THE LIVED EXPERIENCES OF CHALLENGES FACED BY FEMALE STEM DEGREE HOLDERS WHILE IN THEIR PROGRAMS: A PHENOMENOLOGICAL STUDY

by Rebecca Ann Keeter-Lee

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

Liberty University, Lynchburg, VA

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APPROVED BY

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Abstract

The purpose of this hermeneutic phenomenological research study was to describe the challenges female higher education students (FHESs) experience in their science, technology, engineering, or mathematics (STEM) degree program. The central research question guiding the study was: How do female higher education STEM research participants describe their lived experiences while in their degree programs? Sub-Question one was, How do female higher education students describe the influence their personal history had on their choice to pursue a higher education STEM degree? Sub-question two was: How do female higher education students in STEM program describe their reality versus their expectation going into the field? Bandura's theory of self-efficacy served as the lens to describe the participants' experiences overcoming and successfully completing their STEM degree, despite facing challenges in their programs. A supporting theory for the study was post-modern feminist theory, to frame the experiences of being a female student in a male-dominated field of study like STEM. The study was conducted with 10 female research participants who had graduated with a STEM degree in the past 25 years. Data collection methods included initial questionnaires for identifying the prospective research participants, followed by individual interviews, a focus group, and a reflective writing prompt. Data analysis was conducted via van Manen's hermeneutical method of phenomenological reflection, clarification, and explicit description of the meaning of the lived experiences of the female STEM degree holders. This study concluded that female STEM degree students continue to be challenged by a silent gender bias, the demands and requirements of their programs and the balance between home, family and school. This study also found that female STEM students were able to successfully complete their degree programs despite challenges.

Keywords: challenges, determination, education, efficacy, feminist, gender(ed), STEM

Copyright Page

Dedication (Optional)

I dedicate this to my Creator and my Savior Jesus Christ.

Acknowledgments (Optional)

First, I would like to acknowledge Dr. Andrea Beam for her encouragement to continue my doctorate while I was faced with an extremely difficult life experience on the unforgettable date of July 8, 2019, a date that will forever affect me, while completing an intensive course on campus. Through her leadership, prayer, and a class that came together and prayed for me, I made it through.

Next, I want to acknowledge my chair Dr. Rebecca Bowman for telling me on March 4, 2021, regarding my doctoral journey, “no matter how long it takes, we are in this together.”

Finally, I want to acknowledge my husband Andrew (Andy) John Lee, Sr., who provided encouragement to complete my Ph.D. through my entire journey; my two sons Jacob Scott Shedd, Jonah Scott Shedd, and stepson Andrew (Drew) John Lee, Jr., because I want them to know that hard work and dedication will let you accomplish whatever you want to do; and my two brothers, the Reverend Dr. Derrick Rudolph Keeter and Donald Larry Keeter II, because I know I could call them at any moment, and they would come to me. To my mother Rachel Ann Keeter, for loving me unconditionally. To my late father, William Rudolph “RUDY” Keeter, who I love and miss every day. RUDY always said to me, “remember Becky, when all else fails, daddy loves you.”

And finally, to my granddaughter Kaia Nevaeh Shedd and grandson Jaxon Zephyr Shedd, and to any future grandchildren. I aspire to inspire my children and grandchildren to work hard and make a difference in the lives of those around you.I want to be an example of the importance of learning and extreme dedication to carry out your heart’s desires. I thank you all and love you all. Never give up. And remember this: “wherever you go, there you are.”

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List of Abbreviations

Diversity, Equity and Inclusion (DEI)

Female Higher Education Student (FHES)

Healthcare, Elementary Education, Domestic Spheres (HEED)

Impostor Phenomenon (IP)

Institutional Review Board (IRB)

Lived Experience Description (LED)

National Aeronautics and Space Administration (NASA)

Self-Efficacy Theory (SET)

Science, Technology, Engineering, and Math (STEM)

Women's and Gender Studies (WGS)

CHAPTER ONE: INTRODUCTION

Overview

When women choose to enter a science, technology, engineering, and mathematics (STEM) degree program, they often experience gendered stereotypes and receive limited support as a minority group (Redmond, 2020). Therefore, the interest of my study was to focus on women who had obtained their STEM degrees, despite facing challenges as a woman in a male-dominated field of study. Using a hermeneutic phenomenological research method (van Manen, 1997; 2016), my study aimed to describe those lived experiences of the challenges female higher education students (FHES) faced in their science, technology, engineering, or mathematics (STEM) degree programs.

This first chapter presents a review of the historical, social, and theoretical frameworks related to this topic of study. The first section of Chapter One discusses the history of women in the STEM academic world and the theories relevant to frame their lived experiences in higher education. The second part of this chapter investigates the social context of females as a student in STEM higher education. Next, Bandura's (1977) theory of self-efficacy provides the guiding theoretical framework for this research study. In addition to self-efficacy, the supporting feminist theory (Creswell & Poth, 2018; Sharma, 2019), will help provide information relevant to the unique gender challenges FHES experience in their STEM degree programs. Finally, the discussion moves to the problem statement and the purpose for my study, before consideration of the practical, empirical, and theoretical significance of my study.

Background

Women in the United States have not always had the opportunity to obtain equal access to an education like men (Madigan, 2009; Watson, 1977). The focus of this research was

important because historically, before the 19th century, women in the United States, were not afforded an opportunity for education like their male counterparts (Wesleyan College, 2019). When schools did open to female students, those students were met with unique challenges due to gender discrimination in completing their education. Although those unique challenges for women students have gotten better in the 20th century, all the challenges for women have not been resolved (Estrada et al., 2016). The next section thus discusses the historical, theoretical, and social background that facilitate my study of FHES and the challenges they face as a female student.

Historical Context

In the late 18th and early 19th centuries in the United States, the ideology of the right to an education for all persons was being challenged by such revolutionary women proponents as Wollstonecraft, who believed that this would be a powerful tool to create a more just society (Gutek, 2011). In 1792, Wollstonecraft described the struggles of the female student in a male dominated education system. She based her writings on her real-life experiences and observations of society. For example, males were expected to attend and master their education or work skills outside of the home, while women were expected to work in the home and attend to their children (Alsop & Clisby, 2019).

In 1889, nearly one hundred or so years after the efforts for women's education rights was started by Wollstonecraft, another prominent pioneer in the struggle for female education emerged: Jane Addams. Like Wollstonecraft, Addams recognized that the U.S. education system was influenced by the Victorian era, which saw women's roles in the home as mothers and homemakers, with limited public lives (Gutek, 2011). Addams went through a time of reflection and introspection in an effort to overcome the sexism and elitism she was experiencing because

of her gender. It was during this time that Addams determined to change the education and career opportunities for women in the patriarchal United States. Addams founded the Hull House which offered adult education with college extension courses (Gutek, 2011). The self-efficacy of both women, Wollstonecraft and Addams, are representative of the way females have been able to overcome the challenges faced due to the societal expectations of women in the United States.

In the United States, it would not be until the 19th century, that exclusive schools were established that would cater solely to students. One of those is known today as the Wesleyan College in Macon, Georgia (Nash & Romero, 2012; Wesleyan College, 2022). Wesleyan is one of many colleges touting to be recognized as the first female college (Wesleyan College, 2022). Opening its doors in 1839, Wesleyan College admitted 90 young women to the all-female school. A part of the mission statement of Wesleyan College reads "…committed to women's education and helping every student find a unique voice and purpose" (Wesleyan College, 2022).

In the 1930s, female colleges and universities offered more diverse degree options for their women students, but they were still met with unique challenges. For instance, this was a period of the Great Depression in the United States, men and especially women struggled to acquire the financial means to attend higher education. In addition, for women, not only was financing an issue for prospective higher education students, but females were being targeted by a eugenics propaganda from institutes of higher education (Nash & Romero, 2012). Eugenics was a scientific means of improving society by controlling which humans procreated. Colleges and universities attempted to discourage females from attending college by stating that if a woman chose to attend higher education, she might not have children, and that this would not be beneficial to society (Nash & Romero, 2012). Despite the use of eugenics propaganda as a means of discouraging females from attending institutes of higher education, females continued to

enroll and graduate with college degrees. In 1900 there were 85,338 enrolled female students and by 1940 that number had increased to 600,953 enrolled females (Nash & Romero, 2012). Although the number of women enrolling and attending higher education was growing each year, female students would face other unique challenges while attending schools. One unique challenge was due to a lack of women's identity in academic literature. Despite the pioneering efforts of women like Wollstonecraft and Addams to promote the education of women in the universities, textbooks from 1914 through 1955 were still using male-gendered language. One example of this, was the physics textbooks for the female students, which were written to instruct the women students on how to work with the newest household technologies and were carefully written using the societal expectations of gender and class (Behrman, 2017).

In the 1960s, movements in the United States began to integrate women in the realms of higher education, but not without resistance. Historical sources from that period display strong verbal outcries of resistance from male students and faculty who did not want females on campus with them. This excerpt from an article about Dartmouth college included statements such as, "For God's sake, for Dartmouth's sake, and for everyone's sake, keep the damned women out" (Malkiel, 2019, p. B18) and; another statement that reflected the male-dominated higher education system, including "What is all this nonsense about admitting women to Princeton? A good old-fashioned whorehouse would be considerably more efficient, and much, much cheaper" (Malkiel, 2019, p. B18). Female students in higher education have endured remarks and patriarchal beliefs like these for many years.

Gender and gender stereotypes play a significant role in the education pursuits of students (Ardies et al., 2015). Although there have been advances in women gaining access and entry into male-dominated STEM fields of study in higher education, there are still reports of bias within

those degree programs (Riegle-Crumb et al., 2020). In fact, “empirical research has found that interactions with peers and with faculty in science, technology, engineering, and mathematics (STEM) postsecondary classrooms can be particularly negative and exclusionary for female students” (Riegle-Crumb et al., 2020, p.105). After degree attainment, another issue that female graduates face, is a wage gap between them and their male counterparts (Tverdostup & Paas, 2017). According to the Bureau of Labor Statistics (BLS, 2015) gendered segregation among careers reflect a view that women are more adept at working with people and men at working with things, with the result that men continue to hold an advantage for top positions across sectors (Tellhed et al., 2016). However, despite the adversity that females endured during the early years of women being admitted into higher education, some females persevered and were successful in the STEM field. For example, in 1842, the first female to graduate from medical school was Elizabeth Blackwell. Blackwell, who was eventually accepted to Geneva College in New York, had previously applied to several medical schools but was denied acceptance because she was woman (Michals, 2015).

This research study was designed to investigate the lived experiences and challenges that female higher education STEM degree holders faced in their degree program. Having reviewed the historical context for women in higher education and the challenges females have endured, it is important to review the social context for the female higher education students.

Social Context

The social norms of early America expected women to work in the home and attend to their children (Alsop & Clisby, 2019). However, the societal expectations for women have changed since the first opportunities for females to be educated in the higher education institutes. In 2015 -2016 the National Center for Education Statistics reported that during that school year,

those graduating with a STEM degree were 36% female and 64% male (NCES, n.d.). In 2020, the United States Bureau of Labor Statistics (BLS, 2020), reported the STEM fields workforce comprised 28% of women. Despite these promising statistics, a recent STEM program research study reported disturbing sexist behavior of male students making derogatory comments about their female cohorts (Schwortz & Burrows, 2021). One example was in a mix-gendered group of STEM students, one group of three male cohorts, were observed making crude remarks about hypothetical situations in a workplace and one of the males continued to allude to his wife in the hypothetical scenario, as being incompetent (Schortz & Burrows, 2021).

This research study describes the challenges FHES currently experience in their STEM degree program. By describing their challenges, my study may benefit institutions of higher education by offering them ways to strategize and implement equity-building initiatives into their policies, practices, and programs to support under-represented STEM women students.

Theoretical Context

The primary theory guiding this phenomenological research study was the theory of self-efficacy. In the words of Bandura (1977), "efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences" (p. 193). Bandura considered self-efficacy central to analyses of changes achieved through fearful and avoidant behavior (Bandura, 1977). In social cognitive theories, self-efficacy was recognized as a possible explanation for how people differ in their perceived ability to accomplish desired goals in the face of challenges. A female student's self-efficacy within a traditionally male-dominated higher education program, like STEM, is an important factor in her ability to complete the program (Kuchynka et al., 2018; Tellhed et al., 2016). Therefore, by drawing on self-efficacy theory, this research could help provide future STEM women students

with insight into the possible challenges they might experience and strategies for coping with those challenges.

In support of the theory of self-efficacy, this research study used the post-modern feminist theory (Sharma, 2019), as it provided a framework to examine the problem of women being underrepresented in STEM degree programs and the challenges they continue to experience. Feminist theory has many categories, but for my study I used a post-modern feminist perspective. Focusing on identity and how social discourse and language creates an understanding of women is defined as post-modern feminism (Sharma, 2019). Feminism studies establish the importance of contextualizing interpretive meaning (van Manen, 2016). In addition, a discussion of double-minority women students and the additional challenges they face in their STEM degree programs, due to both gender and racial biases will be discussed (Gillooly et al., 2021).

