set aside judgment to assess the subject matter as objectively as possible (Cibangu & Hepworth, 2016). This practice of bracketing, or reduction of ideas, is called epoche, which means to suspend, pause, or check (Cibangu & Hepworth, 2016). Van Manen (1990) stated that reduction is necessary

to strip away expectations or scientific notions that can prevent the researcher from "seeing the phenomenon in a non-abstracting manner" (p. 185).

While researching designs that would be appropriate to answer the research question, I explored different paradigms. One approach that I reviewed was a case study design. A case study focuses on a social phenomenon of a period of time or a group of people, and provides descriptive and exploratory explanations to understand the structure of a social construct (Babbie, 2017). Often case studies are used to explore an existing theory and expound on that theory through a specific case or unit of analysis that is bound by time and place (Ravitch & Carl, 2016). Because the current study did not have a case that was bound by time and space, this research design was not appropriate to answer the research question.

Another research design that I considered was ethnography. This design has historical roots in anthropology and focuses on the culture of a group of people (Merriam, 2009). Ethnography is used to identify the "beliefs, values, and attitudes" (Merriam, 2009, p. 27) of behavior patterns in a population. The primary focus of ethnography is the culture of a social group to provide a detailed description rather than an interpretation or exploration of the social life within that group (Babbie, 2017; Merriam, 2009). Although group patterns or themes may have surfaced from my data analysis, the emphasis of my study was female students' experiences in STEM programs rather than the cultural group itself of programmatic departments.

An additional research design that I considered was phenomenography, which is used to study the different perspectives of people about a phenomenon. In a

phenomenographic study, a researcher "investigates the variation of conceptions related to a given phenomenon" (Cibangu & Hepworth, 2016, p. 148). The focus is on people's differing conceptions of a phenomenon but not the phenomenon itself (Cibangu & Hepworth, 2016). Phenomenography is an approach that addresses all the variations of individuals' conceptions that relate to a phenomenon and how peoples' ways of viewing circumstances vary through collective experiences rather than individual experiences (Tight, 2016). Phenomenography is used to describe and understand experiences through a transcendental, descriptive approach rather than an interpretative, hermeneutic approach (Tight, 2016). I did not choose this design as the focus of the study was through a hermeneutic approach.

The research design that was used for this study was phenomenology. A phenomenological approach was used to explore the lived experiences of female graduates. Using interpretive phenomenology, I explored the phenomenon of gender disparity in STEM programs. Findings may help individuals going into STEM programs, as well as institutions, through identification of the possible barriers and supportive measures needed to promote degree completion. Through exploration of female students' experiences, individuals and institutions might become more knowledgeable about reducing barriers and providing supportive strategies (see Van Manen, 1990).

Participant Selection

The population for participant selection included female students who graduated from an engineering or computer science program at a college or university. Engineering or computer science programs were identified from the STEM Designated Degree

Programs List (U.S. ICE, 2016) and according to a related subprogram that included the definition of STEM programs (NSF, 2014). I used purposeful sampling to recruit research participants based on the selection criteria. Purposeful sampling can sometimes be referred to as criterion-based selection or criterion sampling because it allows the researcher to select participants based on criteria (Creswell, 2007; Merriam, 2009). This type of sampling is often used for qualitative research, especially phenomenological studies, because participants who can purposely inform regarding the study phenomenon are intentionally selected (Creswell, 2007).

Prospective participants were required to meet the criteria based on several questions that I asked when contacting them for an interview (see Appendix A). Participants were identified through prior professional and personal relationships and who were known to have completed a degree in engineering or computer science. Participant recruitment was also conducted through professional networking relationships in which other potential participants were identified. As prospective participants were identified, I sent them an email (see Appendix B). I kept notes on each potential participant through the course of recruitment and throughout the interview process. Once participants agreed to participate, I emailed the participants the Informed Consent Form and required participants to return an email to me stating "I consent."

Instrumentation

The research design that was used for this study was phenomenology. I used semi-structured interviews to collect participants' lived experiences. Participants were asked to reflect and describe their lived experiences throughout their degree program.

Although lived experiences are much more complex and "richly layered than we can fathom" (Van Manen, 1990, p. 42), and may not have included all aspects shared during an interview session, the purpose of reflection and contemplation was to provide various layers of meaning to their experiences.

The setting for the interviews was through virtual methods and Free Conference Call was used for the phone interviews. Interviews were recorded in a MP3 format. Interview transcripts were created from the recorded MP3 file. Saturation of the data was determined when there was "no new information … forthcoming from new sampled units" and redundancy was reached (Merriam, 2009, p. 80). According to Guest, Bunce, and Johnson (2006), theoretical saturation for purposeful sampling usually occurs between six to twelve interviews. Creswell (2007) stated that saturation can occur between five to ten participants. Duke (1984) stated that saturation is reached between with three to ten participants (see Creswell, 2007). Smith et al. (2009) noted that saturation is reached between three and six participants, and that "the issue is quality, not quantity…studies usually benefit from a concentrated focus on a small number of cases" (p. 51). Mason (2010) stated that six interviews were sufficient for theme development and interpretations of data. Again, Smith et al. (2009) stated that studies "concerned with understanding a particular phenomenon in a particular context" must be conducted in smaller sample sizes. For this reason, I began interviewing 5 participants (with a plausible range of 7-10 interviews) and added one interview at a time until redundancy, and therefore saturation, was reached.

Semi-structured interviews lasted approximately 45-60 minutes and followed the interview questions and interview protocol (see Appendix C & D). A semi-structured interview format allowed me to include a series of structured and unstructured questions during the interviews. Interview questions contained open-ended questions with a few structured questions (see Appendix C). Interview questions were adapted based upon Duckworth's (2016) theory of grit. I conducted pilot tests of the interview questions with three colleagues and revised questions accordingly. Questions included broad topical prompts so that the interview process had fundamental boundaries for what prompted the study in the first place (Van Manen, 1990). These specific structured questions garnered similar responses from participants, as well as an understanding of the phenomenon. These broad questions were contained within the interview script.

As the interview progressed, open-ended unstructured questions and follow-up questions were used to explore possible emergent data, and to draw new and unexplored possible factors from the participant's responses (Merriam, 2009). Interview questions used open-ended questions so that participants could define their own experiences to reflect their unique individuality and understanding of their circumstances (Merriam, 2009). Additionally, follow-up questions were asked to prompt for specific instances or concrete examples, to remain on task, and to evoke rich and deep description (Braun & Clarke, 2013; Van Manen, 1990).

Procedures for Recruitment, Participation, and Data Collection

After receiving approval from the Institutional Review Board (IRB), I sent the initial emails to potential interview participants to invite them to participate in this study

(see Appendix B). The initial email invitation included the criteria guidelines for this study so that each potential participant knew from the first outreach whether she qualified for the study (see Appendix B). Additionally, the invitation email included a brief description and explanation of the study. Participants agreed to confidentiality through the Informed Consent Form by returning the email to me with the words, "I consent."

Recruitment of potential participants came from my professional and personal network of individuals who could satisfied the criteria of this study and who I thought might be interested in participating. I also reached out to several contacts who could recommend and introduce other possible participants. The initial introduction email was sent to potential participants or to individuals in my network who knew of potential participants and could introduce me to them.

After the initial invitation email was sent, potential participants were provided the opportunity to schedule a follow-up phone call to ask questions or to gather additional information. Once a potential participant expressed interest in participating in the study, I sent them the Informed Consent Form through email and the participant had to return the email to me replying with, "I consent" in the email. Criterion data was collected at this time through an email. I took notes after the phone call to maintain consistency and structured reflexivity (Ravitch & Carl, 2016).

Interviews were conducted for 45-60 minutes. Interviews were scheduled in advance with reminder emails or notifications sent to the participant several days prior to the scheduled interview time. Interviews were recorded using Free Conference Call for phone interviews and a hand-held recorder. Interviews were transcribed based upon this

recording. Additionally, I used notes to provide observational information after the interview was conducted and which provided descriptive, inferential, or evaluative observations in order to gain meaning from the information and data (Ravitch & Carl, 2016). The phone interviews were conducted and recorded from my home office. Participants exited the study when the interview was concluded, transcripts were finalized, and I sent them a thank you email for their participation.

Data Analysis Plan

There are many different kinds of qualitative research designs in social science research (Babbie, 2017). These differences in research paradigms do not relate to the methodology of how data is collected but rather what the data means and how it is explained (Babbie, 2017). In other words, data analysis is an epistemological approach, which involves systems of knowledge and the science of knowing and investigates the difference between a justified belief as opposed to an opinion (Babbie, 2017). A phenomenological research method often includes exploration of a phenomenon with a group of individuals utilizing interviews as the main source of data collection (Ravitch & Carl, 2016).

Data collection consisted of the interview transcripts. The data analysis plan entailed thematic analysis for overarching themes from a priori coding procedures compiled from the interview transcripts. The thematic analysis process involved searching for similarities, relationships, and differences in data and reflected a generalized “theme” from a data set (Ravitch & Carl, 2016). Thematic analysis answered

the following research question: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

While reviewing the transcripts, I looked for similar codes or categories that were repeated throughout the transcript (Creswell, 2007). From these codes and categories, I looked for similar groupings to create reoccurring themes (Creswell, 2007). Themes were developed that represented the data based upon similar classifications or groupings of the codes and categories that provided pattern coding that was descriptive and interpretive (Creswell, 2007; Ravitch & Carl, 20167). I used both inductive (referred to as a bottom-up or emic and involves using the participant's own words) and deductive (also referred to as a top-down or etic approach and involves using researcher-created words) approaches to coding and creating categories of the data sets (Ravitch & Carl, 2016). To maintain rigor in data analysis, a combination of both approaches was utilized to describe and interpret the data (Ravitch & Carl, 2016).

Additionally, I utilized a holistic reading approach, a selective reading approach, and a detailed reading approach (Van Manen, 2016). In a holistic reading approach, I first read (and reread) the transcript to understand the text as a whole entity to understand the main significance of the script (Van Manen, 2016). Then through a selective reading approach, I reread the text several times to determine which segments in the text seemed essential or revealing (Van Manen, 2016). I made notes of these phrases and marked them by highlighting and underlining. Lastly, I reread the text for a detailed reading in which I examined individual sentences and phrases for clusters (Van Manen, 2016).

Trustworthiness

Trustworthiness in qualitative research is encompassed in credibility, transferability, dependability, and confirmability (Burkholder et al., 2016; Shenton, 2004). In qualitative research, trustworthiness is measured through validity and reliability, which are based on a positivist perspective (Golafshani, 2003; Shenton, 2004). A study that maintains trustworthiness effectively demonstrates rigor and integrity at all steps of the research process (Burkholder et al., 2016).

Validity means that the research maintains credibility with the findings, in that the study measures what it intended to measure (internal validity) (Merriam, 2009; Shenton, 2004). Validity is also measuring in terms of data collected and the reality associated with the phenomena (Merriam, 2009). And since reality is elusive, then validity is "a goal rather than a product" in investigating "people's construction of reality – how they understand the world" and by investigating how different people have experienced and make sense of a particular phenomenon in their world (Merriam, 2009, p. 214).

An aspect of internal validity (credibility) is through member checking. One way to ensure validity and reliability is a thorough review of the transcript after an interview. The recording was used as the way to member check the transcript for accuracy. Transcripts went through multiple reviews for coding and thematic analysis. Additionally, I kept notes to record observations and to utilize reflexivity with researcher biases. The current study exercised internal validity by allowing participants to reflectively voice their experiences with the phenomenon and by the researcher adhering

to participant's dialogue through transcription. Therefore, the study maintained validity through alignment, credibility of data collection, and through triangulation methods.

Trustworthiness in a study also relates to reliability and dependability as both concepts are closely aligned (Burkholder et al., 2016). Reliability in quantitative research demonstrates that a study's results were consistent across all collected data (Burkholder et al., 2016). Similarly, dependability in a qualitative study shows that there was consistency through across the procedures for data collection, analysis, and summary of the findings (Burkholder et al., 2016; Golafshani, 2003). Additionally, if there are shifts in the methodology of a study, the researcher documents and explains this (Burkholder et al., 2016). Typically audits and triangulation methods are used to confirm dependability. Dependability in this research study adhered to IRB procedures and ensured that procedures for participant recruitment, as well as all aspects of this study, were compliant and fully followed. Throughout the data collection and analysis process, I reviewed procedures with my committee to maintain validity and reliability.