Problem Statement

Although FHES in the United States have gained access to higher education programs in STEM, they continue to report the same education challenges as they did in the early 1800's (Alsop & Clisby, 2019; Schwortz & Burrows, 2021). Current research studies provide documentation that gendered issues in the 21st century continue to persist despite the increase of women represented in STEM programs (Alsop & Clisby, 2019; Hansen et al., 2019; Holliday et al., 2020; Kuchynka et al., 2018; Schwortz & Burrows, 2021). This research study was conducted to illuminate the current-day challenges for FHES in the STEM degree programs. Current studies indicate that although institutes of higher education have made progress with providing female STEM students equal access to degree programs, women students are not experiencing equity because of continued experiences of gendered behaviors in the program

(Schwortz & Burrows, 2021; Sharma, 2019). Therefore, my study was necessary to illuminate the ongoing experiences of female STEM degree students, which provides information for programs seeking to improve the retention of, and experiences of women STEM students. There is a gap in the literature on how women's multiple identities shape their realities as FHES in higher education (Sharma, 2019), and my study hoped to fill a part of that gap.

Purpose Statement

The purpose of this hermeneutic phenomenological research study was to describe the lived experiences of FHES in their STEM degree programs. This research study examined the problem that women in higher education degree programs continued to experience unique to their gender. According to Creswell and Creswell (2018), phenomenological researchers explore the lived experiences of several people who experienced the same phenomenon. Therefore, since this research interest lied in the shared experiences of women STEM students, I used a hermeneutic phenomenological method, framed by the theory of self-efficacy (Bandura, 1977) and supported by post-modern feminist theory (Creswell & Poth, 2018). As a female student, I have my own experiences and perceptions of my education degree program. Gall et al. (2007) explained that, unlike the detached researcher in quantitative research, the qualitative phenomenological researcher is "intimately connected with the phenomena being studied" (p. 495). Therefore, since my lived experiences supplied a lens to complement the research data, I had a healthy interest in the participants as sister students.

Significance of the Study

My study had practical, empirical, and theoretical implications for researching and describing the realities for FHES (Female Higher Education Students) and the challenges they experienced in their STEM (Science, Technology, Engineering, and Math) degree programs. It is

important to continue and study the challenges that women are experiencing in their degree programs because the same issues that occurred in 1792 are still being reported today. Institutes of higher education have made some progress in thwarting gendered issues, yet they still exist and warrant continued research attention (Schwortz & Burrows, 2021).

Practical Significance

Using the hermeneutic phenomenological method of research was appropriate as a means to illuminate the ongoing challenges that females in higher education experience. The findings of this research study provide information that may be useful in showing that female STEM students face unique challenges due to their gender. Since FHES continue to experience gendered behaviors and challenges unique to their gender, the efforts of institutes of higher education to provide equitable treatment of women in education are not working (Alsop & Clisby, 2019; Fox, 2021; Sekścińska et al., 2016). My study provides information that higher education program administrators and faculty might utilize when making STEM degree programming decisions. In addition, it provides valuable insight for future female STEM degree seeking students to take into consideration when making their decision to enter into a degree program.

Empirical Significance

My study supports the empirical findings of Tellhed et al. (2016), that girls and women need encouragement when faced with gendered stereotypes and when encouragement is received, it develops their self-efficacy. Reviewing the empirical data for the topic of this research, provided the rationale for my study and how it can contribute to the existing body of knowledge (Galvan & Galvan, 2017; Marco-Bujosa et al., 2021). The findings of this research study provide empirical evidence of the value that the self-efficacy of FHES played in their

ability to successfully complete a STEM degree program. It also illuminates the role that feminism has on women in a higher education degree program that is currently and historically dominated by men.

Theoretical Significance

This research study looked at the research participants' self-efficacy in their degree programs and the challenges they experienced in their course of study. Self-efficacy was recognized as a possible theory of how people differ in their perceived ability to accomplish desired goals in the face of challenges (Marco-Bujosa et al., 2021). According to Bandura (1977), "Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences" (p. 194). Feminist theory can help shed light on underlying assumptions based on the experiences that female STEM students are reporting based on gender (Sharma, 2019). The assumptions that males believe that they are more intelligent than their female counterparts or that females cannot endure the demands of a higher education degree program like a male, creates an environment of bias against women (Fox, 2021). This research study helps to add merit to the theories of self-efficacy and post-modern feminism, of females who have overcome challenges unique to their gender while in their STEM degree programs.

Research Questions

My study looked to supply a description of the lived experience descriptions (LED's) of FHES in their STEM degree programs. The central question asked how the research participants understand their challenging experiences in their degree programs. It looked to explore the central phenomenon (Creswell & Creswell, 2018) of the experience. Sub-questions One and Two

then narrowed down the general central question with more specific details about their experiences (Creswell & Creswell, 2018).

Central Research Question

How do female higher education students describe their lived experiences in their STEM degree programs?

In 1792, Mary Wollstonecraft, one of the first pioneers for women's education, described the struggles of female students in a male-dominated education system. Wollstonecraft based her writings on her real-life experiences and observations of society. Males were expected to attend and master their education or work skills outside of the home, while women were expected to work in the home and attend to their children (Alsop & Clisby, 2019; Sekścińska et al., 2016; Wollstonecraft, 1792). It is important to study the current lived experiences of FHES in their degree programs.

Sub-Question One

How do female higher education students describe the influence their personal history had on their choice to pursue a higher education STEM degree?

Historically, a female's capital was valued primarily in the home, but her value has evolved over several generations, and she has gained value in the education sector and workforce (Sekścińska et al., 2016). However, there continue to be wage (Tverdostup & Paas, 2017) and promotion (Hughes et al, 2017) gaps. These gaps have been attributed to female interests in degrees for lower-paying jobs and a lack of skills for higher-paying jobs (Tverdostup & Paas, 2017). These gaps may be influenced by a female's personal history and their choice to enroll in a degree program that pays less than their male counterparts due to gender norms (Tverdostup & Paas, 2017).

Sub-Question Two

How do female higher education students in STEM program describe their reality versus their expectation going into the field?

A gap in the literature exists for how women's multiple identities shape their realities (Sharma, 2019). This research was interested in supplying an interpretation of the lived experiences descriptions (LED) of the participants' expectations at the beginning of their degree programs versus their experienced realities throughout the programs.

Definitions

Important terms throughout this research study are listed below.

1. *Eugenics* - The use of selecting people for education programming to promote the advancement of society by choosing people who possess desirable traits and denying education programming for those who lack desirable traits (Mathiason, 2021).
2. *Feminism* - An interdisciplinary approach to issues of equality and equity based on gender, gender expression, gender identity, sex, and sexuality as understood through social theories and political activism (Day, 2016).
3. *Folklore* - The traditional stories and culture of a group of people (Cambridge Dictionary, 2021).
3. *Impostor phenomenon (IP)* - A psychological construct characterized by feelings of inadequacy and an irrational fear of being discovered as a "fraud" by colleagues and superiors (Holliday et al., 2020).
4. *Lived experience* - Phenomenological research focuses on describing the human experience of a phenomenon as it is lived through or as it is experienced (van Manen, 2016).

5. *Lived experience description (LED)* - To gain access to a person's experience, you have them write out the experience, this is called the lived experience description (LED).

6. *Post-modern feminism* - A feminist view concerned with language and social discourse's impact on society's understanding of women (Sharma, 2019).

7. *Self-Efficacy* - The expectations to determine how much effort an individual will expend and how long they will persist in the face of obstacles and aversive experiences (Bandura, 1977).

8. *Silent gender bias* - Any experience that one perceives to be gender bias but is not explicitly recognizable as gender bias. Another term for silent gender bias was defined by Bruce et al. (2015) as covert discrimination, which includes subtle nuances like double-standards, discouragement, or biased referral opportunities.

Summary

The lived experience descriptions of FHESs can shed light on the challenges experienced by women in STEM degree programs. Although FHES have gained access to higher education degree programs in STEM, they are still reporting the same education challenges as they did in the early 1800s (Alsop & Clisby, 2019; Sekścińska et al., 2016; Wollstonecraft, 1792). Researchers have explored the factors that contribute to self-efficacy of female degree students who achieve their degrees. Females who have a perceived self-efficacy to pursue a STEM degree display the determination that is necessary for female students to persist to completion (Litson et al., 2021). A gap exists in the literature on the lived reality and challenges FHESs faced in their STEM degree programs. FHES have been included in the research, but few studies have described the lived experiences and challenges of FHES in their STEM degree programs today (Sharma, 2019). By examining their experiences through the theoretical frameworks of self-efficacy (Bandura, 1977) and feminism (Sharma, 2019), higher education institutions can better

understand the needs of future female students. Also, knowing the reported experiences of female students encourages them to develop a sense of self-efficacy which is necessary to finish their program. In this way, higher education administrators might more fully understand what support structures might better prepare their female students for success.

CHAPTER TWO: LITERATURE REVIEW

Overview

A systematic review of the literature to explore the history of women in higher education and the documentation of their lived experiences and challenges in their STEM education programs was conducted for my study. The literature review thus provided the rationale for this research study and how it can contribute to the existing body of knowledge (Galvan & Galvan, 2017). This chapter presents a brief history of the beginnings of women in higher education through to their modern enrollment in higher education degree programs. The first section presents the theories relevant to the lived experiences of female students: self-efficacy (Bandura, 1977) and the related feminist theory (Sharma, 2019). Next, I explore how self-efficacy in the face of these real experiences and feminist perceptions of challenges played a role in FHES ability to achieve their degrees. Social scientists must continue to study the experiences and perceptions of female students because of the effects that negative experiences can have on their emotional health, job satisfaction, and desires to remain in academia (Fox, 2021; McCoy et al., 2013). This chapter begins with an explanation of the study's theoretical framework, a brief history of historical women in STEM education, followed by a discussion of the challenges FHES are facing as they strive to obtain equal access to the higher education and career opportunities as their male colleagues in STEM.

Theoretical Framework

This section presents the relevant literature on the theory of self-efficacy (Bandura, 1977), and post-modern feminism, as well as studies describing the experiences and perceptions of the challenges women have faced in their higher education STEM degree programs. I used a post-modernist feminist theory to further frame the study along with Bandura's (1977) theory of

self-efficacy. Post-modern feminist theory provides a background for the historical context of FHESs, but this research study sought to examine a human issue and not a female issue. The following sections address women's education rights, impostor phenomenon, gender bias, the general population, STEM students, and a summary of the theoretical frameworks and related literature.

Looking through a framework of the theory of self-efficacy (Banduara, 1977) helped me to describe the phenomenological experiences and perceptions of the FHES. This could account for and explain, through lived experience descriptions (LED) and perceptions of the existing challenges, how female STEM students successfully completed their degrees. Finally, a post-modern feminist theory provided a historical perspective of how language and social discourse create ideas about females in STEM degree programs. The feminist theory (Sharma, 2019) has many appendages, but my study used a post-modern view of feminism related to FHES STEM students.

Theory of Self-Efficacy

Self-efficacy theory was first defined by theorist Bandura (1977) who outlined a theoretical framework in which the concept of one's ability to persist was assigned a central role in analyzing changes achieved through fearful and avoidant behavior. Self-efficacy was recognized as a possible explanation for how people differ in their perceived abilities to accomplish their desired goals in the face of challenges: "Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences" (Bandura, 1977, p. 194). Bandura (2012) also noted that "forms of self-efficacy are for navigating the journey, not just for reaching the destination" (p. 32). As STEM student's progress through their degree programs, self-efficacy is important, and a part of the

higher education journey is productivity which requires the self-efficacy to complete the research and finish the degree (Kuchynka et al., 2018). The present study aimed to gain an understanding of women's experiences in a STEM higher education degree program. The information garnered from my study may help institutes of higher education to invest in strategies that will support and retain FHES in the STEM studies.

The Role of Self-efficacy in Achievement

Female students with a high positive self-efficacy report that they do better in college (Johnson, 2017). Interestingly, studies indicate FHES perform better if they report a higher level of self-efficacy, while males perform worse if they report a high level of self-efficacy (Johnson, 2017). There is, therefore, a correlation between FHESs' level of self-efficacy and their academic performance (Johnson, 2017). Also, there is an even stronger link between self-efficacy and achievement in low-achieving compared to high-achieving students (Johnson, 2017). According to Bandura (1997), boys tend to inflate their sense of competence, whereas girls often disparage their capabilities. However, when male students report high degrees of self-efficacy, they score lower on performance in their degree programs, while females tend to score higher when they report a higher degree of self-efficacy (Johnson, 2017). Further, women who are influenced by female role models report higher levels of self-efficacy in academia, and there is a strong correlation between academic success and strong female role models (Gillooly et al., 2021).

Children develop their sense of efficacy when they experience either a lack of or freedom from control. This revolves around a child's perception of whether they do or do not have choices and autonomy in their learning. According to Schunk (2016), students who perceive that they have control over their success are more likely to expend the energy to complete tasks,

while students who perceive that they do not have control will not have the motivation to complete tasks (Schunk, 2016).

Another theory that merits mentioning here is Heider's (1958) attribution theory, which states that a person's behavior is relative to their capacity and motivation to complete a task. For example, a student must have the ability to obtain the needed knowledge for a particular degree program, accompanied by the drive to continue through to completion (Heider, 1958). Students perform better when they have autonomous regulation rather than controlled regulation during their degree programs (Litalien & Guay, 2015). Female and male students are influenced by social aspects at home and in society (Sekścińska et al., 2016). These social aspects can lead female students to underperform in math and problem-solving skills (Deustch & Rubin, 2019). Diprete and Buchmann (2013) suggested that females work harder than males and that it pays off, even though males and females have similar rates of intelligence. Females with mothers who are interested in male-dominated STEM education will be more likely to study STEM (Ardies et al., 2015; Slobodian et al., 2021). Although girls earn better grades and stress over grades more than boys, the societal expectation is that boys can outperform girls (Einberg et al, 2016). In addition, girls also report that they have more demands, and boys have less responsibility and do not take their education seriously (Einberg et al., 2015). Therefore, it is important to pique the interests of female students, and to develop their self-efficacy when it comes to choosing to enroll in a STEM degree. The literature shows a strong relationship between gendered self-efficacy and interest in STEM majors over those related to health, elementary education, and domestic spheres (HEED) (Tellhed et al., 2016). This research study provides a lived experience description of the research participants' achievements, despite the challenges they faced in their STEM degree programs.

Student and Faculty Factors on Self-Efficacy

Higher education students who perceive that the institution's faculty are invested in their degree completion are more likely to be successful (Posselt, 2018). In the research study conducted by Posselt (2018) of underrepresented female minority STEM students, they found that faculty can assist with their degree completion by supplying certain structures of support, including:

1) Supervision: faculty and staff relationships with their underrepresented STEM higher education students, can help retain those students, when they are recognizably facing difficulties and can receive the support needed.
2) Growth mindset: faculty and staff who provided needed support to their struggling underrepresented STEM students, were viewed as trustworthy, and this cultivated a growth mind-set in those students.
3) Interpersonal skills and cultural competencies: an important facet for faculty and staff is understanding *racial literacy*, so that they can communicate in a manner that allows for a holistic support system.
4) Rethinking cultural norms and practices: direct support in the long-term, should allow for faculty and staff to call-out policies and practices, stigmatizing behaviors and double-standards that institutionalize gendered and racialized practices.
5) Normalizing the struggle: when the endemic signs of racism and sexism are recognized by faculty within their institutions, underrepresented students in STEM higher education degree programs, need not hold them back.

Institutes of higher education should provide a holistic approach to supporting the underrepresented students during the admission process and recognize not only the academic but the psychosocial strengths that applicants possess (Posselt, 2018). In addition to describing the

challenges of FHESs in their degree programs, my study sought to describe how they develop the self-efficacy to successfully complete their degrees. Institutes of higher education research, review, and implement strategies to retain help their students persist to degree programs completion. The National Academies of Science, Engineering and Math (2017) published this list of competencies that contribute to the motivation for students to successfully complete a degree:

- Behaviors related to conscientiousness: meaning a student's achievement goals, persistence, self-control, and hard work.
- A sense of belonging: such as the student's sense of belonging in the institution, social integration, and a perception of fitting in well.
- Academic self-efficacy: the student's belief that they complete their degree program.
- Growth mindset: as in the student perceives that their intelligence is not a fixed factor but can be nurtured for expansion and growth.
- Utility goals and interest: meaning the value of their human capital goals. How it can be achieved through the completion of their degree and what that means for their future.
- Intrinsic goals and interest: the internal sense of personal accomplishment a student receives from a strong interest in and of themselves.
- Prosocial goals and values: refer to the student's desire to promote other's development in well-being and/or people of domain's that transcend the self.
- Positive future self: the ideal that a student is reflecting an image of themselves that represents what they are becoming or are going to be when their degree is attained. (p. 182)

Other studies also focus on higher education degree are of completers and non-completers STEM students and examine the factors that can contribute to successful completion (Jelks & Crain, 2020). Completing students underscored the importance of working on a topic that has meaning to them, seeing progress being made, and having a supervisor who is supportive and helps when they get stuck (Jelks & Crain, 2020). The researchers suggested that these components for success are all interrelated and should each be considered together (Devos et al., 2017): (a) Take into consideration the tasks the student is completing and the goals of the student. (b) The processes that occur during the student's journey, such as socialization. (c) The people the student is interacting with and who are contributing to the progress of their work and their socialization. The researchers stressed that the components were interrelated and should be considered together. Although these recommendations are made to all students, female students still struggle with the unique challenges of being FHESs. The factors that contribute to the success of female students in their degree programs and that correlate with self-efficacy warrant further consideration.

For example, Tinto (2017) explains that self-efficacy is only one component to a student's persistence to continue their college courses. Tinto discusses the importance of a student's "sense of belonging within their own institutional communities" (p. 1). Self-efficacy, according to Tinto (2017), is not a fixed but malleable mindset, but self-efficacy is not the only component that contributes to a student's perseverance to remain in school. A student needs to feel valued by their institution, peers, faculty, and memberships, and the result is a sense of belonging to the academic community (Tinto, 2017).

Feminist Theory

Feminist theory supports the main theory of self-efficacy that will frame the study and it merits discussion because FHES report challenges specific to their gender (Alsop & Clisby, 2019; Sharma, 2019). A limitation to using feminist theory is that the *feminist* label may be discomforting to others (Sharma, 2019). Acker (1992) studied the experiences of female students and faculty in higher education and used liberal feminism to frame the studies. Acker (1992) found that problems in higher education are variously stemmed from gendered socialization, family versus career conflict, lack of investment in women's education, sex discrimination, career structures, capitalism, and patriarchy, which can be perpetuated by religious views. Although Acker's (1992) study is framed using a liberal feminism lens, my study was framed using the post-modern feminist perspective. Liberal feminism sees women and men as fundamentally equal but that social conditions cause inequality and is more in line with political changes (Sharma, 2019). Whereas post-modern feminism is concerned with language and social discourse's impact on society's understanding of women (Sharma, 2019). My study was interested in understanding the lived experience descriptions (LED) of challenges that females have faced in their STEM degree programs, by means of explicit language.

Religious institutions and religious views also play a role in the discriminatory practices of denying entry into certain higher education degree programs, solely based on gender or those institutions offer a limited option for degree attainment. For example, higher education institutes with a biblical or sectarian affiliation have a negative impact on women students and they provide degree options of lower prestige and are often costlier to attend (Sherkat, 2007). Some institutions admit men-only to their institutions, such as Morehouse College in Atlanta, Georgia which admits only males and when they do become a student, they are given the label of being a *Man of Morehouse* (Morehouse.edu; Morrison, 2019). Other schools that do not admit females

are lesser-known such as Saint Meinrad who admit men-only to the seminary priesthood program, their website states “Building on the humanity of the *man* interested in the priesthood of Jesus Christ” (LaMoth, 2018; saintmeinrad.edu/priesthood-formation). Using a post-modern feminist theoretical view as a lens, my study sought the interpretation of how language and discourse impacts the opportunity for women to obtain an equitable higher education.

In the general population, both boys and girls begin their education with an equal interest and ability in math and science. As female students get older, however, they report believing that math, in particular, is more appropriate for males and that females do not have the same capacity for math and science (American Association of University Women, 2015; Corbett & Hill, 2015). The American Association of University Women states that, although the number of girls studying the sciences and math have increased, there is still an underrepresentation of women in the engineering and computing professions. According to Sharma (2019), this research study can provide a deeper understanding of how FHESs shape their realities and identify themselves in higher education degree programs. This research study traced the participants’ personal histories and how the challenges they faced shaped their reality as female higher education STEM students. Understanding these perspectives and gaining insight into their lived experience descriptions (LED) may assist institutions of higher education to accommodate women students.

The Role of Feminism in Interpreting Experiences

There are several different extensions of feminist theory. For example, a few of the feminist standpoints are liberal, cultural, and radical feminism. Liberal feminism is more aligned with equality and political change, cultural feminism sees women and men as inherently having different temperaments, and radical feminism focuses on patriarchy being a means of oppression which needs a radical change and not just reform (Sharma, 2019). This research study is most

aligned with the post-modern theory of feminism, wherein identity, social discourse, and language create societal views of women (Sharma, 2019). Interpreting the lived experience descriptions (LED) of female STEM degree holders, my study looked at gender roles and stereotyping along with their sense of belongingness.

Gender Roles and Stereotyping

Phillips et al. (2016) studied a program for male and female students training to become plastic surgeons and reported that "women in academic surgery are 10 times more likely to experience gender discrimination than their male colleagues" (p. 113). The authors also discussed data that indicates that female students were rated as less confident than their male colleagues in the medical program. Although females outnumber males in degree completion, they do not outnumber males when it comes to doctoral degree completion. Women face greater challenges, and my study was interested in the lived experiences and challenges that form the realities of being a woman STEM higher education student in any degree program.

Language is important in understanding our lives and communing through spoken and written words. The words in textbooks, literature, recruitment, and advising at the higher education level have predominantly been patriarchal in manner (Bellini et al., 2019). Van Manen (1997) saw language as the only way pedagogic experience assumes a symbolic form that creates relationships by its very discursive nature. Societal ideals that view males as more qualified and desirable in leadership positions still exist. Folklore is another part of this language, and when folklore is shared amongst women doctoral students, it passes down the ideals of masculine and feminine roles in society and higher education, but often creates a false sense of collegiality (Fox, 2021). In fact, many women also reported finding men more qualified and desirable in leadership positions than other women (Bruce et al., 2015).

Being stereotyped by society as less competent means that women may require more encouragement to alleviate doubt regarding their self-efficacy in their choice of degree programs (Tellhed, 2016). Perhaps competence should be seen as less of a masculine stereotype to increase the self-efficacy among females as they choose their higher education degrees (Tellhed, 2016). My study looked at the role of social constructivism due to the prevalence of socially constructed ideas about males being more intelligent than females (Sharma, 2019; Tellhed et al., 2016). Women notice these socially constructed views, and these play a role in their self-efficacy throughout their education experience: "Being stereotyped as less competent by society implies that girls and women need more encouragement to develop a secure self-efficacy" (Tellhed et al., 2016, p. 93). Tellhed et al. (2016) explained that society structures itself in a manner that does not lend equal status to men and women, and, since men are held in higher regard, they do not struggle with self-efficacy on the same level as women. Other studies refer to intelligence of being more competent in the field of STEM, as that of having brilliance enough to be a student in a STEM program (Deiglmayr, 2019). Biases were found linking STEM fields of study to brilliance and can explain female uncertainty in belonginess to these fields (Deiglmayr, 2019).

One of the key factors for female STEM students to feel like they belong in a program is the presence of female faculty and an issue reported by female STEM students is the gendered symbols and texts (Klein et al., 2019; Marco-Bujosa et al., 2021). It was Acker (1992) who coined the term *gendered institution* to refer to processes within higher education institutions. Acker (1990) identified the following five inequalities in gendered organizations:

1) Organizations that are androcentric display symbols, language, and images that reinforce male positions of power.

2) Interactions between males and females reinforce male dominance and female submission, such as when men interrupt their women colleagues in conversation but not their male colleagues.
3) Thought ideals about work have been observed to favor the male-dominated focus which holds that being successful at work meant that you must work all hours.
4) Evaluation criteria for job performance have been noted to favor male characteristics and preference of work roles.
5) Gender is implicated in the fundamental and ongoing practices of creating and conceptualizing social structures. (Acker, 1990; p. 147)

Connell (2002) called gendered institutions *gender regimes*, categorizing relations within institutions into four areas: relations of power, division of labor, dimension of emotion and human relations, and dimension of culture and symbolism. Similar to Acker's (1990) list, the Connell (2002) list: relation of power refers to a male hierarchy of control and authority within institutions, the division of labor were observed to be divided by occupations like paid work and domestic work, emotion and human relations referred to the manner of attachment divided among gender including feelings of solidarity, prejudice, disdain, sexual attraction and repulsion and finally, symbols and gendered language and the way they define culture.