Transferability (or external validity) relates to the ability to which findings can be applied to other situations (Shenton, 2004). Merriam (2009) noted that internal validity must be satisfied before a study can be externally valid as there is no point in applicability of a study if the study did not measure what was intended. Therefore, external validity ensures that the study's findings can be generalized and applied to other similar situations. Shenton (2004) indicated that there must be enough thick description of the phenomenon so that readers of the study can gain a proper understanding and be able to identify emergent phenomena in their own environments. The interview contained

semi-structured questions which allowed for follow-up, open-ended questions to garner additional descriptions of the phenomenon. In the data analysis and study's findings, I provided deep descriptions of the setting, assumptions of the study, and findings so that readers could apply the principles to their situation (Burkholder et al., 2016). Transference and applicability of the current study's findings may encourage positive social change to institutions of higher education.

Confirmability refers to researcher objectivity and extracting the researcher's biases from any part of the research (Burkholder et al., 2016). In qualitative research, there is a measure of researcher subjectivity, for example as is the case in the interpretation of the study in relation to the conceptual framework, but through utilizing notes and memos through journaling will help to reduce researcher bias (Ravitch & Carl, 2016). I used a peer debriefer as part of this process to ensure that researcher biases did not influence the data collection and analysis process.

Another aspect of confirmability is that the current study's findings accurately reflected the experiences of the participants instead of the preferences of the researcher (Shenton, 2004). Through collaboration methods, I bracketed preconceived notions and carefully reflected the content of participant's transcripts. Confirmability also refers to the procedures, analysis, and conclusions of a study that they are verifiable, and even though a study cannot be exactly replicated, the measures and procedures can be confirmed as valid and reliable (Burkholder et al., 2016).

Ethical Procedures

Ethical procedures require that the researcher adheres to research that is ethical by obtaining IRB approval and by providing participants with all required information prior to participation through informed consent (Merriam, 2009). Merriam (2009) stated that even though policies, procedures, and a code of ethics has been developed at all federal and state levels to protect participants and to ensure that researchers follow ethical designs; however, ultimately, the actual following of ethical procedures rests firmly on the shoulders of the individual researcher's integrity, values, and ethical code. The IRB requirements were followed to protect privacy and adhered to confidentiality. IRB approval was obtained before beginning this research. All participants provided informed consent prior to participation.

Participants were required to return the emailed Informed Consent Form by stating "I consent" before scheduling the interview. They had the right to withdraw from the study at any time, and could place restrictions on their use of information. Interviews were recorded. Participant's information and any revealing information that participant's workplace or institution (e.g. names of institutions) were not included in this study. All information was confidential. I did not share information about an institution, so power differentials in the form of workplace dynamics was not a factor.

Phone interviews maintained privacy through closed doors of my home office. Transcripts were recorded and stored within my office in a locked cabinet. I transcribed all transcripts to ensure that transcripts were not shared with anyone else. All digital information was encrypted and password protected. All information will be destroyed 5

years after the study is complete and the dissertation has been approved and published. At that time, hard copies will be shredded using a personal shredder; digital copies will be deleted with files erased from the hard drive.

Summary

The purpose of this chapter was to provide details of the methodology for this study. This methodology included the research design, the recruitment of participants, data collection and analysis, and addressed the trustworthiness and ethical procedures of this study. Phenomenology research emphasizes the lived experiences of people to provide concreate meanings to a phenomenon (Van Manen, 2016). Through this methodology, I researched the lived experiences of female graduates from STEM programs with high gender disparity to provide positive social change and transferability to institutions and people in similar situations.

Chapter 4: Results

The problem that I addressed in this qualitative phenomenological study was the gender disparity of female students in the STEM programs of engineering and computer science. The purpose of this study was to explore the lived experiences of female graduates in engineering and computer science programs. The nature of this study was a qualitative phenomenological approach. Phenomenology allows a researcher to gain a deeper understanding of the participants' experiences and provide a context for the phenomenon to give a "reflective expression to it" (Van Manen, 1990, p. 38). Engineering and computer science programs have the highest rates of gender disparity (Graf et al., 2018; Smith & Gayles, 2018), and exploring the success factors that female graduates have utilized to complete these programs may influence positive change in this field to decrease the gender disparity. The research question for this study was the following: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

In Chapter 4, I present the findings of the data collected for this qualitative phenomenological study. The data were collected through one-on-one semistructured open-ended interviews with females who had graduated from an engineering or computer science program. The interview results are presented in this chapter, as well a context for the interview findings. The purpose of this study was to explore the lived experiences of female students to understand the factors that helped them be successful in their programs.

Additionally, I provided a description of the methods I used for collecting, recording, and analyzing the data. The results of this study may provide strategies for higher education institutions to develop practices that would enable female students to be successful in programs with gender disparity. I also reviewed the evidence of trustworthiness in the study. The chapter concludes with a summary of the results and a review of the theory of grit.

Setting

In this study, I reviewed the literature and found that the STEM programs with the highest rates of gender disparity were engineering and computer science. The population targeted for this study was women who had graduated from an engineering or computer science program. The selection criteria required participants needed to be (a) female and (b) a graduate of an engineering or computer science program. Participants could have completed any type of degree, such as a certificate, associate's, bachelor's, or graduate. I did not restrict access based on graduation date because gender disparity in these programs has spanned more than three decades (Cheryan et al., 2017; Smith & Gayles, 2018).

During the interview, I asked questions to explore whether the departmental climate of engineering and computer science programs had improved from the 1980s and 1990s. This was relevant because STEM initiatives for recruitment and retention have been promoted through the U.S. Department of Education for the past several decades (Cheryan et al., 2017; Smith & Gayles, 2018). I also asked questions to explore whether

climates had changed and whether male students had become more welcoming toward female students.

I conducted one-on-one interviews with each participant. The interviews contained semistructured and open-ended questions (see Appendix C). I conducted the interviews by phone with participants because I felt this would be more convenient for them and would ensure their confidentiality. Before beginning the recording, I explained the format of the interview and asked the participant if she had any questions. After the interview was completed, I informed the participant that a copy of the transcript would be available to her by request through email. Three participants requested a copy of their transcript. The other 14 expressed that they did not want a copy of the transcript. Each participant was assigned a pseudonym. Interviews were conducted in a consistent manner to ensure reliability and validity of the data.

Demographics

I interviewed 17 female graduates from engineering or computer science programs. Of the 17 females I interviewed, there were 36 degrees earned, transferred, or in progress. A transferred degree constituted at least 2 years of coursework at the institution prior to transferring. Four degrees were 2-year certificates, four were associate's, 20 were bachelor's (with one transferred), and eight were master's. Table 1 shows the total degrees.

Table 1

Total Degrees

Degree type	Total
Certificates (2-year)	4
Associate's	4
Bachelor's	19
Bachelor's (transferred)	1
Master's	8
Total degrees	36

Of these degrees, 25 were engineering programs and two were computer science programs. Nine degrees were not related to an engineering or computer science program. Engineering programs included architectural engineering, civil engineering, electrical engineering, environmental engineering, bio engineering, and structural design engineering. Computer science programs included computer science and computer engineering. Nonengineering or computer science programs included English, mathematics, technology, education, and management. Table 2 shows the program data.

Table 2

Types of Programs and Totals

Program type	Total
Engineering	25
Computer science	2
Total	27
Non-engineering or computer science	9
Total programs	36

Of the 36 programs completed, two engineering or computer science degrees were completed in the 1980s. Four engineering or computer science degrees were completed in

the 1990s. Eleven were completed in the 2000s, and 10 were completed or in progress from 2010 to the present. Table 3 shows the degree program years.

Table 3

Degree Program Years

Years	Degrees in engineering or computer science	Degrees not in engineering or computer science
1980s	2	2
1990s	4 (one transferred)	2
2000s	11	4
2010-present	10	1 (in progress)
Total	27	9

Participants completed their degrees in several regions of the United States. Table 4 shows the locations of schools and universities for all degrees.

Table 4

Location of Schools and Universities (All Degrees)

United States location	Total
Northeast	23
Midwest	8
South	5
Total	36

Data Collection

I conducted a qualitative phenomenological study to collect data from interviews with participants. I received IRB approval (Number 12-12-19-0144868) from Walden University on December 12, 2019. I recruited prospective participants through email invitations. I obtained signed consent forms from each participant through email. During

this time, I answered any questions that participants had regarding the study. Participants signed a consent form via email stating "I consent" prior to participating in the study.

Interviews were conducted with participants over a 2-month period. Pseudonyms were assigned to participants to maintain confidentiality. Scheduling interviews was challenging because interviews were conducted over several major holidays. All interviews were conducted by phone because this provided convenience and enabled accommodation of busy schedules. Conducting interviews by phone also helped me maintain participants' confidentiality. Interview questions were composed prior to the phone interviews and were pilot tested by three colleagues. Most interviews lasted 45-60 minutes. I did not insist on time constraints if participants wanted to share more information. One interview lasted 65 minutes.

Interviews were recorded using Free Conference Call and a handheld recording device. Interviews were conducted in my home office with the doors closed to maintain confidentiality. I transcribed each recording using the Temi app, Microsoft Word, and my notes so that each transcription was an accurate reflection of the interview. After each interview transcript was completed and reviewed for accuracy, I began to analyze the data using thematic analysis coding procedures.

The interview data provided information about women's belief in their abilities and strategies that helped them to complete engineering or computer science programs. During data collection, there were no unusual circumstances that occurred. During the interviews, I took handwritten notes, and I compiled these notes in a Microsoft Word document. The transcripts and notes were the basis for the first cycle of coding. As the

interviews continued, I realized I had reached the point of data saturation when no new themes were identified (see Creswell, 2014) and decided to stop data collection.

Data Analysis

After completing the transcripts and reviewing them for accuracy, I began the analysis of each transcript. Data were analyzed using the framework of the theory of grit. The four components of the theory of grit are: (a) passion and perseverance, (b) sustained interest through practice, purpose, and hope, (c) resilience through obstacles, and (d) deep commitment to goals (Duckworth, 2016). Codes represent the data through a word or phrase that helps to describe what is happening in the data (Ravitch & Carl, 2016). A priori codes were established through the theory of grit and incorporated into the interview questions. The a priori codes were resilience, passion, self-efficacy, and hard work. Through coding and the review of transcripts, two more codes were identified: advocacy and support network.

To begin the data analysis process, I read each transcript and made notes in the margins of ideas and concepts that seem to appear through the first reading. After reading several transcripts, I noted a recurring idea that women with self-efficacy tend to advocate for themselves and others, especially other women. In the second reading of the transcripts, I color-coded the different codes and used the corresponding highlight color on the hard copy transcripts. For example, all quotes that indicated resilience were color-coded as blue, quotes that indicated passion were color-coded pink, and so on. In the margins, I included an abbreviation of the code. For example, resilience was labeled “R,” self-efficacy was labeled “SE,” and so on.

After completing an analysis of the hard copies of each transcript, I transferred the highlighted sections and notes into the electronic copies. Each quote for each section was copied and pasted into a chart titled All Codes and Phrases with the designated participants' numbers for each column. This process yielded three separate documents in addition to the transcripts for the 17 participants. From this process, I created another chart titled 2-3 Codes and Phrases with the corresponding participants. I reviewed all of the quotes for each code section and pulled out the most important two or three quotes that exemplified the corresponding code. This process yielded an additional three documents.

The next phase was to review the important quotes for each code and determine whether there was triangulation by combining similar quotes from different participants for each code. I created another chart titled Combination Codes for Triangulation with three columns (see Appendix E). The first column contained one code for each row. The second column contained one quote from each participant that related to that code. This enabled me to see whether multiple participants were saying similar ideas or concepts related to each code. By developing this chart, I was able to identify codes for participants' responses and determine triangulation for each code (see Appendix E).

I recognized that participants were saying similar ideas that related to each code. For example, as a participant was describing an example of being resilient, she was also describing times when she persevered and committed to hard work to achieve her goal. Therefore, the terms "perseverance" and "hard work" were added to the code category of "resilience." With the code of "passion," participants in multiple scenarios described

examples of “focus,” “deep commitment,” “dedication,” “goal-orientation,” “motivation,” and “purpose” so when these examples were demonstrated, they were combined under the code “passion.” Duckworth et al. (2007) defined passion and perseverance as working through challenges and “maintaining effort and interest over the years” despite challenges and adversities (p. 1087). Therefore, those terms seemed to fit in the code category of “passion.”

During the coding process, several other codes became apparent such as “confidence,” “strong personality,” and “belief in abilities.” These terms were grouped under the a priori code of “self-efficacy” as Bandura’s (1977) theory of self-efficacy included perceived individual beliefs and personal judgment of one’s capabilities. The code “support network” was not an a priori code at the beginning of the coding process. As I read the transcripts, participants mentioned that an essential aspect of being successful was through the support of those around them. Therefore, when examples were shared that indicated “role models,” “mentors,” sources of “belonging,” or “inclusiveness,” these were grouped under the code “support network.”