Feminist scholars offer information that institutions of higher education can use to implement change to the historically gendered ideals of processes, language, and symbolism that reinforce or keep institutions from being equitable to women students and faculty. Unfortunately, women STEM students report that "females who enrolled in and persisted in these majors often had to suppress or reinterpret their female identity to fit in with their male peers in a male dominated environment" (Marco-Bujosa et al., 2021, p.551). This research tells the lived

experiences of the challenges women in STEM higher education experience, and their personal identities within their programs of study.

Klein et al. (2019) reviewed articles associated with implicit gender bias against female doctorate students, often among people who are unaware of their own biases. The authors also provided recommendations for interventions to address gender bias in medical school: “Gender bias is multifaceted and may arise when gender-based normative behaviors and expectations misalign with professional roles and behaviors” (Klein et al., 2019, p. 717). Findings from a study about the belonging of woman STEM doctoral students support the notion that a lack of program structure and expectations contribute to academic disparities and distress. The findings also support the idea that if STEM higher education programs clarified their expectations and standards, this might alleviate some of the disparities and distress amongst women STEM students (Fisher et al., 2019). With the presentation of the male-dominated higher education system it presents another portion of a female deciding to pursue a STEM degree and that is their perception of belongingness.

Belongingness

Part of the reason women are more interested in majors in healthcare, elementary education, and domestic spheres (HEED) while men are more interested in science, technology, engineering, and math (STEM), is related to ideas of social belongingness (Tellhed et al., 2016). For example, Riegle-Crumb et al., (2020) found that female STEM students report chilly climates due to the gendered expectations of both faculty and peers. This results in their elevated impostor phenomenon. Social belongingness is the recognized need for humans to be socially connected in groups and to fit in socially with others (Tellhed et al., 2016).

FHESs have reported feeling like they were viewed as inferior to their male colleagues. For example, there is “Merton’s… Matilda effect, suggesting that female researchers systematically receive less recognition for their work compared with male colleagues” (Lindahl et al., 2020, p. 313). Reported experiences like this could inhibit female students from seeking degrees in certain academic areas, but these experiences and the perceptions of female students in higher education could also help shed light on the reasons for this. Like the Matilda Effect (Lindahl et al., 2020), impostor phenomenon theory (Posselt, 2018) shows that many women and Black, Latino, and Native American students hold self-doubts. In the current context, impostor phenomenon refers to the women’s perception that they do not belong because they are female in a male-dominated arena. Researching and describing the lived experiences of women students in higher education might2 provide valuable information to institutions and degree seekers who experience a feeling of not belonging.

The Matilda Effect in academia continues to underrecognize female research, leadership, training (Lindahl et al., 2020, p. 313), especially in STEM programs, where more respect and emphasis are placed on males in training, mentoring, research, and leadership: “We are part of a patriarchal society, although scientists and academics often fail to recognize it” (Slobodian et al., 2021, p. 2). Females have reported experiences of social intimidation, inappropriate male behavior, and have noted that being in a STEM higher education degree program felt like being in the “boy’s club” (Marco-Bujosa et al., 2021, p. 551). This systemic bias toward female scientists in academia is an ongoing issue that has created a system less conducive to women’s progress in the scientific and academic community. Slobodian et al. (2021) listed the following as observed challenges women in STEM and academia are currently experiencing: 1) household chores, child rearing, caring for elderly family; 2) experiences of harassment because of gender

and sexual orientation; 3) being less cited and/or credited for their work; 4) an unfair division of labor and credit for research that undermines women in scientific work. Although the challenges women experience today mirror the biases seen in 1792, the 1930s, and the 1960s, changes are being recognized for females in STEM and academia. For example, one effort to create change is the organization called Parent in Science (parentinscience.com), which calls for consideration of the effects of parenting while attending an academic program (Slobodian et al., 2021, p. 4).

Gibson-Beverly and Schwartz (2008) studied impostor phenomenon (IP) among women graduate students and found that female students are more likely to experience impostor phenomenon due to gender role stereotyping and their early socialization. Holliday et al. (2020) researched IP among medical and dental students at Harvard University and found that the female gender was the most prevalent predictor of IP in students. They therefore suggested that the prevalence of IP among female students should be addressed at a managerial level and that some programs should cultivate leadership, confidence, and resilience in female students who report IP. This same study indicated that only 11% of male students and 18% of female students scored at an intense level for impostor phenomenon (IP).

Interestingly, current studies still indicate that female students report impostor phenomenon more than their male colleagues: “Despite an overarching mission of increasing education access and equity for marginalized groups, findings illustrate that community colleges do a disservice to women by implementing gender-neutral policies and procedures in in STEM programs” (Marco-Bujosa et al., 2021, p. 556). Another historically male-dominated field of study in higher education is Computer Science, where women report experiences of gender bias, such as male students’ resistance to accept courses on women’s and gender studies as a part of the program requirements (Horwoth & Diabl, 2020). One factor in cultivating a mindset of

growth that helps to minimize the impostor phenomenon in students, is for faculty of higher institutions to provide support to underrepresented students (Posselt, 2018).

Despite these ideological strongholds, women are succeeding in higher education, but they are still underrepresented compared to their male counterparts, both among STEM students and STEM faculty (Gillooly et al., 2021). Females are outperforming their male colleagues in higher education and are persistent in their goals to finish, but on average they spend more time studying, engaging in active learning, when accompanied by a slightly higher degree of social integration (Kamphorst et al., 2015). A major factor in their successful degree completion is women's intentions to persist due to their purposeful selection of a STEM degree (Kamphorst et al., 2015). Another factor concerns the type of regulations the degree program places on the students (Litalien & Guay, 2015) and whether they are controlled regulations or autonomous regulations. Autonomous regulation is when a person perceives their behaviors to stem from their own choices, while with controlled regulations a person perceives that their actions are designed to elicit recognition from others or to avoid punishment and feelings of guilt or shame (Litalien & Guay, 2015).

In addition to experiencing Impostor Phenomenon (IP), there is a silent gender bias and female doctoral students report feeling like they are the "other" in relation to male doctoral students (Holliday et al., 2020). Pingleton et al. (2016) researched silent bias among women professors who had attained their professorships. Academic power remains in the hands of men, and women are still limited by a glass ceiling, since men preside over most doctoral dissertations and women serve more in the education capacity (Vallejo et al., 2016). Explicit gender bias was found in a study of U.S. physician residents, who favored men in leadership positions (Hansen et al., 2019). However, men reportedly have gender-based barriers when it comes to programs like

nursing. These biases stem from societal ideas of the nursing profession as one rooted in caring behavior and thus associated with women (Aubeeluck et al., 2017). However, gender biases against women prevail in STEM. The past few decades have seen advances in this area, but inequality for women in the areas of wages, promotions, evaluations, and recognition between men and women remains apparent in the United States (Feldon et al., 2018; Kuchynka et al., 2018).

Gender biases in education are improving for female students and professors. Clisby and Holdsworth (2016) studied the changes in women's opportunities in education, explaining that institutions of higher education remain highly gendered arenas, but with visible improvements with respect to women. For example, one study conducted in Great Britain traced the high attrition rates of female surgical students and their perceptions and experiences in surgical programs (Bellini et al., 2019). The female surgical students perceived the language of the courses to be gendered and viewed the program as more supportive of males, reflecting the sociocultural norms embedded in masculine discourse. The greatest barrier reported in the study was that women wanted to pursue their career aspirations alongside child rearing but found this difficult to accomplish because of the nature of surgical training (Bellini et al., 2019). Strides have been made towards gender equity in education. However, gender-based discrimination continues to persist in the training and practice of women medical students, so the faculty must increase their vigilance, to improve the equitable access of women to the successful completion of their degrees (Sharma, 2019). The first step to eliminating the effects of gender bias is to raise awareness of gender disparities in academia (Feldon et al., 2018). My study will describe the challenges FHESs have experienced or face now in their STEM degree programs.

Tinto's (1993) model of persistence theorizes that a student's persistence depends on their ability to become integrated with the social and academic system of higher education institutions. Among doctoral graduates, reports indicate that some students feel that they are impostors, frauds, or that they fooled people or were just lucky, instead of attributing their successful completion to their knowledge, arduous work, and persistence (Chakraverty, 2020). Studies report that women in doctoral degree programs continue to have the primary responsibility of their children and the home. These same women also reported that their motivation to obtain their doctoral degrees was found in their desire to have the power to control their destinies and to obtain personal fulfilment. In addition, the research also points to a powerful yet invisible barrier these women face, which stems from cultural beliefs about the female gender (Gregor & O'Brien, 2015). Women doctoral early completers reported the greater role of family support, whereas late completers reported more delays in finishing due to child rearing responsibilities (10% for early completers and 36% for late completers), marital problems, and other family issues (7% for early completers versus 28% for late) (Maher et al., 2004). Because of these cultural beliefs, FHESs often feel that they do not belong, that they are impostors, or experience biases.

Researchers studying female attrition rates in STEM have attempted to identify reasons that females leave STEM programs or do not choose a STEM degree program in post-secondary education (Blickenstaff, 2005). The following are a list of explanations of female attrition Blickenstaff (2005) provided in previous STEM studies:

1) Biological differences between men and women.
2) Girls' lack of academic preparation for a science major/career.

3) Girls' poor attitude toward science and lack of positive experiences with science in childhood.
4) The absence of female scientists/engineers as role models.
5) Science curricula are irrelevant to many girls.
6) The pedagogy of science classes favors male students.
7) A 'chilly climate' exists for girls/women in science classes.
8) Cultural pressure on girls/women to conform to traditional gender roles.
9) An inherent masculine worldview in scientific epistemology.

No simple reason can explain the underrepresentation of women in the STEM studies (Blikenstaff, 2005), which is why my study sought to contribute to the body of knowledge on females' experiences in their STEM degree programs.

Female Human Capital

The Human Capital Theory developed by Becker and Mincer (1975) merits discussion of FHESs' decisions to invest in their education and training. Human Capital Theory explains a human's decision to invest in his or her education and training and their lifetime earnings based on their investment (McKernan & Ratcliffe, 2002). Traditionally, males place value outside of the domestic duties of the home, and male education is valued more than female education (Sekścińska et al., 2016). Women cohorts born in the 1940s showed an increased participation in the labor force and were expected to be in the labor force longer than their mothers (Bowlus & Robinson, 2020). Historically, a woman's capital was valued primarily in the home, but it has evolved over several generations (Sekścińska et al., 2016). With that evolution, women are gaining value in the education sector and workforce (Sekścińska et al., 2016). Females have lacked access to the same resources as males: for example, role models, social networks, which

they need to achieve higher levels of human capital: creativity, innovation, problem-solving, (Edokpolor, 2019).

While there have been gains in the human capital of women, females still face unique challenges because of questions of gender (McGowan et al., 2015). The gender roles of men and women have changed quickly in the past half century. Women have increasingly found themselves in the workplace instead of being a traditional homemaker (Sekścińska et al., 2016). The main reason being, that women in non-traditional cultures are pursuing higher education degrees, because they need to contribute financially to their households. For example, in Israel, highly Orthodox Jewish women are finding their roles changing through a new dual capacity of caring for the home while obtaining higher education degrees to prepare for work outside of the home (Deustch & Rubin, 2019). Approximately 11% of highly Orthodox Jewish women in Israel are pursuing degrees (Deustch & Rubin, 2019). These women are considered highly religious and are reporting unique challenges with secular curriculum and societal conflict, but they continue for economic reasons (Deustch & Rubin, 2019).

The human capital of women may be more prevalent today as they gain in education, but studies indicate that they are still paid less than men (Tverdostup & Paas, 2017). One reason for this might be that female students underperform male students in math and problem-solving skills, which would afford them higher wage-paying jobs (Deustch & Rubin, 2019). The numbers of women entering STEM doctoral programs are increasing, but their salaries do not increase much more than if they had a master's degree, in contrast to their male counterparts (Bryan & Guccione, 2018).

Women STEM PhD graduates find the following intrinsic and extrinsic advantages from completing their degrees: significant skills value, personal value and, value at work (Bryan &

Guccione, 2018).

- Significant skills value: Female PhD STEM students had received the skills that they need to enter the work force, while their co-workers must catch up to them.
- Personal value: The more time that passes after obtaining a STEM PhD, the greater value women with STEM degrees report.
- Value at work: Women report that their employers value their credentials and compare other workers to them.

As societies and cultures begin to value the human capital of women, this poses challenges in the diversity of institutes of higher education (Crenshaw et al., 2017; Sekścińska et al., 2016). This hermeneutic phenomenological study aimed to provide a detailed view of the challenges current FHESs experience in their degree programs.

Gender Inequalities

Institutes of higher education have documented existing gender inequalities in academia, so faculty who supervise graduate students must increase their vigilance to improve equitable access for women toward the successful completion of their degrees and to understand how academic tasks differ between men and women. A first step to eliminating the effects of gender bias is an awareness of gender disparities in academia (Feldon et al., 2018). Some institutions of higher education are requiring all students to take a course on women and gender studies to illuminate gender issues, but this requirement has been met with mixed reviews (Horwath & Diabl, 2019).

U.S. institutions of higher education should take notice of female-inclusive initiatives in other similar countries, like the United Kingdom. In the United Kingdom, higher education institutions have developed and implemented a holistic program called BRIDGE (Building

Routes into Degrees with Greater Equality) to attract and retain more diverse cohorts in their departments of engineering, architecture, building, planning, and technology. Most students in higher education degrees related to construction have historically been males, and less than 1% of the 800,000 students enrolled in construction-related degree programs are female. The research has identified the following six reasons why women do not choose program in construction-related degrees: 1) a negative image of the industry; 2) a lack of career knowledge; 3) the gendered stereotype of the career; 4) the masculine-centric culture of the industry; 5) sexist attitudes toward recruitment; and 6) training and education (Strachan et al., 2020). Institutions of higher education must continue to make changes to include females in recruitment and retention in degrees that are viewed as male dominated. Thomas et al. (2017) outlined strategies for retention and student success in higher education, including: having leadership and staff at all levels involved; creating a culture and policies that value retention and success; systems and processes that enable everyone to work toward success; having students involved in the process of change; collecting data and evidence that inform success; and providing academic support and regulatory practices that foster support. Continued research on the lived experiences of females in higher education are necessary to expand the knowledge base about equity for women in higher education.

Related Literature

Historical accounts and studies have included the struggles that women have endured to achieve an equitable education like their male colleagues (Phillips et al., 2016; Redmond, 2020). One area of study, that females continue to be underrepresented in, is the STEM studies (Phillips et al., 2016; Redmond, 2020). Despite their underrepresentation, females have made contributions to the STEM science fields of study.

U.S. History of Females in STEM

Science, technology, engineering, and mathematics programs of studies have historically been dominated by males (Deiglmayr, 2019; Jelks & Crain, 2020). However, females, including the underrepresented women of color, are making gains in admissions and graduations from STEM programs of study (Deiglmayr, 2019). The following are a brief look at the gains that females including underrepresented females, are making in the STEM programs of study.

Science

The first woman to graduate with a medical degree in the United States was Elizabeth Blackwell. Although Blackwell was finally accepted at Geneva College in New York, her letter of acceptance was initially meant as a joke. Despite this, Blackwell went on to graduate in 1849 at the top of her class. At the onset of her endeavor to attend medical school, locals considered Blackwell a bad woman for going against her gender role as a female (Michals, 2015). Blackwell faced discrimination and obstacles in medical school, such as being denied the opportunity to participate in labs and being made to sit separate during lectures, because she was a female (womenhistory.org).

Technology

In the technological field, Rear Admiral Grace Murray Hopper was at the forefront of computer language and programming development from the 1930s through the 1980s (The Untold Story of Women in Science and Technology, n.d.). Hopper came at a time in history when it was unusual for women to attend college and her ability to excel in a male-dominated field in the 1920’s and 1930’s, was an exceptional accomplishment (president.yale.edu).

Engineering

Edith Clarke, who was the first women graduate from Massachusetts Institute of Technology (MIT) with a degree in electrical engineering, was hired in 1922 as the first woman electrical engineer. Clarke, who was identified as having a learning disability when it came to reading and words, excelled in mathematics. Edith Clarke helped to pave the way for women in STEM and engineering and was inducted into the National Inventors Hall of Fame 2015 (The Untold Story of Women in Science and Technology, n.d.). Clarke was quoted as saying, "I had always wanted to be an engineer, but felt that women were not supposed to be doing something like studying engineering" (ge.com/news).

Mathematics

Meanwhile, Mollie Orshansky, a child of Polish immigrants, graduated from Hunter College in 1935 with a degree in mathematics and statistics. Then, in 1958, she joined the Social Security Administration as a social science research analyst and was instrumental in the war on poverty in the 1960s (Social Security Office of Retirement and Disability Policy, n.d.).

Women of color in STEM

Women students of color ranked the lowest in having a gap between male and female achievement of STEM degrees in the United States ((NCES)). The National Center for Education Statistics (NCES) reported that in 2015-2016 the gap was only 11%, with White women being the highest at a 33% gap. Although women STEM student degree completers outnumbered their White female counterparts, they represent only 9% of the population of women working in a STEM field, while White females are at 61% (National Science Board, 2020). The number of Black women STEM students who graduate is improving based on a 2015 statistic reporting that percentage at just 2.9% (National Science Board, 2020), while the number of them working in

2015 in a STEM field was at 5% (Maryville University, n.d.). These numbers indicate a gradual rise in Black women who graduate and work in a STEM field.

Despite women of color facing the barriers of race and their gender, they have historically overcome those barriers, to be successful not only in higher education, but the STEM fields (nasa.gov). As many of the women of color who have been discussed thus far, yes, there are those who seek a STEM degree and are quite successful, but they continue to be underrepresented (National Science Board, 2020).

The first African American woman surgeon in the 1900s, Dorothy Lavinia Brown. Brown was accepted as an intern surgeon at Harlem School by Dr. Brown. It was said that Dr. Brown was brave because he accepted her even though staff said that women could not stand the rigors of surgery (cfmedicine.nlm.nih.gov). Despite facing the dual challenges of racial and gender bias, Dr. Marie M. Daly became the first woman chemist of color after she graduated in 1947 from Columbia University.

In 1958, Mary Jackson became the first aeronautical engineer for the National Aeronautics and Space Administration (NASA) and devoted her life to assisting other women in STEM programs. Jackson's route to education was not direct, having to receive special permission by the City of Hampton to attend courses at Hampton High School because of her race. Jackson began her career in an era when being black and a female in engineering was a rarity (nasa.gov).

In the field of mathematics, Katherine Johnson completed the NASA calculations necessary to land several space missions, which included the 1969 moon landing. Johnson was only one of three African Americans to desegregate the West Virginia State College (nasa.gov).

In 2015, she was awarded the Presidential Medal of Freedom for her work with NASA's flight research division (Maryville University, n.d.).

Women in STEM fields are increasing in numbers, but ongoing research is needed to give a voice to the lived experiences and struggles of women in their STEM degree programs today. The number of female graduates in 2008-2009 increased by 66.3%, but female STEM degree recipients in 2017-2018 was 32.4% of the total graduating (usafacts.org, 2020). By continuing to research the challenges female STEM students face, my study illuminates issues that drive the high attrition rates of women STEM students and/or that may be creating barriers for women deciding to become STEM students.

Female STEM Degree Choice

For my study, the issue of degree choice for females entering a post-secondary education program, is their underrepresentation in the STEM studies. Historically females have chosen degree choices other than those represented by a greater number of males (Tellhed et al., 2016. Several factors have been hypothesized to explain this lack of interest by females in going into the STEM degree fields. For example, a lack of preparedness of girls toward those degree choices that require a strong reliance on mathematics (Deustch & Rubin, 2019). Also, although when girls and boys begin their elementary educations, they show equal ability and interest in the math and sciences, at some point girls begin to lose their confidence in their math skills (American Association of University Women, 2015; Corbett & Hill, 2015; Nix, 2015). Numerous studies have been conducted on the experiences of females in their post-secondary degree programs and the challenges that they have faced. There is a gap in the direct study of STEM degree completers from a phenomenological reflective standpoint on the experiences of challenges they faced while in their STEM degree programs. Further study is needed to

investigate in a deeper, reflectively detailed method, to illuminate the lived experiences of FHES in STEM programs. The findings of my study may help institutes of higher education incorporate changes that help to attract and retain females in STEM degree programs.

Success Factors

In addition to describing the challenges of FHES's in their degree programs, my study describes how FHES's develop a sense of self-efficacy to successfully complete their degrees. Institutes of higher education research, review and implement strategies to help their students complete their degree programs successfully. The National Academies of Science, Engineering and Math (2017, p. 182) published this list of competencies, that contribute to the motivation for students to successfully complete a degree:

- Behaviors related to conscientiousness,
- A sense of belonging,
- Academic self-efficacy,
- Growth mindset,
- Utility goals and interest,
- Intrinsic goals and interests,
- Prosocial goals and values, and
- Positive future self

The purpose of my study was to describe the current challenges FHESs face while in their STEM degree programs. This was done by transcribing all the interviews, reflecting on the transcripts to recognize emerging themes, and providing an interpretation of the meaning of the experience for the research participant to describe the lived challenges FHESs experience and to describe how FHESs are strategically coping with those challenges. My study describes the lived

current challenges for females in STEM higher education degree programs and may add to the body of knowledge for students and higher education institutions. This research might benefit women who seek STEM degrees and allow for more discussion about the need for change in practices for equity in these programs.

Challenges For Institutes of Higher Education

In practice, universities and other institutes of higher education have and are attempting to make changes that facilitate equity among students and retention, but recent research studies have shown that there are still issues that need to be resolved (Alsop & Clisby, 2019; Sekścińska et al., 2016). For example, a study on the experiences of women and under-represented students in a computer science department conducted over a 10-year period by Crenshaw et al., (2017) found that these students experienced more biases than their male colleagues. While some changes were made over ten years, women students, students of color, and other underrepresented students continued to report bias, discrimination, and harassment (Crenshaw et al., 2017). Also, female students and faculty continued to be underrepresented in STEM programs (Gillooly et al., 2021).

STEM Student Attrition

One component of female STEM student attrition is the degree to which they perceive support from their professors. When higher education students, especially underrepresented students, feel supported by their professors they are more likely to remain in their degree program. Underrepresented minority STEM students relate their attrition to a lack of support in their degree programs, non-existent mentoring, and no guidance (Whitcomb & Singh, 2021).

Sexist Practices

Females encounter sexism in male-dominated degree programs and these experiences

have a direct effect on their ability to perform at their skill level (Huerta, 2017). Reports show that the most common contributing factor to gender bias comes from male peers toward their female colleagues (Robnett, 2015). In 2018, a graduate textbook for teaching assistants (TAs) at the University of Maryland's Computer Science department instructed their female TAs to, politely handle, any form of sexist behavior encountered by their male students (Fox, 2021).

Not only do women students experience gender biases, but they also experience low self-efficacy. Bandura (2006) posited that a lack of self-efficacy to control negative experiences could be associated with poor academic performance. Huerta (2017) found that the self-efficacy of female students who exhibited significant stress showed a large correlation to the student's writing anxiety. In all three regression models for Huerta's study, gender was found to be statistically significant - women exhibited higher writing anxiety compared to their male colleagues. The gender bias that FHESs reportedly experience explains the chilly climates (Riegle-Crumb et al. 2020), and lack of feeling that they belong in the male-dominated classroom or program (Phillips et al., 2016).

Patriarchal Textbooks

In addition to female students experiencing gender bias and low self-efficacy, there is the issue of the use of masculine-focused literature in institutions of higher education (Lindquist et al., 2019; Sharma, 2019). The use of older textbooks written for doctoral programs poses relational issues for women doctoral students. For example, pedagogical and education texts have been critiqued and identified as having a masculine stronghold (Sharma, 2019).

Further, higher education textbooks and communications that are focused on male students rather than female students create a culture of exclusion, and females are less apt to apply to historically male-dominated degree programs (Lindquist et al., 2019). In the past,

textbooks were written with a masculine tone, which did not include a woman's perspective or language. Being able to feel included and important in a degree program is difficult for women students who are learning solely from texts written with a patriarchal view (Sharma, 2019).

Faculty Member Gender

Although female students report struggling with masculine-dominated textbooks and literature, FHESs who study under a female faculty member in any degree program performed better than when they studied under a male faculty (Johnson, 2017). Male students, however, performed the same with a male or female faculty professor (Johnson, 2017). Women scored higher on performance and men scored lower when they were more involved with their peers at college. Also, men scored lower on performance when they scored higher on self-efficacy (Johnson, 2017). One of the key factors in a student's degree completion is feeling supported by faculty and faculty members who are involved in their higher education (Rockinson-Szapkiw et al., 2014). As discussed, self-efficacy is an important mediator of gender differences for students making the choice between a STEM major or a HEED major. Because women perceive social belongingness in HEED major programs and males perceive a social belongingness in STEM majors, the students' self-efficacy reflects gendered norms (Tellhed et al., 2016). As stated, perhaps competence should be less of a masculine stereotype, which would lessen the self-efficacy doubts among women choosing their higher education degrees (Telhead, 2016).