Another code that become apparent through the coding process and was not an original a priori code was the code “advocacy.” Participants shared that they had to advocate for themselves and for others. Advocacy for themselves included examples of going to an instructor for help, reaching out to an advisor or mentor, or challenging a situation that seemed to contain unfair expectations. Advocacy for others included examples of volunteering their efforts in community groups or advising scenarios to help guide the younger generation, volunteering on engineering or computer science boards

and panels to affect positive change in their communities, and paving the pathway for females coming behind them, these instances were grouped under the code "advocacy."

After combining these codes into the code categories of resilience, passion, support network, self-efficacy, advocacy, and hard work (see Appendix E), I put the combination codes into a chart to see which participants were identifying with each code as identified by "X" (see Table 5). Every participant related to these 6 codes as is shown below in Table 5.

Table 5

Codes and Triangulation

Codes	Pauline	Kathy	Anne	Christine	Kirsten	Abby	Melissa	Lynn	Lydia
Resilience	X	X	X	X	X	X	X	X	X
Passion	X	X	X	X	X	X	X	X	X
Support network	X	X	X	X	X	X	X	X	X
Self-efficacy	X	X	X	X	X	X	X	X	X
Advocacy	X	X	X	X	X	X	X	X	X
Hard work	X	X	X	X	X	X	X	X	X

Codes	Maureen	Heather	Jessie	Marie	Grace	Sarah	Rebecca	Hannah
Resilience	X	X	X	X	X	X	X	X
Passion	X	X	X	X	X	X	X	X
Support network	X	X	X	X	X	X	X	X
Self-efficacy	X	X	X	X	X	X	X	X
Advocacy	X	X	X	X	X	X	X	X
Hard work	X	X	X	X	X	X	X	X

Results

The purpose of this study was to explore the gender disparities through the lived experiences of female graduates in engineering and computer science programs. The research question for this study was the following: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

The results and findings from the data analysis process produced six themes that aligned with the research question and conceptual framework of grit for this study. The chart below identifies the themes and theme statements (see Table 6). As demonstrated in Table 6, the themes comprised of phrases that summarized what participants shared about being successful and resilient through their programs.

Table 6

Theme and Theme Statements

Theme	Theme statement "Women in engineering and computer science programs…"
Resilience and perseverance through challenges	Demonstrate resilience in their degree programs. Persevere through hard challenges. Exemplify stubbornness.
Finding passion focuses drive and determination	Are passionate and focused on completing their degrees and in obtaining their career goals through that degree. Demonstrate that when you are passionate about something, you work hard. Being passionate makes you a hard worker Are driven and ambitious, and they enjoy what they're doing.
Build a support system	Report that a support system is necessary for degree completion and success. Report that dynamics of male peers may make girls feel "lesser" in the program.
Confidence and belief in abilities	Believe in themselves. Define success as what drives their passion. Seek environments that they are comfortable in. Exhibit confidence in knowing the extent of their abilities.
Advocate for self and other women	State that they had to advocate for themselves and others during their degree program. Use a support network to advocate for themselves.
Hard work is necessary for success	Report that successful completion of their degrees was through consistent, hard work. Have passion that fuels their drive and ambition and makes them a hard worker. Report that to be good at something, you just have to keep doing it over and over.

Theory of Grit Components

The theory of grit explains how individuals sustain their passion and perseverance through obstacles and adverse situations and maintain a deep interest and investment towards goal achievement. The theory of grit is used to explain individuals' sustained interest, practice, and purpose in achieving their goals. The four components of the theory of grit are: (a) passion and perseverance; (b) sustained interest, practice, purpose, and hope; (c) resilience through obstacles, and (d) deep commitment to goals (Duckworth, 2016). The six themes identified in this study relate to the components of grit (see Table 7). All 17 participants shared examples of resilience, passion, needing a support network, self-efficacy, advocacy, and hard work.

Table 7

Themes and Grit Components

Themes	Passion and perseverance	Sustained interest, practice, purpose, and hope	Resilience through obstacles	Deep commitment to goals
Resilience and perseverance through challenges	X	X	X	X
Finding passion focuses drive and determination	X	X	X	X
Build a support system	X	X	X	X
Confidence and belief in abilities	X	X	X	X
Advocate for self and other women	X	X	X	X
Hard work is necessary for success	X	X	X	X

Theme 1: Resilience and Perseverance Through Challenges

According to the theory of grit, a person who demonstrates grit exhibits sustained interest, practice, and purpose in achieving their goals, as well as persists through adverse situations. An individual who demonstrates grit practices a centralized focus and hard work (Duckworth, 2016). The theme "resilience and perseverance through challenges" was identified as women shared stories of how they demonstrated resilience through their programs, persevered through hard challenges, and exemplified stubbornness to reach their goal of graduation and a career. Maureen shared the value of persistence through trying times. She stated that she was "horrible" at her first course and had to take a course twice. Abby completed two degrees and stated, "Finishing both of my degrees was really... I think more of a personal sense of responsibility and just a sense of accomplishment, knowing that I could do this and that I would always have that." Christine described her academic undergraduate as "academic hazing" and stated that, "It really challenges you to see if you have the intellectual ability to handle whatever discipline you may choose to go into." She continued in saying that professors are looking at a person's individual ability, to challenge them intellectually, and "to see how adaptable and tough you are." She continued that it is all worth it thought because "it's like you've just got to get through it and then your career is going to be so fruitful and you're going to have such excellent opportunities that will open for you."

Almost all participants stated that they had to keep working on their programs and that quitting was not an option. Kathy stated that resilience in her program was necessary because "failure was not an option." Marie stated that she doesn't "quit at anything once

started." Maureen stated that after going through a difficult time in her personal life that if she could endure that "without a nervous breakdown, you can pretty much get through anything." Lynn shared that "they were trying to get rid of people that they didn't think should be there. And I wanted to prove that I should be there." Grace summed up having resilience when she said, "There's nothing that can prevent you from doing it but yourself. I think the combination of those two things, knowing yourself and being able to ask the right questions, …those two things helped me push through a lot of obstacles."

Theme 2: Finding Passion Focuses Drive and Determination

Participants shared that finding their passion is what focused their drive and determination. Heather stated that, "I sound like a broken record, but just having that passion behind it makes you work hard." Often, participants shared that their passion enabled them to enjoy what they were doing in their career fields. Examples of passion showed the character traits of drive, ambition, and singularly focused. Sarah shared that "I gained my own confidence in my ability to complete the material and really understand the concepts and thrive in that environment and excel in a program that was challenging." Hannah demonstrated singular focus when she said,

> I think just seeing how far I had already come and knowing that it was just temporary struggles. And the overall outcome in the end was going to be a lot better. So I'm glad I pushed through. [You can't] be afraid of the uncomfortable.

Sarah shared her drive and ambition when she stated, "I want to be in the top of my class. I want to excel and exceed expectations. And my goals were to do that." During the interview she shared that she completed both of her degrees with a 4.0 GPA. Sarah

shared that she "just loved the material. I have hardly ever had a course in one of these programs that I didn't just really, really enjoy."

Often the codes of resilience, passion, and hard work were synonymous. Maureen mentioned that the first mathematics class she had to take in her program, she failed and had to take it twice. She stated that mathematics was not her "strong suit" but that she was determined to finish her degree even during that first semester, so failing a class was not going to stop her from graduating. Sarah stated that "I was always looking how to leave my programs with the tools that I needed to succeed in industry and to do it better than everyone else."

Additionally, resilience and hard work often times combined with examples of advocacy, passion and self-efficacy. Lynn said, "There was never a question of leaving school. There was never a question of not completing. It was that, 'Screw you. I'm completing this degree.'" Heather denoted passion and hard work when she said, "I can't work hard if I don't have passion. Period. I just don't. Can't get motivated. Don't want to do it. Wasted time type of feeling." Maureen said that "practice makes perfect!"

Theme 3: Build a Support System

The theme of building a support system was mentioned by all 17 participants as a necessity for their success for degree completion and in the workforce. Participants shared that their support network helped them to sustain their interest, helped to identify their purpose in completing their degree, and gave them hope that they would reach the completion of their degree. Kirsten stated that, "Finding that role model is so critical to me." And Kathy mentioned that "if not for the encouragement, I probably wouldn't have

done this." Throughout the shared scenarios, female graduates stated that the dynamics of being the only female in their classes combined with the dynamics of male peers may make female students feel "lesser" in their programs, therefore, finding and establishing a support network was necessary for degree completion as well as gaining a sense of empowerment and feelings of success.

A support network provided several facets for participants. Participants support network provided focus, sometimes redirection, and at all points encouragement to continue what they had started. Some participants already had a support system in place before beginning their degree programs in the form of family and close friends. Other participants created their support system once their degree program began. All participants mentioned that having a support network was critical for feeling "included" and "supported," having "encouragement," getting "help," and feeling "empowered." Rebecca summarized the necessity for a support network best when she said, "I had my team…I knew that they weren't going to let me fall." Christine shared that she developed a core study group that was comprised of four other female engineering students. In this same example, Christine shared that she wished she had become more involved with clubs because as she stated, "The more you get involved with your fellow students in other activities outside of the classroom, you develop more bonds. Those bonds make you more apt to ask questions, more apt to go to them for help because you have this comfort level [with them]."

Theme 4: Confidence and Belief in Abilities

Participants mentioned having a strong confidence in their abilities and a deep belief in themselves. Grace mentioned that she had "strong agency" in her decision and that her decision was not "influenced by anyone trying to direct her path." She believed that the "combination of those two things; knowing yourself and being able to ask the right questions" enabled her to "look back on the path or trajectory with[out] any regrets." She stated that it is important for female students to "be confident in who they are. Know themselves. That's worth repeating. Know yourself and then nothing will shake you." Jessie also stated

> I think I am just a natural leader, so when I'm in a group setting I tend to always take the lead whether it's for work or school, it's just a natural think that I'm going to do. I'm going to be in control because I know it'll get done and it'll get done right.

Confidence in abilities was a central theme. Abby stated, "I've always been pretty confident." She stated that she was the only female left in her junior and senior years and she shared, "I kind of wore it I guess, like a bit of a badge. I felt like I kind of carried that, like I can do this…I can finish this out." Grace shared, "I think people's expectations of me were different, but by then I was…already confident in who I am and I was like that in terms of my work ethic." Sarah stated that she "felt quite confident in my understanding of the materials."

Participants knew when they were in their major that they had made the right choice. Heather shared, "Switching my major? No. Never. Once I got into it and I started

taking the classes, I was very happy with my choice." Pauline felt confident of her choice when she stated, "Was it worth it? Staying up all these nights? I wouldn't change it. I'm glad I did what I did even though it was brutal at times. It's just this self-satisfaction that just made it worth it." Melissa mentioned that choosing her career path was easy because "I just always had a strong aptitude for math. I really loved [it]. [And] I was looking for a more practical way to apply it and a direct career path." Christine shared that looking for her career path was "just basically finding myself, like what's going to make me happy? [And then] once I got there, ever since then I've been very driven to finish and complete."

Theme 5: Advocate for Self and Other Women

Participants mentioned that advocating for themselves and others was an essential aspect to being successful in their program. Several participants shared that they were the only female in their programs. Several women shared that their professors or peers supported them, but other participants shared that they did not have any support. Sarah shared that although she felt a small measure of support from her male professors, her male peers were either indifferent or antagonistic. As shared in one of her examples, she stated

A fellow student kind of wanted to make me feel like I didn't belong. My personality reaction to that was like, 'Who the heck is this guy? I'm going to show this guy.' Like, 'Forget this! You don't tell me where I do and do not belong. Also, who in the world are you?' So that I'd call sassiness. I think that that was my immediate reaction to those sorts of sentiments.

As we discussed in the interview "sassiness" or advocacy is necessary for success. Additionally, as in Sarah's example, her advocacy also reinforced her passion and self-efficacy in her decision-making and persistence to degree completion.

Self-efficacy and advocacy seemed to coincide in the examples shared by participants. Grace mentioned that she had "full agency" in her decision and that she "wasn't influenced by anyone trying to direct [her] path." Rebecca said that she finally felt like she had "earned that clout" and that she "[had] control and [had] a voice now." These concepts of self-efficacy correlated with advocacy of self and for others. Melissa stated that she felt it was important to "not be afraid to push, [to] advocate for yourself." Rebecca mentioned that she "will question anything and everything regardless of whether I have a smidgen of knowledge about it or not." Maureen stated that women who are in the minority in these programs must "exert [themselves]."

Several participants mentioned the need to advocate for the generation of women coming behind them. Jessie stated regarding the activities she volunteered in as "it's just a great, great activity in order to give back. We're helping future generations of science/engineering students to be." Sarah summarized her reason for choosing her degree path, "The fact that there weren't that many women in computer science and I was like, 'Well I can do this.'" She continued by sharing her belief, "I think there should be more women…and more representation here and I can do something about that…. And I believe that I have been successful in my programs."

Theme 6: Hard Work Is Necessary for Success

All 17 participants shared scenarios of hard work throughout their degree programs. Some participants shared that certain aspects of their degree came "easy" for them, while others shared that every part of their degree program required continual investment of hard work. They shared that in order to be good at something, a person needed to keep doing it over and over. Rebecca summed it up this way

> And when you think you're done, you're going to do it 100,000 more times because you can't put a letter grade on a skill. You have to learn the skill. You're learning how to deal with the situation and adapt to it in everyday life. So you just have to keep doing it over and over.

Two other participants mentioned that they "worked their tail off." Participants' stated that their passion fueled their drive and ambition, that it made them a hard worker, and these aspects were essential for successful completion of their degree programs.

All participants shared a deep commitment to completing their goals. Participants shared that their motivation to graduate was only slightly less important than completing their goal with excellence. Their purpose of achieving their goals with distinction was both for self-satisfaction and to demonstrate women's capabilities to make the pathway easier for future female students. Participants' shared that their success was due to hard work in combination with talent and skill. However, all mentioned that although it was helpful to have natural ability, especially in mathematics and science, it was not necessary to achieve their goals. Several participants shared that their natural talents were in the humanities or creative arts, but they were deeply driven and motivated to complete

their program. They stated that the foundation for their success was their deep commitment to hard work and completing their goal of graduating. Kathy stated that "it's not so much aptitude as hard work." Several participants mentioned that they were "horrible" at mathematics or science, or had no previous exposure to hands-on, technical, or engineering or computer science concepts prior to entering their degree programs. Kirsten stated that completing her degree was "a lot of hard work and determination" and she "never once felt that things came easy to" her.

Every participant stated that their success in their program was due to continuous hard work. Anne stated that "it's the end of the day that the work ethic is just going to be important across the board." Many participants described themselves as a "hard worker" or "driven" stating that "it was the practice that made perfect." Pauline stated

> That was my goal and that's what I decided it was going to be. And that's what I worked towards every single day. You need to have that drive. I definitely worked hard and put in the energy just because I knew I wanted it so bad.

Overall, this sense of needing to work hard was an ideal that female graduates were not only setting for themselves but also because they were setting an ideal for future students. As Marie shared that she felt the ideal of "you're gonna have to be a little bit better. You're gonna have to try a little bit harder. The standards in some ways are a little bit higher."

Participants' Experiences With Academic and Departmental Climates

Research has shown the barriers that women in engineering and computer science degrees face continual obstacles that they have to overcome (Smith & Gayles, 2018).

Throughout the interview process, female graduates shared examples of different departmental and academic climates. Some participants shared departmental climates that that were outwardly hostile towards them as well as subtle biases that they had to overcome. Others mentioned academic climates that although they were male-dominated with faculty and student peers, but they were overall supportive of female students. Two participants shared academic climates that had almost equal female representation.

Women who completed degrees in the 1980s and 1990s, the barriers came from instructors or administrators that tried to deter women from signing up and completing these programs. For example, one participant who completed her degree program in the 1980s shared that a professor in an engineering class would require students to come to the board to solve problems. When it was her turn to go to the board, the professor would give her problems that she could not solve. However, the problems that he gave to the other male students, she could solve. She shared that eventually she identified that the professor was giving her problems from chapters not covered yet to humiliate her and to prove that women do not belong in engineering. To solve this problem, she would study ahead in the textbook to learn the concepts prior to when they were taught in class. The next time the professor called her to the board to solve problems not yet taught, she solved it, and from that time on the professor never called her up to the board again. In another scenario, Kathy mentioned that “the teacher was trying to get me to drop this class but instead of dropping it, it made me mad” and she mentioned that she wanted to do well so that she could show him that she could do it.

Another participant mentioned that she felt that she was tolerated but definitely not welcomed or felt a sense of belonging with the other students. In her reflection, she stated that at the time she defined it as bias, but looking back on it now, she deemed it as an issue of being uncomfortable with her or perplexed by her and as she explained, “they just don’t know what the hell to do with you.” Faculty and male peers did not know how to relate to her. She shared that she was the only female student in the class, and additionally, she was the first female student in the program.

Female graduates who completed degrees during this span of years mentioned that there were no female faculty or female administrators in their departments at that time. Female participants described the male faculty in their programs as “unapproachable,” having superior “egos,” and “sexist.” Female participants shared how they had to persevere and that the bias increased their determination to not only continue, but to “show them they could do it.” As one participant summarized, the biased environment increased her stubbornness.

The barriers that women faced in the 2000s-2010s were a mixture of instructor bias and peer bias. Jessie shared that male faculty held female students to different expectations, with more accountability and higher standards than the other male students. Several participants mentioned classes that occurred earlier in their sequential coursework as “weed-out” classes that instructors used to determine students’ resolve to continue in the program. During one of these classes, professors would make disparaging comments to female students. Peer bias consisted of male peers telling the female students that “they didn’t belong and why are you taking these classes anyhow?” Implicit

bias consisted of male students comparing themselves to female students with grades and would express subtle disparaging and discouraging comments.

Female students in this decade shared examples of how they were able to appeal through self-advocacy to an instructor or to an administrator for help and the bias lessened somewhat. Oftentimes though, their support networks, grit, and self-determination enabled them to continue in their programs and helped to strengthen their resolve, even when circumstances did not change.

The barriers that women faced in 2010s-2020 were more often from male peer bias although some professor bias was still present. At times, the male student bias was denounced by professors, other students, and administrators. Female students shared examples of their program departments being more like a "boys club." One participant shared that peer bias occurred when a male student compared himself to her in front of the class to "put her down." Lydia shared that certain male students would identify her with domestic duties, such as ordering her to "go make him a sandwich." Lydia shared in this specific example that their female professor overheard the exchange and proceeded to lecture him and the class that all students were equal and gender roles no longer existed. Several female students shared examples of male students who viewed them as potential dates or partners rather than as an equal intellectual. Additionally, in extreme examples several participants shared scenarios of male peers stalking and harassing them, which required intervention by the institution's administration. Generally, female students reported feelings of tolerance and acceptance especially after establishing a

support group within their courses. However, prior to establishing a support group, female students reported feeling like an “afterthought” in their classes.

Over the years, the departmental environment and academic climate has not changed significantly. Several participants reported feeling excluded, unwelcomed, and lacked a sense of belonging. While other participants mentioned environments that were “helpful,” “accommodating,” “supportive,” and contained “equal expectations.” Some participants felt that their presence demanded a higher standard because as they were the only female in their classes so they couldn’t “hide in the crowd” and therefore, their names and projects “stood out” the most. Often they mentioned that they felt the weight of responsibility to show that female students were just as capable, if not better, than their male counterparts so that future female students would be accepted more readily. All participants mentioned a direct connection between healthy departmental environments where class sizes and college size were smaller than bigger universities with larger class sizes. Participants who completed several degrees or transferred from large universities identified that in large classes students were “just a number” to their professors and teaching assistants. They shared that in these environments, it seemed that bias and stereotypes were prevalent. Participants compared this environment with smaller class sizes and shared that their professors, either male or female, were able to develop individual relationships with students in which a community was established where all students were known, expectations were the same, and bias and gender stereotypes lessened. Female participants shared that in these smaller classes, they felt included and supported, and that they were held to the same expectations as the male students.

The numbers of female representation have not increased over several decades. From the 1980s to present, all participants mentioned that they were the minority in their program. Participants from the 1980s and 1990s mentioned that they were the only female in their classes and oftentimes, they were the first female to complete their programs. Participants from 2000s to present often were one of two to four female students in their programs. Female faculty and administration representation showed a slight increase over the decades with zero female faculty representation in the 1980s and 1990s, to one or two female faculty in the 2000s to present. During this time frame, a few participants mentioned a female administrator in their program that helped and supported them throughout their programs.

Class sizes consisted of typically 25-50 with a couple of sections, or in larger universities a total of 80-100 with several sections. Class sizes of 25-50 typically had 1-4 female students. Classes of 80-100 with 4-8 female students at the beginning of the courses. By the end of their coursework, overwhelming the majority of female participants stated that they were the only female graduate or one of three (in the larger class sizes). Two participants shared close to a 50/50 ratio of male and female students throughout their programs although the numbers dropped the closer they got to graduation. However, most participants reported a percentage of female representation between 10%-20% at the beginning of the coursework, and around or less than 10% at graduation. Several participants in both engineering and computer science degrees mentioned that they were the only female be in their graduating class. For example, Abby stated, “There were 40 of us that started [the program] and I think there were 5 girls,

including myself. [And] four years later, I think 24 of us graduated and I was the only girl."

Participants' Advice for Future Female Students

When asked the interview question, "What advice would you give to a future female student going into your program?" participants mentioned factors that related to the themes of this study. Anne stated that she needed to be "tough" and have a "thick skin" because people will already have "painted a picture of you…that you know the answer" and so students will need to have a good "work ethic" to "show up, communicate, accomplish tasks, be pushed, and meet deadlines." Marie mirrored this advice when she said that "people will expect you to be a little bit better…[and] you will need to try a little bit harder" because "eyes will be on you and you can't hide in a crowd" so students will need to try their best.

The theme of "advocacy" was strong in Marie's advice that future female students are "responsible for showing that we can do it" and that it is "a heavy weight in some ways" so female students have to be strong and responsible. Her encouragement for developing this strength was to establish connections with other women and "to establish a support network, if you don't already have one." Lydia stated that female students should "be the best for yourself! Don't compare yourself to others." She shared that "just because you speak a different language doesn't mean that your language is wrong" and "when you're backed into a corner…just remember…to brush it off" and not to let them change you. Maureen stated that females need to have a "strong personality… you need

to exert yourself." Melissa shared that "you need to advocate for yourself" by being "determined, finding like-minded people" and being motivated to succeed.

Most participants mentioned that to being successful in a program with low female representation requires two things: (a) know what you want to do, and (b) establish a support network. Participants described female students need to know what they want to do, and shared that they must be "super passionate," "to follow your heart," "be dedicated to your goals," "be confident in who you are," and that female students cannot let not letting anyone distract them from what they want. Grace stated that future female students need "to be confident in who they are. Know themselves. Know yourself and then nothing will shake you." She continued by stating that if a person knows what they want, are confident in their abilities, and can ask the right questions, then that assurance "takes away the doubt or future regrets."

Sarah stated that it is important for a person to know what they want to do with their degree and why they want to do it. She pointed out that many who start their degrees have no prior experience and have a "nebulous" idea of how to use that degree after graduation. Her advice was to find a role model that can help a female student navigate "what using your degree will actually mean once you're done with it." Christine advised that for future female students to be successful, they need to take advantage of mentor relationships to help with career guidance and job shadowing. She continued that any clubs that are related to the content area provides activities and networking outside of the classroom which provides mental breaks, professional and personal relationships, and opportunities to get to know advisors and faculty.

Every participant mentioned that future female students need to believe in themselves. Abby shared that girls are a lot quicker to give up on themselves. For example, she shared that if they fail a math test, they are quicker to state that "they suck at math." She mentors female students at secondary schools and shares that we need to "find a way, especially with girls, to get them to believe in themselves a little more." Abby shared that

> Failure is part of the process… It doesn't make you stupid…That doesn't make you incapable. You're not always going to get the highest grade. You're not always going to be perfect.

She said that girls need to be encouraged that failure "doesn't mean we give up on it. You can do [it]. It doesn't have to be a smooth road, but you can still get it done." Several participants mentioned the theme of grit to get through their programs. Lydia shared that you have to "have a mindset" and be "someone that can, against all odds, put [your] head down, get to the grind, and still get what the end goal was accomplished." Christine stated that "I definitely consider myself as somebody who has quite a bit of grit. To kind of just clench my teeth and get through it, whatever needs to get done." Participants shared that a central theme to their success to a belief in themselves and their tenacity to achieve their goals.

Jessie stated that "you need to work as hard as you can" and "be responsible…[and] take accountability." Kirsten said that girls need to "just stick with it!" The struggles that "you may have are only temporary…it is not permanent. It is hard, but just do it." Hannah shared that girls should "not be afraid of the

uncomfortable…don't be afraid to ask questions…look for the light at the end of the tunnel. It is worth it." Heather said that future female students need to

> 100% follow their passion. Don't be intimated by what you might be going into. Don't make yourself feel like the victim...[and] don't even put that notion in your head before you go. If you have passion behind something, [and] you're willing to work hard… [you can] get to the end point.