The Future for Underrepresented STEM Students

The history and current research of females in education and especially STEM programs, represents an array of challenges for women who want to attend the higher education institutes alongside their male counterparts. Literature reviews of pedagogical studies, attrition studies, historical perspectives, sexism, patriarchy, human capital, self-efficacy, belongingness,

faculty support, impostor phenomenon, gender and racial bias, self-efficacy, feminism, for this STEM study promote the need for this current research study and for future STEM studies (Crenshaw et al., 2017). STEM jobs are on the rise all over the globe and the demand to fill those positions with qualified personnel is too. The STEM workforce continues to be dominated by males and females, especially double-minority females, are grossly underrepresented in the workforce (NCES, 2015-2016; Phillips et al., 2016; Redmond, 2020).

The future for female STEM students and those students who are considered a double minority, will continue to improve, provided that, institutes of higher education recognize and acknowledge that barriers continue to exist. In addition, institutes of higher education realize that changes are imperative for these students to be retained in their programs to degree completion (Alsop & Clisby, 2019; Sekścińska et al., 2016.)

The current literature covering the future for female and underrepresented STEM students show a need to attract and encourage STEM interest early on. Understanding the perspectives of race and gender interest in STEM students have been the focus of several studies of the past two decades and continue to warrant studying (Martin and Fisher-Ari, 2021).

Although female interest in the STEM studies is multifaceted, the following are the primary reasons girls do not choose to pursue STEM (Farland-Smith, 2015).

- A lack of female identity in STEM
- Gender stereotyping of females who are interested in STEM
- Limited family flexibility in STEM activities early on
- Females lacking a sense of belonging in STEM fields

The following are strategies that can help educators to attract and promote participation of underrepresented students in the STEM studies (Farland-Smith, 2015):

1) Exposing underrepresented female students to the STEM studies in early education programs can help pique their interest in STEM.
2) Providing female role models for underrepresented students can help them feel empowered.
3) Share the history of females in the STEM studies primary to teaching solely about historical male figures in STEM.
4) Finally, keep a check on hidden biases toward either female or male STEM students and create a culture of acceptance.

The future for underrepresented students in STEM studies continues to evolve, as equitable practices by institutes of higher education are implemented (Alsop & Clisby, 2019; Sekścińska et al., 2016) and as strategies to attract and promote participation by underrepresented females in STEM (Farland-Smith, 2015) continue.

Summary

Studying the lived experiences and perceptions of female STEM students offers information that can contribute to the academic design and support female students who seek advanced degrees need to succeed. Researchers have explored the factors that contribute to self-efficacy of female STEM students who achieve their degrees. Additionally, researchers have examined the experiences of gender biases toward women who decide to pursue STEM degrees despite the advances that have been made. Institutes of higher education could benefit from studies that focus on female decisions to enter a STEM degree program and what the lived challenges have been for female STEM degree completers. Female students who have the self-efficacy to pursue a degree develop the skills they need for FHESs to persist all the way to their degree completion.

CHAPTER THREE: METHODS

Overview

The purpose of this hermeneutic phenomenological study was to understand the challenges female higher education students (FHESs) experience in science, technology, engineering, and mathematics (STEM) programs of study. This methods chapter section explains the design of my study, the research questions, and the setting and participant sampling procedures. It also discusses the procedures, data collection and analysis, the trustworthiness of the data, ethical considerations, and finally offers a summary of the research conducted.

Research Design

This was a qualitative hermeneutic phenomenological research study to investigate the experiences of FHES in their STEM degree programs. I was not interested in providing strategies or solutions to any identified challenges, but rather in collecting and interpreting the lived experience descriptions (LED) of the challenges females reported while in their STEM degree program.

Phenomenology is not simply research of the experience of a phenomenon; it is more about knowing how the phenomenon was experienced by a person and what meaning it has for that person: “The fundamental model of this approach is textual reflection on the lived experiences and practical actions of everyday life with the intent to increase one’s thoughtfulness and practical resourcefulness of tact” (van Manen, 1997, p. 4). There are two types of phenomenological research methods, transcendental and hermeneutical, both methods explore the lived human experience (Creswell & Poth, 2018). Transcendental phenomenology focuses on providing a textural and structural account or of the participants’ recollections of an experience with an emphasis on description rather than interpretation (Moustakas, 1994). In contrast, in a

hermeneutic phenomenology the researcher serves in an interpretive role, seeking to illuminate about and bring to recognition the recollections of people's lived experience descriptions (LED) and the meanings they assign those experiences, to uncover deeper meanings and a greater understanding (van Manen, 1997). The following table provides a visual tool for referencing the steps of van Manen's hermeneutic phenomenological method of qualitative research:

Table 1. van Manen's method of phenomenology (adapted from van Manen, 1984, p. 42)

Concurrent Procedures	Steps
Turning to the Nature of the Lived Experience	1. Orienting to the phenomenon 2. Formulating the question 3. Exploring assumptions and preunderstanding
The Existential Investigation	4. Exploring the phenomenon: generating data using personal experience, tracing etymological sources and idiomatic phrases, experiential descriptions from participants. 5. Consulting phenomenological literature
Phenomenological Reflection	6. Conducting thematic analysis – uncovering themes, isolating statements, composing linguistic transformations 7. Determination of essential themes
Phenomenological Writing	8. Attending to spoken language 9. Varying examples 10. Writing and rewriting.

Interviewing, observing, and writing allow researchers to provide a better understanding of the lifeworld of the people they study. Gall et al. (2007) explained that, unlike the detached researcher in quantitative research, the qualitative phenomenological researcher is intricately

connected with the phenomena of the study. This is one of the goals of phenomenological studies. Human science research studies aim to reach the deep, unrecognizable meanings people attach to their experiences. For this to occur, researchers must provide textual recollections of those experiences in words that allow others to understand the meanings the subjects are giving to their experiences on a deeper level. The hermeneutic phenomenological research study was the appropriate design for the desired data collection and interpretive method, to understand the lived experiences of the participants.

Research Questions

Central Research Question

How do female higher education students describe their lived experiences in their STEM degree programs?

Sub-Question One

How do female higher education students describe the influence their personal history had on their choice to pursue a higher education STEM degree?

Sub-Question Two

How do female higher education students in STEM programs describe their reality versus their expectation going into the field?

Setting and Participants

Setting

The setting of my study was conducted virtually, with the interviews and a focus group were both recorded and transcribed using Microsoft Teams program. The research participants were from the West Georgia area, but may have received their degrees from elsewhere in the United States within the last 25 years. The research participants were graduates who hold their

STEM degree at any level. Although the participants were not located at a single site, the most important aspect is that they all experienced the phenomenon attributed to the study (Creswell & Poth, 2018).

Participants

This study included 10 participants through convenience or snowball sampling. A pre-screening questionnaire was provided to persons identified by means of networking with colleagues who know prospective females who have graduated with a degree in a STEM field. Moustakas (1994) indicated that a sample size of 10-25 participants is recommended for phenomenological research designs. Participant identification and recruitment ceased when the pool of participants was saturated. Saturation occurs when additional data gathering will no longer produce new insights or properties into the topic of research (Creswell & Creswell, 2018). The participants selected were STEM graduates at any degree level, 25 years or less since degree completion in the United States. First, a survey was provided for prospective participants to confidentially answer for appropriate participant identification purposes. Gender was an identifying factor because the study was about the challenges STEM FHESs have experienced in their degree programs. The research participant's degree held degrees in any of the fields of science, technology, engineering, or mathematics and are considered by higher education to be a STEM degree. An extensive list of STEM degrees offered in the United States is provided on the Department of Homeland Securities website at https://www.ice.gov/sevis/students. However, for the purposes of this research study I have provided an abbreviated list of the leading categories. Participants were identified as having completed a degree in one of the following categories: Sciences, Engineering, Biological and Biomedical Sciences, Mathematics and Statistics and Physical Sciences.

Although age and ethnicity are not immediately identified as factors, a variation of research participants were identified by a recruitment questionnaire (Appendix B), by asking their age, race, employment, and degree earned. Recruitment ceased when a saturation of participants was achieved. Saturation occurred when increasing the number of research participants would not yield additional pertinent information for my study.

Researcher Positionality

I chose to conduct a hermeneutic phenomenological research study because I was interested in telling the lived experience descriptions of women who obtained their STEM degree in higher education. I recognize my individual experiences and positionality to my study throughout my continuing education and realize any personal thoughts or feelings I possess as the researcher. I have taken into consideration my personal experiences, when I interpreted the meanings of the research participant's lived experience descriptions. I identified my positionality throughout my study and continued to recognize my values and personal biases based on my own experiences, which I might have had pertaining to the subject of study.

Interpretive Framework

This exploration of the lived experiences and perceptions of challenges for FHESs must draw on a theory that captures the paradigm of a social constructivist interpretive framework. Social constructivism is a paradigm that asserts that meaning is subjective, and individuals construct meaning through interaction (Creswell & Poth, 2018). The theory of self-efficacy (Bandura, 1977) provided a lens to examine the experiences and perceptions of FHESs. Finally, feminist theory (Sharma, 2019) provided a historical perspective of females in STEM education and their challenges they encountered because of their gender and race.

Philosophical Assumptions

Philosophical assumptions are important to address in a qualitative research study because they play a role in the researcher's decisions (Creswell & Poth, 2018). In this section I discuss my personal philosophical assumptions: ontological, epistemological, axiological, and methodological. An important purpose for understanding the philosophical assumptions of the researcher is to provide a coherent report of the researcher's findings (Creswell & Poth, 2018).

Ontological

The question is to determine what the nature of reality is. The ontological assumption links the nature of reality and its characteristics (Creswell & Poth, 2018). I understand that reality can be viewed as a multi-faceted characteristic of a participant's perspective. I recognize that each participant may perceive their experiences of challenges in their STEM degree studies differently. As different perspectives of the findings began to emerge as themes, I reported those themes to further develop findings.

Epistemological

Minimizing me and the research participant's separateness is important in obtaining the subjective experience of the participant (Creswell & Poth, 2018). The epistemological assumption provides the subjective experiences of the research participants according to their individual experiences (Creswell & Poth, 2018). I realize the importance of gathering subjective data from the research participants by spending extended time with the participants. My research study included several hours spent with the research participants for information gathering. I then followed up with the research participants, to review the transcripts of their individual interviews, to check the information for accuracy.

Axiological

Axiological assumptions relate to the researchers' biases and values (Cresswell & Poth,

2018). As a qualitative researcher who adopted hermeneutical phenomenology as the research method, I realize that my research is value-laden and my biases about the study are present, shared, and influenced my interpretation of data. I am aware that I went into this research study as a woman who possessed subjective values and biases about my own experiences while in a higher education degree program. However, I took steps to ensure the findings are authentic representations of the participants' lived experiences and the data retrieved was triangulated and checked by the research participants for correctness.

Rhetorical

The rhetorical assumption in a qualitative study is that the researcher will relate the findings through the very words of the participants (Creswell & Poth, 2018). I transcribed the interviews verbatim and provided a rich narrative of the lived experiences of the participants, relying heavily on their own words in the representation of findings in Chapter Four.

Methodological

Methodological assumptions relate to the process employed to ensure interpretations are accurate (Creswell & Poth, 2018). I worked closely with the details and described in detail the methods and context of my study and continually revised my questions as I noticed themes emerging (Creswell & Poth, 2018). I understand that my methodological assumption for this research study was affected by my individual experiences and positionality, in the data collection and analyzation process. I identified my positionality throughout my research study by reporting my values and biases.

Researcher's Role

As a woman doctorate student who has a history of being nurtured in a male-dominated household, I always assumed that males were more intelligent than females. This ideology was

the basis for my academic struggles and to some extent still influences me. I began my college courses later in life, I was 28, and I initially enrolled in pre-med courses. However, I changed my major to psychology, because I had failed chemistry two times and was very discouraged. In reflecting on my experience with failing chemistry, I had spoken to my female colleagues who informed me that the chemistry professor did not like women, and he rarely passed females. I recall how terrible I felt, because my desire to become a medical doctor was thwarted by a male professor. My ideology was formed by my experiences, and they inform me of my values and biases in this research proposal. The idea that males are more intelligent than females might be an ideology that some have, and I was interested in knowing why, how it currently affects women students, and how changes might be made to dispel this ideology and to see female students as equally intelligent as their male counterparts.

Procedures

After obtaining Institutional Review Board (IRB) approval (see Appendix A), the participants were identified by solicitation using convenience and snowball sampling, seeking FHESs willing to participate in a study about their challenging experiences during their degree programs. Convenience-sampling is used to recruit participants who have experienced the same phenomenon (Creswell & Poth, 2018), in this case, of challenges in their STEM degree programs. My study began with prospective participants I identified by convenience and snowball sampling in the West Georgia area.