Participants' Advice for Marketing STEM Programs to Female Students

Participants mentioned that STEM programs need to be promoted to future female students in a different way. Many females mentioned that the "attractiveness of a STEM degree" and the creative aspects of STEM fields are overshadowed by the necessity to "be really good at or love math and science." Oftentimes, in secondary and postsecondary advising sessions, STEM programs are endorsed as a good degree fit for students who love to work with mathematical and scientific concepts. This often leaves no room for students to consider a STEM program if they self-identify as being poor learners with mathematics or science. Kathy shared that she believes that more female students do not consider STEM degree programs because of how it is presented. In her case, she shared that she "did not love math or science," as she felt her strong suits were in the humanities, English, and creative arts. Maureen shared that students who feel that they are not strong in Calculus or Physics can still complete a STEM degree because the program teaches students how to think logically. She stated that she personally felt that she was "not good" at math or science, but that the main thing a STEM degree is teaching you is how to problem-solve with logical progression.

Abby shared that she often tutors female students in math and the biggest "hurdle" that she has to overcome is to instill in her female students' confidence in their mathematical ability. Abby shared that often when one of her female student fails a math test, she is very quick to give up on herself and say that she "sucks at math." Jessie also advocates for future female students and serves in a volunteer capacity on several boards and Technical/STEM societies. Her advice was that the motivation for success is internal, that female students can succeed in a STEM program, not necessarily through a natural aptitude for math and science, but through hard work, support of others, and taking accountability for their own success.

Kathy advocates to all students to go into a STEM degree because the course sequences within the degree teach students how to problem solve and be a linear thinker. She stated that this ability opens doors for future careers, even careers that may not be in a STEM field. Additionally, Kathy stated that STEM programs should be marketed as creative and fun, because it is. She said that she "never felt like she was born" to do her degree, but she just really liked it and so she worked hard at completing it. She stated that engineers are "made not born." Over the years as an engineer, she believes that she has been successful and has made a difference because she is always learning and has set a good example that if she can do it, then they can do it too.

Jessie shared that volunteers with STEM activities for middle and high school students, and the activities focus on problem-solving, creativity, and working cohesively together as a team. When the programs are run with these goals in mind, more female students sign up to participate and enjoy working with the scenarios. She shared that

when one of her female students found out that this was a STEM activity, she was "surprised" because they "hadn't been working with math equations the whole time" and it was fun. Overall, many of the participants shared that a STEM degree opened proverbial career doors for them, where the completion of their degree consisted of hard work and determination, but that the success of completing their degree was empowering to their self-identity and confidence.

Evidence of Trustworthiness

Trustworthiness in qualitative studies relates to the aspects of credibility, dependability, transferability, and confirmability (Burkholder et al., 2016). Multiple strategies can be used to establish trustworthiness in a study and through these aspects, rigor and integrity can be demonstrated through each step of the qualitative research process (Burkholder et al., 2016). Trustworthiness is essential component in ethical research that demonstrates rigor and integrity through all steps of the research process (Burkholder et al., 2016). If data cannot be trusted, validated, confirmed, and credible than the new knowledge gained through the research cannot be used to form new initiatives and it cannot be applied to future contexts thereby influencing positive social change objectives.

Credibility or internal validity addresses the research question and the data collected and is the process by which researchers "can affirm that their findings are faithful to participants' experiences" (Merriam, 2009; Ravitch & Carl, 2016, p. 186). The research question of this study explored the experiences of female graduates in engineering and computer science degree programs. I adhered to the research design and

conducted one-on-one, semi-structured interviews with participants who met the criteria of this study. I used both inductive and deductive approaches in coding the transcripts and developing themes from the transcripts to describe and interpret the data (Ravitch & Carl, 2016). In coding the transcripts, I used a combination of reading approaches such as holistic, selective, and a detailed to identify the significant and essential segments of script which became codes and themes (Van Manen, 2016). The data collected answered the research question by providing a "holistic interpretation of what is happening" (Merriam, 2009, p. 215).

Dependability in a study is that the concepts are closely aligned and that the study's results were consistent across all collected data (Burkholder et al., 2016). During the interview process, each interview was conducted in the same format. All interviews were recorded using Free Conference Call and a handheld recorder. Interviews were conducted behind closed doors in my home office. Interview questions were subjected to pilot testing and were reviewed by three colleagues to ensure that the questions would gather data that related to the research question. Interview questions were the same for each participant adhering to dependability of the study. Transcripts were created using the interview recording. I reviewed each recording several times to ensure accuracy between the written transcript and the interview recording. This enabled dependability and reliability in this study by reflecting consistent data collection results (Burkholder et al., 2016). Once the transcripts were completed, I read and re-read the transcripts for multiple reviews for coding and thematic analysis. As I read the transcripts, I took notes of my observations to use reflexivity to reduce researcher bias. I also maintained

dependability in this research study by adhering to IRB procedures to ensure the practices for participant recruitment and confidentiality of data were compliant and fully followed.

Transferability or external validity relates not to the ability to create "true statements that can be generalized" but to "develop descriptive, context-relevant statements" (Ravitch & Carl, 2016, p. 189). Transferability also applies to the application of thick descriptions and variations of examples (Burkholder et al., 2016). I provided a detailed description of the setting, recruitment process for participants, and data collection process so that the reader can apply these findings to similar contexts. Transferability of the findings of this study can be applied to other similar contexts such as at other institutions where female representation is low in engineering and computer science programs. Participants were recruited through purposeful sampling and were required to meet the criteria for the study before they were interviewed. Interview questions provided rich, deep descriptions of their lived experiences and reflections which enabled the transferability of the findings of this study to multiple contexts. In reporting the findings in this chapter, I provided detailed descriptions of the results of the study so that readers could identify emergent phenomena and can apply the results of the study to similar contexts thereby encouraging positive social change to similar contexts within higher education (Burkholder et al., 2016).

Confirmability in research refers to the process that procedures, analysis, and conclusions of the study are verifiable, valid, and reliable (Burkholder et al., 2016). To ensure that confirmability was achieved, I adhered to the interview protocol with participants by asking the same follow-up question prompts for each participant. This

enabled me to maintain neutral to participant responses. I bracketed my thoughts through notes that helped to reduce researcher bias (Ravitch & Carl, 2016). Data was collected using the same procedures for each interview. All transcripts were analyzed using the same methods throughout the coding process. This demonstrates that confirmability in the study's results were consistent across all collected and analyzed data.

Summary

In Chapter 4, I summarized the results of the interview process and participant responses. The purpose of this study explored the lived experiences of female graduates in engineering and computer science programs to gain insights about gender disparities in the academic field. Data analysis through a priori codes revealed six themes that supported the conceptual framework for this study and answered the following research question: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs?

In Chapter 5, I will discuss the interpretation of the findings as well as the conclusions of this study. Additionally, I will discuss the limitations of this study and recommendations for future studies. I will conclude with potential implications for positive social change and recommendations for next steps.

Chapter 5: Discussion, Conclusions, and Recommendations

Engineering and computer science programs have the highest rates of gender disparity in STEM degree programs (Cheryan et al., 2017). The problem addressed in this study is the gender disparity of female graduates in engineering and computer science programs. The purpose of this study was to explore the lived experiences of female graduates in engineering and computer science programs to gain insights about gender disparities in the academic field. The research question for this study was the following: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs? The nature of the study was a phenomenological qualitative design with semistructured interviews with female graduates. Phenomenology is the "study of the lifeworld" (Van Manen, 1990, p. 9) and focuses on gaining understanding of participants' daily experiences to obtain meaning regarding the phenomenon.

The conceptual framework of the study was the theory of grit, which has four components: (a) passion and perseverance; (b) sustained interest, practice, purpose, and hope; (c) resilience through obstacles, and (d) deep commitment to goals (Duckworth, 2016). The data were collected and analyzed using a priori codes of resilience, passion, self-efficacy, support network, advocacy, and hard work. The key findings of the study were six themes:

1. resilience and perseverance through challenges,
2. finding passion focuses drive and determination,
3. build a support system,

4. confidence and belief in abilities,
5. advocate for self and other women, and
6. hard work is necessary for success.

There were 17 participants in this study. Their graduation years were the 1980s to 2020. Participants attended college and universities in the Northeast, Midwest, and South regions of the United States. Degree programs consisted of certificates, associate's, bachelor's, and graduate degrees in the areas of engineering or computer science.

The findings support existing literature that addressed the importance of departmental and academic climates for female recruitment and retention in engineering and computer science programs. The findings also support the necessity for individual motivation and tenacity of female students for goal achievement. The research question was answered through the conceptual framework that was grounded in the theory of grit. Findings may influence positive social change in these fields to decrease the gender disparity in engineering and computer science programs.

Interpretation of the Findings

Findings were consistent with previous studies that showed that gender disparity is present in engineering and computer science programs (see Doerschuk et al., 2016). Duckworth et al. (2007) showed that women must demonstrate grit in environments that contain challenging circumstances. My findings were consistent with Smith and Gayles (2017) who showed that hostile or unwelcoming academic and departmental environments create greater gender disparity and attrition of female students. Wang and Degol (2017) found that even though women complete more than half of the bachelor's

degree programs earned in the United States, they are graduating from STEM disciplines with less than 20% representation. The persistent gender disparity of female representation in engineering and computer science degree programs, which provide workers for the fastest-growing and highest-paid occupations, merited further investigation to explore the successful experiences and strategies of female graduates (see Charlesworth & Banaji, 2019; DiBella & Crisp, 2016).

The findings of the current study revealed many similarities across the demographic population of participants who completed degrees at institutions in the South, Northeast, and Midwest regions of the United States. Degrees were earned by female graduates from the United States, as well as an international student from the West Indies. Participants earned their degrees from the 1980s to 2020. Participants represented various ethnic groups. Several participants were transfer students whose pathways consisted of a completed degree at a 2-year institution (including both community colleges and technical colleges) to a 4-year institution, or a 4-year institution to another 4-year institution. Participants completed a variety of 2-year degree programs, certificates, 4-year degree programs, and graduate studies. Several participants completed or were in the process of completing a master's program. Female graduates completed degrees in engineering and computer science programs with representation from environmental engineering, civil engineering, computer engineering, architectural engineering, construction engineering technology, chemical engineering, carpentry, structural design, electrical engineering, integrated business and engineering, engineering

product design, welding, welding joining technology, plastics manufacturing, fabrication skills, and computer science.

The data collected and analyzed answered the research question: What are the lived experiences, in terms of grit, of female graduates from engineering and computer science programs? Participants shared their experiences with completing an engineering or computer science degree program, and six themes were identified. Data were analyzed using the conceptual framework of the theory of grit. The four components of grit used for this study were: (a) passion and perseverance; (b) sustained interest, practice, purpose, and hope; (c) resilience through obstacles, and (d) deep commitment to goals (Duckworth, 2016). The interpretation of the findings is organized by the six themes and supporting literature.

Theme 1: Resilience and Perseverance Through Challenges

The results indicated how participants were able to sustain their perseverance through challenging and adverse situations and demonstrated resilience. The third component of the theory of grit is individuals have the ability to be resilient through obstacles. It was evident from the results of this study that women demonstrated resilience throughout their degree programs.

All participants shared that female students in their programs were the minority. According to the participants interviewed, the engineering program that demonstrated the highest level of gender parity was civil engineering. Posselt, Porter, and Kamimura (2018) found that civil engineering programs have begun to demonstrate higher numbers of female representation. A few participants in the current study (two from civil

engineering and one from welding) mentioned that at the beginning of their programs, there was almost equal representation of female students. These participants mentioned that the higher representation may have been due to several factors: female faculty who advocated for female students, female representation in administrative offices such as a female dean of their department or a female chair of the department who also advocated for female students, female faculty advisors who were paired with female students, hands-on applications of concepts, male and female faculty having the same expectations for all students regardless of gender, course expectations based on merit, application of concepts, individual work ethic, support groups composed of other female students in the same classes, and a supportive environment that communicated belonging.

Results also indicated that in engineering and computer science programs, the first 2 years of the programmatic course sequence included weed out classes (e.g., Lynn). The concept of early classes being used to determine who could cut it in the program was reported by most of the participants. Herrmann et al. (2016) noted that STEM fields "emphasize challenging introductory courses designed to 'weed out' students early in their academic career, a philosophy unique to these areas" that increases the attrition rate of students in these programs (p. 258). Also, Lynn shared that "they were trying to get rid of people that they didn't think should be there." Christine stated that the first two years of her program seemed like "academic hazing" because the professors and department wanted to see whether they could handle it. Christine shared that in her first class for chemical engineering, the professor stated "I want you to look to your right and look to your left. Half of them won't be here in two years." Herrmann et al. found that male

faculty “comprise the majority of STEM faculty at universities in the United States” p. 259). Academic or departmental environments that are “hostile or unwelcoming” to female students are directly related to their “social and academic withdrawal” from those environments (National Academies of Sciences, Engineering, and Medicine, 2016, p. 61). Smith and Gayles (2017) reported that unsupportive academic environments are a factor that cause women to leave these environments.

Participants in the current study also demonstrated resilience through their programs that demonstrated gender stigmatization. Lydia shared that a male peer demanded that she “go make him a sandwich.” She also shared that a female faculty member proceeded to “rip into him for about 20 minutes about how gender roles don’t exist anymore.” Lydia demonstrated resilience in this situation and stated that “[you] kind of get this thicker skin…and you get used to the male generated comments.” The support of the female professor also helped to quell further sexist comments in her classroom and throughout the program. Studies indicated that competent female role models assist with motivational processes to help women achieve their goals and develop a sense of belonging (Dennehy & Dasgupta, 2017; Herrmann et al., 2016).

Several participants in the current study mentioned sexual harassment or gender harassment as a deterrent in their programs, although these situations did not cause them to quit. Participants who completed programs between the 1980s and 2000s shared examples of how male professors demonstrated gender harassment. Kathy shared an example of gender harassment in a class with a male professor. She was one of the two females in the class. Kathy shared how the male professor would humiliate her and the

other female student in his class by making them solve problems in front of the class on material that had not been covered in class, and then deride them when they could not solve the problems. When the other female student went to him for help, his advice to her was that she should drop out of the class. Later, Kathy found out that this male professor "didn't think that women should be engineers." When Kathy realized what was happening, she studied ahead in the class and the next time she solved the problems in front of the class correctly. Afterward, he never called her up to the board again. Smith and Gayles (2017) also found that women in male-dominated fields are "treated differently" and that these academic environments are described as "chilly climates" (p. 1201).

Participants who completed programs between the 2000s and 2020 shared examples of gender harassment not only from male faculty but also from male students. Women in male-dominated programs often found themselves the subject of unwanted advances; they were seen as a potential date rather than a peer. Sarah stated that a male student in her class took "the time to tell me that I wasn't going to be able to succeed in this program and that I should find something else to do." Sarah also stated that she felt "unwelcomed by her peers but not her professors" in her undergraduate program, that all of her content-specific courses were taught by male professors, and that she was the only female student in all of her classes. She also stated that comments that she received from her male peers were "demeaning." Additionally, Sarah shared that

> when you're the only woman in a room full of gentleman who spend a lot of their time in other rooms full of gentlemen, either in academia or in industry, and

> you're assumed that for the gentleman who are attracted to women, you can end up being seen more as a possible partner than you are as a peer.

She also stated that she often received "unwanted advances" and shared that "that can be really challenging."

Abby stated

> I was …the only female in a room with all these guys. Reflecting back and at the time I think it's really easy to justify other people's behavior and words and you know, you don't want to be the one that continually overreacting. But…there were lots of what now I would consider very inappropriate comments. They [male peers] would ask me in class… [questions that were] definitely very, very sexual questions.

Fernando, Cohen, and Duberley (2019) also found that women in male-dominated degrees and professions are subjected to a sexualized visibility that overshadows their other attributes and values.

White and Massiha (2016) found that women face challenges in STEM programs that can be overt, subtle, and covert revealing latent and obvious biases. In the current study, Kirsten shared that a male student in her class

> looked at me up and down and he says, 'You don't look like you're in [that particular program].' And that stuck with me so hard for four years. Like that kind of reaction, 'Oh, you're kind of pretty and you're a girl and there's no way you're smart.' That was just insane to me.

Pauline shared that one of the male students in her classes always compared himself to her "putting her down" and "rubbing it in her face," which was frustrating for her.

Asplund and Welle (2018) noted that underrepresentation of women in STEM fields can be "partially attributed to implicit bias" where individuals find themselves working against an "unconscious set of expectations" and those who are "not in line with this stereotypical idea…often find themselves working against an invisible barrier" (p. 635). Additionally, gender bias in STEM can be attributed to "peer perception bias" in which male students showed preferential treatment towards other male students as being more knowledgeable and competent contributing to the chilly atmosphere of STEM courses for female students (Salehi, Holmes, & Wieman, 2019, p. 2). Women in these situations stated that they knew the biases were there but that they were not going to let the biases define them and their abilities.

Participants persevered in this type of environment by sharing that they knew that this was happening and they were not going to "let them get rid of you" (Lynn). Participants exemplified perseverance and stubbornness throughout their programs and refused to allow the situations or circumstances to keep them from completing their degrees. All participants demonstrated resilience as the cornerstone of their success and shared that in order to be resilient and to be successful in their program, they had to focus on their passion, build a support system, believe in their abilities to succeed, advocate for themselves, and that they needed to continually push hard and to work hard to show that they were capable and deserved to be there. Both academic and departmental environments matter and hold significant influence over women's success. Hodgkinson,

Khan, and Braide (2019) stated that women need to adapt within challenging circumstances and adopt strategies that enable them to identify with their field. Resilience and grit were the foundations that strengthened women's determination to succeed and complete their programs.

Theme 2: Finding Passion Focuses Drive and Determination

The results indicated the theme of "finding passion focuses drive and determination" is that individuals demonstrate grit with passion and perseverance. Women are passionate and focused on completing their goals. Through their experiences women shared that being passionate enabled them to work hard and that it focused their determination to complete their degree (Sigmundsson, Haga, & Hermundsdottir, 2020). Some participants demonstrated drive and ambition to complete their goals. One participant explained it as "you just need to grit your teeth and do it!" Other participants shared that completing their degree was because they enjoyed what they were doing and could not consider any alternative options. Anne shared "I am just passionate and I work very, very hard. And what else could I do? It just sparked me." Rebecca stated simply that "I have to do what I like." She continued by stating

> For me when it gets challenging, I just loved it. I loved it from day one. I was like, 'This is fun. I love this. How can I sit behind a desk and look at a computer screen when there is THIS is the world?'

And that passion drove her to work hard, advocate for herself, and "earn her clout."

Being passionate is what drives women to be hard workers, and in some ways, their passion can almost be described as an obsession in completing their goals.

Participants shared examples of not being able to think about anything else, losing sleep over wanting to learn more about their craft, and driven to the exclusion of all else to obtain more knowledge and experience. Goal passion is a factor of grit that sustains one's effort and interests through projects that can take significant amounts of time to accomplish or complete (Duckworth & Quinn, 2009). Passion is what fueled participants' drive and focus to complete their degrees.

Theme 3: Build a Support System

The results indicated that participants experienced success with their degree programs by building support systems that sustained their resilience, hope, passion, and determination to graduate. The theme of "build[ing] a support system" represented the second component to the theory of grit which maintains that individuals with grit sustain their interest, practice, purpose, and hope (Duckworth, 2016). Support networks help women to be resilient. Strong support networks and systems are essential for women's success.

All participants stated that having a support system was an essential component to their success. A support system can be a combination of several things: family support or a parent who invests into one's life, a close friend, a club or organization at the college, classmates or peers that form a study group, or any combination of these components. An important factor that involved building a support group was finding an encouraging and supportive mentor. Participants shared that their mentors were often a current faculty member or an administrator. Often participants would seek mentors in these roles (for example a faculty member or administrator) who were female that could serve as a

visible role model. However, participants shared that they chose their mentors, both male and female, based upon their positive relationship with them, and their encouragement and support. Participants shared that they found a mentor who they could "lean into" (Sarah), who was "approachable" (Lynn), is "super helpful" (Rebecca), very "supportive" (Hannah, & Rebecca), very "inclusive" and "ideas are valued equally" (Melissa), who can give you "practical advice" (Maureen), who "encourages you" and "advocates for you" (Lydia), who "builds up your confidence" (Abby), and who can "provide career [and networking] guidance" (Christine, Sarah, Melissa, & Kathy). A mentor infuses confidence and self-efficacy into their mentees which empowers them for success.

Mentors and role models are essential for the retention of women in STEM degrees, as female students are more likely than male students to drop out of STEM majors (Herrmann et al., 2016). Male students can make female students feel unwelcomed through subtle bias and implicit stereotypes (Charlesworth & Banaji, 2019). The benefits of a role model or mentor protect women's sense of belonging in their program, insulates them against the barriers present especially within the first two years of the program when attrition is the highest, and the benefits last longer than the first years of college providing a greater percentage of retention of women in STEM degrees (Dennehy & Dasgupta, 2017). A support network, a role model, or a mentor can help to develop mindsets that are adaptable to countering gender-specific stereotypes and develop stronger resilience (DiBella & Crisp, 2016). Pauline shared that development of a support network and finding a mentor were crucial to countering the dynamic of male peers in her class that often made girls "feel lesser in the program."

Theme 4: Confidence and Belief in Abilities

The results indicated that participants maintained confidence and belief in their abilities throughout their degree programs. Self-efficacy is the belief in one's abilities (Bandura, 1993). Participants shared examples that demonstrated their confidence in their abilities and the belief that not only could they succeed, but they could do it better than anyone else. Confidence in abilities were demonstrated through mathematical or science acquisition and application. Participants shared that they were not necessarily confident in mathematics, science, or the technical aspects of their degrees, but they were confident in their ability to adapt to any situation and thrive.

Confidence in abilities was also demonstrated in personal values. Abby shared that her group had "strong character" and this helped to sustain her confidence. Hannah shared

> I would say, most importantly, don't be afraid of the uncomfortable. Going into it obviously is very uncomfortable being a girl as a minority …[but] just remain focused and go after what you're trying to go after to benefit yourself and everything will fall into place as it needs to.

DiBella and Crisp's (2016) research indicated that the stereotypes that women face in STEM degrees may cause them to develop adaptability, flexible mindsets, and greater resilience. Further research demonstrates that women tend to adopt their career as an identity more strongly over their male peers which enables sustainability in their program (Godwin, Verdín, Kirn, & Satterfield, 2018).

Theme 5: Advocate for Self and Other Women

The results indicated that participants needed to advocate for themselves throughout their degree program, and in doing so, they felt that they were advocating for the female students coming after them. In several cases where female students had female peers in their programs, they also felt the need to stick together and advocate for one another. Melissa shared that for women to be successful they need to:

> Try to [find] a core group of people in your major that can help you get through the harder times. Try to support other women in the program. Look for the other women, make friends with the women, [and] support each other as best you can.

To counteract gender stereotyping and marginalization, women must be committed to "finding a place for herself, and women more generally" in their profession (Seron, Silbey, Cech, & Rubineau, 2018).

Successful women see the value in what they are doing and that passion fuels them to work through the struggles. Additionally, women who advocate for themselves and for others found that their self-efficacy and confidence in their ability increased and helped them to see the fruition of achieving their goals. Women's passion became the impetus to advocate for themselves and others, and to seek role models that would advocate with them. Female students tend to have a strong emphasis of doing good for themselves and for others in society that compel them to continue through hardships (Engström, 2018).

Theme 6: Hard work Is a Necessary for Success

The results indicated that all participants emphasized that hard work enabled them to be successful in their degrees. Most participants shared that their success was a combination of both natural skill and hard work. However, other participants mentioned that they were successful because of their determination, persistence, and hard work even though they did not feel they had natural ability. Female graduates' dedication to hard work to degree and career attainment corresponded with the component in the theory of grit regarding a deep commitment to goal acquisition (Duckworth, 2016). Engström (2018) stated that women's emphasis upon their future professional roles compel them to succeed even if they may "lack… a high degree of educational or scientific capital" (p. 239). Rebecca stressed the point of hard work when she shared,

> And when you think you're done, you're going to do it 100,000 more times because you can't put a letter grade on a skill. You have to learn that skill. You have to develop muscle memory.

Hard work, persistence, and perseverance make an individual gritty in the achievement of goal acquisition (Akos & Kretchmar, 2017).

Participants shared that their passion motivated them to work hard, as well as enjoying what they were doing encouraged them to continue working hard at their degree. Lynn stated that although she was "good at math," she had to work exceedingly hard to succeed in her program. Participants also shared that in order to be good at something, one had to keep working on it over and over. Women still have a "deep fear of failure" (Rebecca) but their passion, motivation, and hard work enable them to keep

moving toward their goal. Several participants shared that once they started, they could not quit so the only option was to keep moving forward. Individuals with grit develop habits that sustain hard work, constant effort, and a continual pursuit of their goals (Rimfeld, Kovas, Dale, & Plomin, 2016). Women demonstrated grit in their programs and in accomplishing their goals as revealed through the six themes identified in this study.

Participants' Advice for Recruiting Future Female Students

The findings demonstrate that there is a need to revise the methods used to endorse STEM degrees to future female students. In secondary and postsecondary institutions, guidance counselors and college advisors must reevaluate, revise, and adapt methods to promote STEM that will appeal to and attract a broader population. The current methods of how STEM is endorsed is failing to attract female students and does not help to address the issues surrounding gender disparity within these programs. Kathy stated that STEM degrees must be "sold" in a different way to females. Kathy and Abby made a rhetorical point, "Why would someone want to go into a degree that emphasizes math and science when they self-identify as being poor mathematical and science learners?" Students will not naturally seek out opportunities where they experience frequent failure.