The study then entailed conversational interviewing and close re-reading of the transcripts and dialogue, followed by written recollections of the experiences shared. Hermeneutic phenomenology uses more than just open-ended interview questions but seeks to inquire in a manner that elicits a deeper mode of questioning: “Language is the only way by

which we can bring the pedagogic experience into a symbolic form that creates by its very discursive nature a conversational relation" (van Manen, 1997, p. 111). Also, unlike social science research where direct observations are made, hermeneutic research requires close phenomenological reflection, meaning that the researcher is as close to the research participants as is ethically possible. The researcher must then analyze the written expression of the participants' recollections with a focus on providing the most detailed accounts of the interviews and observations collected. Hermeneutic phenomenology positions itself not as a social science but as a human science that provides a reflection of life (van Manen, 1997).

Permissions

Once IRB approval was granted, I issued screening questionnaires to identify the research participants who possessed a higher education degree in either science, technology, engineering, or mathematics (STEM). Initially research participants were identified through convenience and snowball sampling of females residing in proximity of the West Georgia area and further identified as a potential participant by reporting: I experienced challenges while in my STEM degree program (Appendix B). Part of the process of conducting research requires obtaining consent from the participants, which I did by providing prospective participants with a letter explaining the procedures for the study and with an informed consent form (Appendix C). This letter explained the nature of the research and explained that the participants could withdraw from the research study without penalty at any time (Creswell & Poth, 2018).

Recruitment Plan

For my study, 10 participants were identified through convenience and snowball sampling. Moustakas (1994) indicated that a sample size of 10–25 participants is recommended for a phenomenological research design. As the researcher of my study, I did not have any

knowledge of the prospective participants from the convenience sample other than their STEM degree status, at any level. Snowball sampling occurred during and after the convenience sampling, by asking the prospective convenience-sampled participants for other prospective participants who may be interested in participating (Creswell & Creswell, 2018; Creswell & Poth, 2018; Gall et al., 2007). Data gathering for this research study ceased when thematic saturation was achieved. Saturation occurs when additional data gathering will no longer produce new insights or properties into the topic of research (Creswell & Creswell, 2018).

Recruitment Questionnaire

In addition to snowball and convenience sampling to identify a pool of potential research participants, I provided a recruitment pre-screening questionnaire (Appendix B). To establish and identify possible research participants, it was necessary to screen for the purpose of researching the problem stated: I am a female who completed my degree in a STEM field and faced unique challenges as a female in the program. The pre-screening questions were as follows:

1) Did you graduate with a higher education degree in a field of science, technology, engineering, or mathematics (STEM)?
2) While in your STEM degree program, did you experience unique challenges as a female student?
3) If you answered yes, to both questions above, would you be interested in being a participant in a research study about female STEM students who experienced unique challenges as a female in the program?

If you would like to be considered as a potential participant in the research study, please answer the following additional questions:

a) What is your age?
b) What is your ethnicity?
c) What higher education STEM degree do you hold?
d) Are you currently employed and if so, where at and what is your position/title?
e) Have you obtained any certifications in addition to your STEM degree and if so, what are the certifications?

Data Collection Plan

For the data collection of my research study, I used the qualitative hermeneutical method, with the use of individual interviews, a focus group, and a reflective writing prompt. Obtaining data from these three sources I achieved triangulation of the study. Triangulation strengthens my study's credibility and dependability. The hermeneutical method used descriptions of the individual experiences of the research participants regarding their challenges during their STEM degree programs. I then developed a list of statements, followed by reflection on the statements, coding of those statements and finally describing the meaning of the lived experience descriptions for the participants. Interviews of the research participants entailed the primary means of data collection, along with researcher observations documented in descriptive and reflective notes followed by phenomenological reflection. Focus group questions are outlined below and are intended to add to the narrative of the research study's purpose. Finally, each participant received a reflective writing prompt to complete. The writing prompt was sent via email from me, and they were asked to respond to me within 3 days of receiving the email. To promote confidentiality, a pseudonym was assigned to each prospective participant. Due to the ongoing COVID-19 pandemic, in-person interviews may not be conducive for the safety of the

researcher and/or research participants, however, one individual interview was conducted face-to-face.

Individual Interviews

I developed the interview questionnaire for the individual interviews according to the information needed for my study. The most pertinent element was that the participants have all experienced the same phenomenon being studied and could articulate it (van Manen, 2016). The individual interviews were audio- and video-recorded either via Microsoft Teams or face-to-face, when appropriate. The same open-ended interview questions (Appendix D) were presented to each research participant. The questions were the following:

Interview Question	Related Research Question
1. Tell me about yourself currently.	(CRQ)
2. Tell me about the influence your childhood family history had on your decision to obtain your degree in STEM.	(SQ1)
3. Describe how your personal experiences influenced your education endeavors in the STEM field?	(SQ1)
4. Describe how your strengths and interests influenced your persistence to complete a STEM degree program.	(CRQ)
5. Describe how your religious beliefs influenced you during your time as a STEM degree student.	(SQ1)
6. Describe your experiences with gendered norms or expectations within your STEM degree program.	(SQ2)

7. Tell me about your positive experiences with the faculty in your STEM degree program.	(CRQ)
8. Tell me about any negative experiences you encountered with faculty in your STEM degree program.	(CRQ)
9. Explain when you decided on your STEM degree choice and why.	(SQ1)
10. Describe what your reality as a female STEM student was compared to what you expected going in.	(SQ2)
11. Describe any challenges you are having or had while in your STEM degree program.	(SQ2)
12. As a female, explain what effect your challenges had on your STEM degree progress.	(CRQ)
13. How did you respond to those challenges?	(CRQ)
14. How do you think you would have responded to your challenges if you were a male?	(SQ2)
15. Describe positive changes you would implement to degree programs that would benefit future female STEM students.	(SQ2)
16. Describe what strategies you utilized to assist in your completion of your STEM degree program.	(SQ2)
17. Please provide any additional information you believe is important to the topic of the reality of the challenges female STEM students face in their degree programs.	(CRQ)

Question 1 established rapport with the research participants and gave them the lead in my research study. This is where knowledge was obtained between the interviewer and interviewee (Creswell & Poth, 2018).

Question 2 defined how the participants' childhood family histories influenced their education decisions and degree choices. This part of the interview attempted to understand the interviewees' points of view in their real-lived experiences of the world (Creswell & Poth, 2018).

Questions 3–9 discussed the pivotal moments in the participants' education, the challenges they faced, and the effect of those challenges on their education. Like Question 2, Questions 3 through 9 built on the interviewee's point of view.

Questions 10 and 16 allowed the participants to make suggestions to help others experiencing the same phenomenon. In practice, universities and institutes of higher education have and are attempting to make changes that facilitate equity for all students, but the literature shows that there are still issues that need to be resolved (Crenshaw et al., 2017).

Finally, Question 17 allowed the research participants and researcher to bring clarity to any questions that emerge from the preceding questions. It also allowed for the research participants to share anything they have not yet discussed (Creswell & Poth, 2018).

Individual Interview Data Analysis Plan

Data analysis was conducted via van Manen's (1997; 2016) hermeneutical method of reflection, clarification, and explicit description of the meaning of the lived experiences of the female STEM degree holders. Transcription of the individual interviews was completed via Microsoft Teams and the transcriptions of the data were reviewed by the research participants for accuracy of reporting for clarification. The hermeneutic method uses descriptions of the

individual experiences of the research participants who have faced challenges in their STEM degree program to develop a list of codes for clarification of the data to mediate the findings and offer a meaning of the lived experience (van Manen, 1997, p. 79). The use of open coding of the responses provided by the research participant's individual interviews was used to assist in the identification of emerging themes. I conducted a holistic reading by reading of the individual interviews as a whole, then followed up with hi-liting of the text and then a line-by-line review of each research participant's individual interviews to seek common words and phrases within the interviews. "Phenomenological themes can be comprehended as structures of the experience" (van Manen, 2016, p. 79). I continued data analysis by using phenomenological reflection with reading and rereading of the transcripts to delineate and list emergent themes specific to the interviews. In literature, a theme is called a motif which occurs frequently in the text (van Manen, 2016). Theme is often referred to as the meaning an author is trying to understand and theme analysis refers to the process of recovering the theme or themes that are contained in the evolving meanings and imagery of the work. Essential themes were identified by using van Manen's holistic reading approach, in which I read the entire text and asked myself "what phrase throughout the whole text captures the main significance of the whole text?" I organized the identified codes from the open coding into emerging themes with codes grouped according to meaning units. I reviewed the themes identified and used imaginative variation to determine if the themes were essential or incidental. To determine if a theme is essential or incidental, I posed this question to each theme (if this were not present or if that was not present, would this theme have emerged?) and continued until a determination could be made to develop an interpretation by relating the themes. Writing and rewriting externalizes internal thoughts and fixes it on paper (van Manen, 2016, p 125). Finally, I penned the aphoristic statements from the

identified essential code themes in an effort to provide an interpretation of the lived experience descriptions.

Focus Groups

Focus groups were conducted following the individual interviews via Microsoft Teams recording and transcription. Focus groups could be advantageous for my research study because the participants may have yielded different information than that voiced in the one-on-one interviews (Creswell & Poth, 2018). The focus group questions (Appendix E) were used to encourage collaboration between the participants in sharing their experiences of a similar phenomenon while in their higher education degree programs. The open-ended focus group discussion questions were the following:

1. As female STEM students, what challenges did you perceive affected you more than your male counterparts in your degree program?
2. Did you perceive any differences in your relationships with female versus male professors and fellow students? Please explain.
3. Did you experience additional stressors because of the societal norms and expectations that are placed on females as students in STEM? Please explain.
4. What advice could you provide to other females who are facing similar challenges in the STEM degree program?

The first question in the focus group provided an open floor for each participant to share their experiences of the challenges they faced or endured. Sharing challenges built rapport between the participants and supported collaboration. The second and third questions allowed the participants to share their own perceptions of any differences experienced in their degree programs because of their gender. The fourth question gave each participant an opportunity to

provide students facing challenges with ideas for how to deal with them.

Focus Group Data Analysis Plan

Like the interviews, analysis of data generated from the focus groups was conducted via van Manen's (1997; 2016) hermeneutical method of reflection, clarification, and explicit description of the meaning of the lived experiences of the female STEM degree holders. Transcription of the individual interviews was completed via Microsoft Teams and the transcriptions of the data were reviewed by the research participants for accuracy of reporting for clarification. The hermeneutic method uses descriptions of the individual experiences of the research participants who have faced challenges in their STEM degree program to develop a list of codes for clarification of the data to mediate the findings and offer a meaning of the lived experience (van Manen, 1997, p. 79). The use of open coding of the responses provided by the research participants individual interviews were used to assist in the identification of emerging themes. "Phenomenological themes can be comprehended as structures of the experience" (van Manen, 2016, p. 79). I conducted a holistic reading by reading the focus group transcription as a whole, then followed up with hi-liting of the text and then a line-by-line review of the focus group transcription to identify common words and phrases within the group. I continued data analysis by using phenomenological reflection by reading and rereading the transcripts to delineate and list emergent themes. In literature, a theme is called a motif which occurs frequently in the text (van Manen, 2016). Theme is often referred to as the meaning an author is trying to understand and theme analysis refers to the process of recovering the theme or themes that are contained in the evolving meanings and imagery of the work. Essential themes were identified by using van Manen's holistic reading approach, in which I read the entire text and asked myself "what phrase throughout the whole text captures the main significance of the whole

text?" I then listed the identified codes from the open coding of emerging themes and then grouped them into meaning units. I reviewed the themes identified and I used imaginative variation to determine if the themes were essential or incidental. To determine if a theme was essential or incidental, I posed this question to each theme (if this were not present or if that was not present, would this theme have emerged?) and continued until a determination could be made to develop an interpretation by relating those themes. Writing and rewriting externalizes internal thoughts and fixes it on paper (van Manen, 2016, p 125). Finally, I penned the aphoristic statements from the identified essential themes in an effort to provide an interpretation of the lived experience descriptions. Followed up by writing an explicit description of the lived experienced descriptions (LED).

Reflective Writing

At the conclusion of the individual interviews and the focus group, the research participants were emailed a reflective writing prompt (see Appendix F). They were requested to read the writing prompt, reflect on their participation in my study, and return their reply via email within 3 days of receipt. A part of hermeneutical phenomenology is obtaining the Lived Experience Description (LED) from the research participant, this is completed by requesting that the participant write a description of their lived experience, while abstaining from generalizations (van Manen, 2016). The prompt is the following: "Write a description of a challenging experience you recall while you were in your STEM degree program. Provide the following information in your descriptive account of the experience: Your feelings, mood, emotions, setting, the time of day/night, time of year, duration of time, during the experience."