Research found that if a student lacks confidence, or if the fear of failure is present in a student's learning environment, they will reach out for help (Butcher, Clarke, Wood, McPherson, & Fowle, 2019). Kathy stated that humans do not have a natural tendency to participate in environments where they feel stupid or inferior because they

feel that it endorses a perpetual cycle of failure. Students' previous and current experiences develop one's sense of self-esteem and attitudes towards their learning, and positive experiences can develop their grit, perseverance, and persistence (Weisskirch, 2018). Additionally, within human nature, when a person experiences success, they attribute their prior success to future endeavors thereby increasing the possibility of future success (Beauchamp, 2019). This increases their confidence and their courage to attempt more challenges (Weisskirch, 2018). Conversely, negative experiences produce the opposite effect.

Participants' emphasis on completing a STEM degree, however, does not require one to excel at mathematics or science concepts (Abby). One study stated that students do not need to have high amounts of mathematic or scientific "capital" to be successful (Engström, 2018, p. 239). Kathy stated that she is especially good at English and being creative, but had to work hard to understand other concepts. Additionally, she stated that the power of a STEM degree enticed her because she was a social person and working on problems as a team-effort really intrigued her. Maureen stated that STEM degree programs are teaching students how to become problem-solvers and linear thinkers. Studies support the idea that STEM degrees develop cognitive skills such as "flexibility, creativity, and lateral thinking" (DiBella & Crisp, 2016, p. 195). Therefore, STEM degrees need to be marketed to future female students as creative, problem-solving, team-effort endeavors in order for more females to become interested in pursuing these areas.

Limitations of the Study

There were several limitations that arose from this study. First, this study conducted semistructured interviews on a small sample size of female graduates from various parts of the United States. Participants' geographic areas where they completed their degrees within the United States were from the South, Northeast, and Midwest regions. Different findings may have resulted from participants interviewed from institutions in the West or Southwestern regions of the United States. Additionally, this study's population did not represent any STEM degrees completed from an international institution, which may have also resulted in differing female perspectives of degree completion.

The second limitation of this study is the number of participants who represented degrees from engineering programs. Only two participants of the 17 participants were interviewed who had completed a degree from a computer science program. One possibility for the lower representation of female graduates from computer science programs is that overall, computer science degree programs graduate female students at the lowest factor of all the STEM degrees (Master, Cheryan, & Meltzoff, 2016). Therefore, those who would have qualified for participation in this study from a computer science program were harder to locate and recruit for participation in this study.

A third limitation of this study is possible participant and researcher bias. Some participants completed their degree programs almost 40 years prior to conducting their interview for this study. Participants' perspective and recall of details may have changed over time, and their reflections may have had different perceptions at the time of

completing their programs. Even though I encouraged participants to share their unique experiences, it is possible that participants may have shared topics and issues that they felt I, as a researcher, wanted to hear thus contributing to possible participant bias. Throughout the interview process, I encouraged participants to share their lived experiences by probing for greater detail, asking for specific examples, and asking extended questions for clarification. This allowed and enabled participants to share their unique experiences rather than share what they think I wanted to hear. The interviews asked the same questions to each participant, and I took intentional steps to ensure that data was carefully considered and analyzed for interpretations and descriptions that represented participants' experiences.

Recommendations

There are three recommendations for further research that are grounded in the strengths and limitations of this study. The first recommendation is that as this research was conducted within the STEM disciplines of engineering and computer science, further research should be conducted within other STEM degree programs that contain gender disparity to determine if similar results are found. Engineering and computer science were the two STEM programs that had the highest gender disparity, but other STEM programs contain gender disparity as well. Female gender disparity is also apparent in other STEM programs, for example within the physical sciences (Graf et al., 2018).

The second recommendation is that further research should be conducted within STEM programs with gender disparity with male students. For example, gender disparity occurs within health care sciences where female students are the majority population and

male students are the minority, such as is the case of nursing programs (Kiekkas, Igoumenidis, Stefanopoulos, Bakalis, Kefaliakos, & Aretha, 2016). All students must develop resilience and grit to successfully complete degree programs and further research is recommended to investigate campus-wide climates to determine what messages (both implicit and explicit) that are propagated within the student body, faculty membership, and administrative environments.

Campuses and departments could implement and adapt targeted policies and strategies that encourage grit, resilience, positive approaches, and empowerment inside and outside of the classrooms. And climates that disseminate negative stereotypes and implicit bias need to adapt and implement different practices. Additionally, further research is recommended for male students within female-dominated STEM degree programs to determine if similar challenges exist to their grit and resilience, as well as exploring and identifying the presence of any implicit biases and negative stereotypes (Dunlap & Barth, 2019). Unequal treatment of students within higher education is present at many levels and among various groups that can directly disadvantage students' performance and levels of success (Kiekkas et al., 2016).

The third recommendation is that further research should be conducted at large and small universities and colleges to determine their academic and departmental climates, especially for programs where gender disparity is present. Institutions should review practices of organizational culture and individual mindsets where gender disparity is present (Charlesworth & Banaji, 2019). Then implement interventions that target practices to sustain students who are in the minority. Additionally, institutions should

provide training for faculty and administrators for implementation of retention strategies for female students. Academic departments and student services should develop departmental and campus-wide programs that counteract the negative effects of gender bias and stereotypes among faculty and the student body. Furthermore, institutions should implement mechanisms to request feedback from female students who have completed programs with gender disparity on an annual basis in order to adapt practices based upon their feedback that would support the retention of future female students.

Implications

The implications for positive social change may influence future female students completing degrees within engineering and computer science programs. This study may help to close the gap in practice of gender disparity within these programs. The first implication for change is for academic and departmental climates at institutions to implement strategies that confront the implicit and explicit bias within their departments, as well as adapt and implement strategies that would support female students within their departments. Underrepresentation of women in STEM degree programs is not related to intellectual capacity, aptitude, or abilities, but rather to presence of gender bias (Charlesworth & Banaji, 2019). Departmental and academic climates within institutions must develop three important facets: (a) cohesiveness between faculty and administration, (b) building positive relationships with each student, and (c) similar expectations for all students. Cohesiveness between the faculty and administration within departments generates communications and ideologies in which a teamwork mentality is

established. This mentality trickles down to the students' psyche and implicitly communicates high expectations without bias or prejudice.

Women should not be considered heroic to sustain a career or degree in the areas where men dominate (Kirk, 2009). Additionally, the power of cultural context where one group dominates or is privileged in some way over another is not a valid educational approach for degree attainment (Kirk, 2009). Furthermore, expectations should be the same for all students, regardless of gender. Through the adaption of positive practices and success strategies, future female students may receive the support and advocacy needed to be resilient within male-dominated degree programs. This could potentially increase the retention and completion rates of female students in these programs.

The second implication for positive change can occur when female graduates are supported through engineering and computer science programs, it enables them to earn a sustainable income. Maureen shared that one of the factors that she considered a success was that fact that her degree and her career enables her to support herself and her dependents. She stated, "I don't have to depend upon anybody. If I need to raise my kids on my own, I can." This was a matter of pride for Maureen, as well as self-empowerment. Many STEM field contain some of the fastest growing occupations, and careers within engineering and computer science have some of the highest annual mean wages (Fayer et al., 2017). Increasing the retention and completion rates of women in engineering and computer science has the potential to impact women's financial stability, as well as the financial stability of their families, gains in equitable pay and compensation, recognition

through awards and grants, and authorship of publications (Charlesworth & Banaji, 2019).

The third implication for positive change may also impact the demands of innovation and diversity within STEM fields (Charlesworth & Banaji, 2019). Companies and corporations need gender diversity as inclusivity in the workforce affects a company's growth and profits (Webster, 2018). Additionally, the STEM workforce is experiencing a shortage of skilled workers and increasing the representation of women could potentially help fill these shortages (Cheryan et al., 2017). Increasing representation of women in STEM could enhance creative problem solving through diverse perspectives and increase representation in the field for young women hoping to enter.

Conclusion

This phenomenological qualitative study explored the lived experiences of female graduates within engineering and computer science degree programs. This study examined the factors of grit and resilience that female graduates incorporated to counteract the bias and stereotypes present within their degree programs which contained gender disparity. Data was collected from 17 participants who completed degrees from engineering and computer science programs through semi-structured interviews. The data analysis identified six themes that women attributed to their success in completing their programs, and development of their grit and sustainability through adverse circumstances.

Female graduates developed grit and resilience to successfully complete programs within degrees that contained gender disparity. Their success was attributed to resilience, a hard work ethic, advocacy for themselves and other females, increased confidence and self-efficacy, development of support networks, and focused passion and determination. This study demonstrated that women who are determined in accomplishing their goals are unstoppable and develop a self-identity that is empowered and confident in their abilities. Successful women are proud of their capacity to adapt and thrive in adverse cultures. Female graduates who exemplify passion and perseverance are the way-pavers for future female students to succeed and reach gender parity within STEM degree programs. The practical applications of this study are that future female students could learn from the results and the insights could help them complete their degree programs with success.

Participants in this study emphasized that the academic and departmental climates of institutional environments matter. Institutions must establish more supportive mechanisms for all students, in which success begets more successful experiences (Beauchamp, 2019). College and universities could incorporate the recommendations and themes identified in this study to support students, which could potentially impact the retention and sustainability of future female students through programs with gender disparity. This could also potentially increase institutional retention and completion rates. Implementation and adaptation of practices that encourage and support equity increase diversity within institutional programs, as well as within the workforce. Establishment of equitable practices enables educational programs to prepare students for 21st century success.

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Appendix A: Criterion Checklist

1. What degree(s) did you earn (i.e., certificate, associate degree, bachelor's degree, graduate)?

2. What program did you complete (i.e. engineering or computer science)?

3. When did you graduate?

4. At what institution(s) did you earn your degree(s)?

Appendix B: Email to Potential Participants

Email to Potential Participants

Share your experiences from your engineering or computer science program

Hello.

My name is Jennifer Watson and I am a doctoral student in Walden University's School of Education program. I am researching the experiences of female graduates from Engineering or Computer Science degree programs. According to research, these STEM programs have high gender inequality rates of females completing these programs and I am interested in learning more about female graduates' experiences in completing these programs. Particularly, I am studying how resilience and grit enabled female students to completed these programs. Your contribution to this study may inform future female students of strategies and techniques that they can utilize while completing programs with high gender disparity rates. This study will be used towards the completion of my dissertation in fulfillment of my doctoral degree in higher education.

I am interested in learning what your life experiences were as a student. Not all students experience college in the same way. Not all students overcome challenges in the same way.

Your responses will be shared as part of my doctoral study and your identity will remain confidential. Only pseudonyms will be used in my dissertation. Participation is voluntary and you may withdraw from participation at any time.

I will schedule a 45-60 minute interview time with you. We will complete the interview through a phone call and the interview will be audio recorded. Once the interview is finished, I will transcribe the audio recording. I will analyze the transcript for data analysis with the study.

If you are interested in participating in this study, please reply to me at jennifer.watson@waldenu.edu. If you would like to discuss the study further, we can communicate via email or we can schedule a phone call in which I can answer any questions you may have.

In your reply, please answer the following questions:

1.) What degree did you earn (i.e., associates, bachelors, etc.)?
2.) What specific program(s) did you graduate from (i.e. type of engineering or computer science program)?

I look forward to hearing from you!

Thank you,
Jennifer Watson

Appendix C: Interview Questions

Criterion Checklist

Background Information (verification)

1. What degree(s) did you earn (i.e., certificate, associate degree, bachelor's degree, graduate)?
2. What program did you complete (i.e. engineering or computer science)?
3. When did you graduate with your degree(s)?
4. At what institution(s) did you earn your degree(s)?

Semi-Structured Interview Questions

Academic Persistence & Perseverance

Prompt: Think back to the years you were studying in your program.

1. Question: Describe your classes and/or program.
    a. Give an example that would describe your classes or program.

Sense of Belonging

2. How did you feel about your academics?
    a. Did you feel welcomed/included in your classes/program? Who made you feel welcomed (i.e. other students, profs, TAs)? What was it that they did to make you feel welcomed/accepted? If not, what did they do to not make you feel included? (other terms: part of the team, accepted, included, fit in with the class/program/department)
        i. Synonyms tags: *sense of belonging*, acceptance, inclusion, welcomed

Academic Resources

b. As a primary resource, did you feel like you could ask your professor for help? If not, why not? What did you do instead?
    i. Did you use other resources on campus or within the department to help you?
    ii. Tags: persistence, resilience, tenacious, *persevere*

Resilience

c. How did you respond if you felt like you were not meeting your professors' (or TAs' for graduate students) expectations?
    i. Tags: persistence, resilience, tenacious, *persevere*

School Connectedness

d. How did you feel **emotionally** about the college, your classes, your program, school in general?

Department Connectedness

Prompt: Think of your program department and the climate in the program.

3. Question: Describe how people operated within your program's department.
    a. Was is cohesive, inclusive, like a team or was it divisive, exclusive, isolated?

Gender Inequality

4. Were there other female students in your classes?
    a. Approximately, how many other female students were in your classes? How many male students?

b. Did certain classes have more male students than female students? Which ones?

c. Did you spend more time working with female or male students? (i.e. for studying, working in groups/pairs, on projects)

d. What gender did you find it easier to work with?

i. Tags: gender inequality, gender minority, gender disparity

Gender Treatment

e. Were female students treated differently than male students? How?

i. Tags: resilience, perseverance

Resilience

Prompt: Think about your program/major.

1. Question: Did you ever feel like switching your major to another program? Why?
    a. What made you stay in your program instead?
2. Question: Were there sacrifices that you made to complete your studies/program?
    a. What did you have to sacrifice?
    b. Why did you feel that this was necessary?

Perseverance

Prompt: Think of a challenging time.

3. Question: What happened during this time/event that make it challenging? Why?
    a. How did it make you feel? (i.e. discouraged, frustrated, isolated, stupid, not smart)
4. Question: How did you cope with this situation?

a. What did you do to overcome it?

b. What did you do to resist the urge to leave or quit?

Personal Perseverance

Prompt: Think of your personal habits.

5. Question: How did you feel about things **outside of academics** (i.e. campus life, dorm life, making friends)?
6. Question: What were some personal experiences (i.e. study habits, tutoring, etc.) that you had while studying/completing your program?

Hard Work

7. Question: Do you believe that completing this degree was something that you were just good at or that it was a lot of hard work? (Tags: talent vs. hard work)
    a. If someone were to describe your work ethic, how would they describe you or your efforts?
    b. What things did you do that someone would look at and describe you as being a hard worker?

Passion

1. Question: What was your goal?
2. Question: What was your focus? What was your vision? (i.e. graduate, complete program)
    a. Did you feel that this would help you reach your goal?
    b. How did it help you?
    c. What did you do to maintain your focus or vision?

i. Tags: *passion*, enthusiasm, excitement, true calling, strong feelings

Hope

3. Question: What gave you hope?
    i. Tags: *hope*, expectation of a positive outcome, confident expectation, anticipation

Hope & Focus

4. Question: What did you do to be motivated throughout your program?
    a. What strategies did you use to stay motivated?

Success

5. Question: Do you believe you were successful in your program? What constitutes "success?"
    a. What are the things that you did that helped you be successful?
        i. Tags: sense of pride

Advice for Future Students

Prompt: Think of the things you wished you had known going into this program.

6. Question: What advice would you give to a future student?

Prompt: Advice for a future or current *female* student

7. Question: What would be helpful for her to know *before* going into a program like this?
8. Question: What suggestions would you have for females *already in* this type of program?

9. Question: If you could share only one thing with her – give her your best piece of advice – what tip would you share?

Last Comments & Recommendations

10. Are there any additional comments you would like to share?
    a. i.e. about how you overcame? …what helped you to graduate?
11. What question should I have asked but didn't?

Appendix D: Interview Protocol Form

Interview Protocol Checklist

Participant Name: _____ Date: _____

Participant Pseudonym: _____

Completed/Date	Objectives
	Participant has been informed of confidentiality of their statements.
	Participant has been informed of their ability to terminate the interview at any time.
	Participant has been informed of the purpose of this study.
	Participant has been provided with the Informed Consent Form.
	Participant has signed the consent form by returning the email stating, "I consent."
	Participant has completed the interview.
	Participant has been thanked for their time and information via email.

Appendix E: Combination Codes for Triangulation

Codes	Combo
Resilience (Perseverance, Hard work)	Pauline- I mean it was definitely hard. I ended up studying and then I took it and passed it. Kathy-Failure was not an option. Anne- They did not divulge that information. I had to seek it out. Christine- The undergraduate degree seemed like academic hazing. It's like you've just got to get through it and then your career is going to be so fruitful and you're going to have such excellent opportunities that will open for you. Kirsten-I was never discouraged by any of these comments guys were making or anything like that. I wouldn't let that stop me. Abby- I would get annoyed and I would tell him to shut up and things like that, but I would just move on and I would just [do] my work. Melissa-I would say that was a very trying time. Lynn- There was never a question of leaving school. There was never a question of not completing. It was that, "Screw you. I'm completing this degree." Lydia- How I coped with it like I knew it had to be done. So, in my mind, failure wasn't an option. Maureen-The first class you have to take...I had to take it twice. It was a struggle. Heather- The first time I met him [a professor], I realized that this was more of a challenge. I eventually developed a good relationship with him and it was more of a mission. Jessie- I had a very hard time with the subject matter … And I had to really go out of my comfort zone to work with people, like asking for help in the class of people that were doing very well in the class. Marie-I don't quit anything, once I start. Grace- There's nothing that can prevent you from doing it, but yourself. I think the combination of those two things, knowing yourself and being able to ask the right questions, …those two things helped me push through a lot of obstacles. Sarah- I gained my own confidence in my ability to complete the material and really understand the concepts and thrive in that environment and excel in a program that was challenging. Rebecca- For me when things got rough it was just like you're in too deep now. You can't go back. You just got to keep moving forward. Hannah- I think just seeing how far I had already come and knowing that it was just temporary struggles. And the overall outcome in the end was going to be a lot better. So I'm glad I pushed through. [You can't] be afraid of the uncomfortable.
Passion (Focus, Deep commitment, Dedication, Goal-oriented, Motivation, Purpose)	Pauline- You need to have that drive. I definitely worked hard and put in the energy just because I knew I wanted it so bad. Kathy-Still doing what I love doing. Anne- I'm very passionate and I work very, very hard. And what else could I do? It just sparked me.

	Christine- It was just basically finding myself like "What's going to challenge me? What's going to make me happy?" And then once I figured that out then I was more direct in getting my goal. Kirsten- I always have goals. I just like went full speed ahead. Abby- Finishing both of my degrees was really... I think more of a personal sense of responsibility and just a sense of accomplishment, knowing that I could do this and that I would always have that. Melissa-I really wanted a career path. Lynn-Then you start getting into your specialty classes…those were the things I really enjoyed doing. Lydia- I'm proud to say that I did it. Maureen-I was a totally different person. Focused. Heather- I can't work hard if I don't have passion. Period. I just don't. Can't get motivated. Don't want to do it. Wasted time type of feeling. Jessie- I knew deep down that that's what I want to do. Marie-I was really focused on that. That was the one I wanted to do. Grace- If someone else can do that, you can do it. So if you want to do it, there's nothing preventing you from doing it. Sarah- I want to be in the top of my class. I want to excel and exceed expectations. And my goals were to do that. Rebecca-[It] just made me push harder … And literally every minute … I was at the lab. I loved it from day one. Hannah- And the end of the day I think I just wanted something that was going to drive me and challenge me.
Support Network (Role model, Mentor, Belonging, Inclusive)	Pauline- So they were definitely a big support system. Kathy- If not for the encouragement, I probably wouldn't have done this. Anne- I probably wouldn't have even thought that if I didn't have support from family. I guess support from anybody would be helpful. Christine- You really want somebody who's in the industry who could help you with career guidance or job shadowing. Kirsten- Finding that role model is so critical to me. Abby- I was fortunate to also be surrounded by people with stronger character. So I did have the support and comradery that I felt like I needed and I wanted. Melissa- I feel like I had a good group of people that were inclusive. Lynn- I feel like as long as you have at least that one person you can go to, it made a lot of difference. Lydia- You become kind of like this really close knit family or group of people. Maureen-You don't want to be in this alone. You want to have kind of a mentor. Heather- College instructors were all right there near the classes... so if you had a question, you just walked in their office … and they were always willing to help. Jessie- You hung out outside of class, you did homework with them. They were like your posse. Marie- I had a support system. Grace- My father always told me, "If someone else can do it, you can do it" because I came from a place where I was told if I wanted to achieve something, I can do it.

	Sarah- I had lots of the people who are just my general support network and help me kind of feel empowered. Rebecca- I had my team… I knew that they weren't going to let me fall. Hannah- You realize everybody learns a little differently. So you can help each other out.
Self-efficacy (Confidence, Strong Personality, Belief in abilities)	Pauline- I didn't feel like awkward that I was the only girl. Kathy- I don't regret it. I wouldn't change a thing. Anne- I wasn't worried about being the only female. Christine- I already had a job in industry. I knew I was gonna love it. Kirsten- I couldn't be more grateful that it was that hard because first of all, it allowed me to feel successful. Abby- I've always been pretty confident. Melissa-I am happy what I'm doing right now working [as an] engineer. Lynn- I think you're successful when you love what you're doing. Lydia-I love what I do and as long as I'm happy in what I'm doing, that's successful to me. Maureen-I do feel that I have been successful. Heather- Switching major? No. Never. Once I got into it and I started taking the classes, I was very happy with my choice. Jessie- I also think that I am just a natural leader. So when I'm in a group setting, I tend to always take the lead … it's just a natural thing that I'm going to. I'm going to be in control because I know it'll get done and it'll get done right. Marie-I think I was successful in my program. Grace- I felt like I had full agency in my decision. It was my decision and it wasn't influenced by anyone trying to direct my path. Sarah- I felt quite confident in my understanding of the materials. Rebecca- I finally earned that clout …I finally feel like this is my job and I have control and I have a voice now. Hannah- One thing too that I enjoy is the hands on work.
Advocacy (Oneself, Others)	Pauline- The classes that I struggled with, I definitely used college resources. If there was a question that I had …. I would go to him [my advisor]. Kathy- [I] really could go up to the professor or I could go in and see the Dean anytime I wanted. Anne- I think that's really helpful to bring in people from industry to talk. Christine- I'm not afraid to ask questions if I want to learn more about it, even if it is during class time or after class. I don't have a fear at all of asking questions now at my age. Kirsten- You get a little bit of a leg up when you can go to the career center, get your resume straight and then get a good internship that'll lead you to another, and another, and then a good job. That's priceless. Abby- I was never hesitant to go and ask a professor for clarification or for help. Melissa-Not being afraid to push, advocate for yourself. Lynn- I always tended to go to the professor. Lydia- Just because you think differently doesn't mean that you shouldn't state your thoughts out loud or that your opinions don't matter. And never let someone

	push those opinions, no matter how different they are, and make you feel less of a person than them. Maureen-So you do have to exert yourself. Heather-100% follow your passion. Don't be intimidated by what you might be going into. And don't make yourself feel like the victim. Don't put that notion in your head going into it before you go. To me, if you have passion behind something, you're willing to work hard and get to the end point. Jessie- I think it's just a great, great activity in order to give back. We're helping future generations of science/engineering students to be. Marie- We've gotta be able to see somebody doing what we're considering doing. It has to be possible. If we can somehow see ourselves, you can imagine doing it. Grace- I guess when you have that agency and say, Well, it's my decision to choose the field and I'm choosing it because these things interest me. Then that helped me to get through. Sarah- I encourage women to do whichever thing is right for them. Sarah- A fellow student kind of wanted to make me feel like I didn't belong. My personality reaction to that was like, "Who the heck is this guy? I'm going to show this guy." Like, "Forget this! You don't tell me where I do and do not belong. Also, who in the world are you?" So that I'd call sassiness. I think that that was my immediate reaction to those sorts of sentiments. Rebecca- I will question anything and everything regardless of whether I have a smidgen of knowledge about it or not. Hannah- Don't be afraid to ask questions.
Hard work	Pauline- It was just…that was my goal and that's what I decided it was going to be. And that's what I worked towards every single day. You need to have that drive. I definitely worked hard and put in the energy just because I knew I wanted it so bad. Kathy-It's not so much aptitude as hard work. Anne- it's the end of the day that the work ethic is just going to be important across the board. Christine- I wanted to get it and get it done as soon as possible. So I was very, very driven at that point. Kirsten- It was a lot of hard work and determination. I never once felt that things came easy to me. Abby- I put in the work and made sure it was visible so that everyone knew that I was doing this on my own. Melissa-I definitely had to work hard at getting through my classes and getting the grades I got. Lynn- I can say I definitely worked my ass off. Lydia- I would describe myself as a hard worker. Maureen-I was studying. I was doing homework…I was practicing because it was the practice that made perfect. Heather- I sound like a broken record, but just having that passion behind it makes you work hard. Jessie- I know that the hard work that I put in in college has gotten me to the point where I am right now.

Marie- You're gonna have to be a little bit better. You're gonna have to try a little bit harder. The standards in some ways are a little bit higher.
Grace- I liked the field, but I also worked hard at it.
Sarah- I just worked my tail off.
Rebecca- You're learning how to deal with the situation and adapt to it in everyday life. So you just have to keep doing it over and over.
Hannah- To be honest, it was very hard for me. It was something you had to work at every day to make sure you keep up to date on your studying. I kind of had to dig deeper.