Reflective Writing Data Analysis Plan

Just like the interview and focus group data, analysis of the reflective writings was conducted via van Manen's (1997; 2016) hermeneutical method of reflection, clarification, and explicit description of the meaning of the lived experiences of the female STEM degree holders. Transcription of the individual interviews was completed via Microsoft Teams and the transcriptions of the data were reviewed by the research participants for accuracy of reporting for clarification. The hermeneutic method uses descriptions of the individual experiences of the research participants who have faced challenges in their STEM degree program to develop a list of codes for clarification of the data to mediate the findings and offer a meaning of the lived experience (van Manen, 1997, p. 79). The use of open coding of the responses provided by the research participants written responses was used to assist in the identification of emerging themes. I conducted a holistic reading by reading the written responses as a whole, then followed up with hi-liting of the text and then a line-by-line review of each research participant's responses to seek common words and phrases within the reflective writing responses. "Phenomenological themes can be comprehended as structures of the experience" (van Manen, 2016, p. 79). I continued data analysis by using phenomenological reflection with reading and rereading of the transcripts to delineate and list emergent themes (see Appendix G). In literature, a theme is called a motif which occurs frequently in the text (van Manen, 2016). Theme is often referred to the meaning an author is trying to understand and theme analysis refers to the process of recovering the theme or themes that are contained in the evolving meanings and imagery of the work. Essential themes will be identified by using van Manen's holistic reading approach, in which I read the entire text and ask myself "what phrase throughout the whole text captures the main significance of the whole text?" After I created a list from the open coding and emerging

themes, I grouped them into meaning units (see Appendix H). I reviewed the themes identified and I used imaginative variation to determine if the themes were essential or incidental. To determine if a theme is essential or incidental, I posed this question to each theme (if this were not present or if that was not present, would this theme have emerged?) and continued until a determination could be made to develop an interpretation by relating those themes. Writing and rewriting externalizes internal thoughts and fixes it on paper (van Manen, 2016, p 125). Finally, I penned the aphoristic statements from the identified essential code themes in an effort to provide an interpretation of the lived experience descriptions.

Data Synthesis

Data synthesis was achieved by triangulating the data collected and themes generated from the analysis of individual interviews, focus group and the reflective writing. The data synthesis for this research study was conducted using van Manen's (1997) hermeneutical method: "The insight into the essence of a phenomenon involves a process of reflectively appropriating, of clarifying, and of making explicit the structure of meaning of the lived experience" (p. 77).

Phenomenological Reflection and Writing

Synthesizing of the research data was conducted using a holistic approach in which I concurrently reflected on and considered the emergent themes identified from all three data sources. According to van Manen (2016), synthesizing data is completed in a circular manner referred to as a "validating circle of inquiry" (van Manen, 2016, p. 27). During this synthesizing of the data, I kept a journal of my own thoughts and opinions about experiences that were presented during my deep reflection and considered my own experiences as a part of the analysis. "…the phenomenologist knows that one's own experiences are also the possible

experiences of others" (van Manen, 2016, p. 53). I had my own experiences as a former STEM student and the struggles I faced as a female in a male-dominated program. I eventually became discouraged by those experiences and changed to a non-STEM major. "The purpose of phenomenological reflection is to try to grasp the essential meaning of something" (van Manen, 2016, p. 77). Grasping the essential meaning was carried out by immersing myself in the data collected from the three sources and reflecting on the statements concurrently. I used the process of writing and rewriting as I kept a strong and oriented place amongst the phenomenon while comparing the whole to the parts of the text and vice versa. As I was immersed in the texts, I considered how the emergent themes and parts contributed to my understanding of the phenomenon. Unlike transcendental phenomenology which seeks to describe a lived experience, hermeneutical phenomenology seeks to interpret the lived experience (van Manen, 1990). According to van Manen (2016), the duty of phenomenological research is to assemble a possible interpretation of the nature of a certain lived experience. Each text was read and reflected on separately, significant statements from each data were noted and I then synthesized the data from all three sources to interpret the essential meanings of the lived experience descriptions and finally provided a textual interpretive report of my findings.

Trustworthiness

For a research study to be considered trustworthy, the researcher must address a number of items to determine whether the research can be considered credible, dependable, transferable, and confirmable. Creswell and Poth (2018) stated that validation is the idea that the research is well-grounded and supported. Trustworthiness can be established by conducting measures of credibility, dependability, and confirmability.

Credibility

Descriptive richness is one item van Manen (2016) lists as a method of gauging the credibility of the information reported in a study. My study was grounded in valid open-ended phenomenological questions and used the method outlined by van Manen (2016) to test its level of validity. Van Manen (2016) provided questions to ensure a credible source is used to conduct a study. For example, one question asks, "Is the research appropriately grounded in primary and scholarly phenomenological literature?" The triangulation of three different data sources (individual interviews, a focus group, and a reflective writing prompt) helped me validate the data retrieved and analyzed. Participants were also provided with the entire transcript of their interview and the findings, to validate the accuracy of the reporting.

Transferability

The information from the research is transferable if it is likely that the study can be found relevant in other situations or populations (Creswell & Creswell, 2018). This hermeneutical phenomenological research study examined a phenomenon experienced and perceived by females in their STEM degree programs. The results of my study are considered trustworthy if they can be transferred to other contexts through the concentrated, clear descriptions of those who have experienced the same phenomenon. A variation of research participants was identified via the pre-screening recruitment questionnaire (Appendix B), by asking their age, race, employment, and degree earned. Each participant was asked the same set of questions and had the same opportunity to email or text with follow-up information and were provided with the transcript of their individual interview for review. Each participant was also given a questionnaire and reflective writing prompt in the appendix to allow future researchers to utilize these same techniques

Dependability

To strengthen the dependability of the research participants, the researcher must engage in prolonged engagement and observation in the field of study (Peoples, 2021). To strengthen the dependability of the research participants, the researcher must engage in prolonged engagement and observation in the field of study (Peoples, 2021). In addition, I kept a reflective journal to write down any thoughts or feelings I had about the phenomenon. Journaling helped identify any views or biases, as a researcher with similar experiences as the participants, that I may have and recognized this during the data analysis. For this phenomenological research study, each item was supported through phenomenological reflection of the data retrieved and provided an interpretation of the lived experienced descriptions (LED).

Confirmability

A means to confirm the data collected during the study is important; in this case, the researcher could conduct follow-up interviews with the research participants to clarify or confirm the analysis of the data (Peoples, 2021). Triangulation of the data was done by providing an illumination of the lived experience description (LED) account of the participants' information of the same phenomena. Providing an audit trail of this research study (see Appendix H), participants reviewed the transcripts of their interviews, followed by a written interpretation at the conclusion of my study.

Ethical Considerations

As the researcher, I abided by all identified ethical considerations during the procedures of my study, as some of the research questions could have caused negativity. I obtained IRB approval prior to conducting the proposed research study. The prospective research participants were provided with a typed notification form outlining the purpose of the research, and an informed consent form. For this research, the participants were referred to by using pseudonyms

to ensure confidentiality. The identity of each research participant and the pre-interview questionnaires will be kept in a locked file cabinet and destroyed after 3 years. The files will be kept in a password-protected database and deleted after 3 years. Any documentation provided by the research participants, along with the names found by their pseudonym, will also be kept in a locked cabinet and destroyed after 3 years. As the continued, and if other ethical considerations arise, I would have presented those to the IRB for further guidance and/or approval, if warranted.

Summary

The purpose of this hermeneutic phenomenological study was to understand the challenges FHESs experience in their higher education studies and their determination to successfully complete their degree programs. This chapter has supplied the research questions for my study, the setting, participants, procedures, and outlined the researcher's role. Data collection was triangulated to strengthen the credibility and dependability of the study, to confirm the accuracy of the participant interviews and focus group summaries. My own reflective journal entries will be shared so that my study can be duplicated or transferred by another researcher. Finally, this chapter outlined and explained the ethical considerations so that participant identities and transcripts would remain anonymous. All data and identifying information will be kept confidential and destroyed 3 years after this research study.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this hermeneutic phenomenological study was to understand the challenges female higher education students (FHESs) experience in science, technology, engineering, and mathematics (STEM) programs of study. Challenges for females in higher education continue to exist despite institutes of higher education attempting to make changes to facilitate equity amongst all students, and those challenges can have a negative impact on female students (Alsop & Clisby, 2019; Huerta, 2017; Sekścińska et al., 2016).

This chapter describes each research participant, followed by a discussion of the emergent themes discovered from the data collected during their individual interview, reflective written responses and the focus group. Finally, this research study's questions are discussed along with a description of the essence of the experience of the challenges for the FHES while in their degree programs followed by a discussion of their motivation to complete their degrees successfully.

Participants

The research participants for this study were solocited after receiving IRB approval (see Appendix A). The methods of convenience and snowball sampling were both used to solicit and obtain the research participants. The pre-screening recruitment questionnaire can be found by referring to Appendix B. Demographics of the research participants are outlined below in Table 2 and the demographic survey can also be found in Appendix B. Twenty-five protentional participants were solicited, eleven replied with their informed consent, and ten of those eleven took part in my research study. Soliciting for additional research participants was not necessary because thematic saturation was met and adding more participants would not add new data for

the benefit of this study's purpose (Creswell & Creswell, 2018). Participant's STEM degrees ranged from an associate to a doctorate STEM degree. Of the ten participants, one held an associate, five a bachelor, two a master and two a doctorate, as shown in Table 2 below.

Table 2

Participant Demographics

Participant	Age	Race	Degree/STEM Area	Working In STEM
Kaia	25	Caucasian	Associate of Diagnostic Medical Sonography	yes
Megan	26	Caucasian	Bachelor of Science Ecology	no
Rudina	22	Caucasian	Bachelor of Science Mathematics	no
Indie	47	Caucasian	Bachelor of Chemical Engineering	yes
Morgan	23	Caucasian	Bachelor of Science Biology and Integrated Science	yes
Kennedy	51	Persian/White	Bachelor of Computer Science and Mathematics	yes

Melody	26	Caucasian	Master of Science Economics	no
Holly	27	Caucasian	Master of Biological Sciences	yes
Rachel	40	Caucasian	Doctorate Veterinary Medicine	yes
Sabrina	43	Caucasian	Doctor of Medicine	yes

Kaia

Kaia graduated with her Associate of Science degree in diagnostic medical sonography and is now working at a local hospital. Kaia indicated that her degree program was predominately female, but she chose the degree because of her desire to work in the field. In discussing the challenges she experienced as a STEM student Kaia explained that she struggled with the balance of her homelife and school, “I feel like a lot falls on the female when dealing with those situations, those situations being childcare, and having to take time off, take kids to and from school, stuff like that”.

Megan

Megan obtained her Bachelor of Science in ecology. After she obtained bachelor degree in ecology she went on to obtain her juris doctorate and is now an environmental attorney for the Environmental Protection Agency in the District of Columbia. In discussing how she handled challenges while in her STEM degree program, Megan elaborated, ” I'm very good at picking things that I know I will do well at, some work you know may not be immediately great, but eventually I know that I can do well.”

Rudina

Rudina has a Bachelor of Science in mathematics and her future endeavor is to work for the United States Air Force research lab. Rudina is currently working on completing her master's degree in Mathematics. She is attending a university distant from her family and friends, which she indicates is stressful. In addition to completing her coursework for her graduate degree, she has been accepted and is concurrently working on her PhD in mathematics. When asked about how she coped with her stressors in her degree programs Rudina replied that for her, therapy was helpful in being successful in her program.

Indie

Indie has a bachelor of chemical engineering degree. When she made the decision to go into a STEM degree, Indie knew that she was entering into a field that was male-dominated, but chemical engineering was what she wanted to do. Indie described a challenging experience while in her STEM degree, "I had never in my life received what would be equivalent to a C, yet here I was looking down at my paper where a number three was written. I felt embarrassed, angry, disappointed in myself and overall, upset."

Morgan

Morgan's STEM degree is a bachelor in integrated sciences and biology. Morgan is currently pursuing her master's degree in her teaching interest for sciences, in the public-school setting. While concurrently earning her master's degree in teaching, Morgan is teaching physics and biology at a local public high school. According to Morgan the time constraints and demands of her time during her degree program presented the greatest challenge was, "the comparison between the amount of work that I had and that of my friends, who were not in a STEM degree. Many of my friends had a lot of free time, and I did not have much free time."

Kennedy

Kennedy holds two STEM degrees, a bachelor in computer science and a bachelor in mathematics. Kennedy is currently a math teacher and works at a private school teaching 6th through 12th grade mathematics. Initially, Kennedy went to school and obtained her computer science degree, but after having a child, she had to stay home. Not feeling confident in her decision to work in computer science, Kennedy decided to pursue her degree in mathematics to teach, which was what she wanted to do in Iran, because more females are teachers. Kennedy described her childhood education experience growing up in Iran as a female, she wanted to major in math but she was told that she could not. The high school told her that she will be given a major based on the grade she made but Kennedy believed that they did not give her the right grade.

Melody

Although Melody's STEM degree is a master of science in economics, she continued and obtained her juris doctorate and is currently working as an attorney for the Department of Justice. In describing her experience with her peer interactions early on in her STEM degree, Melody reported, "I think there was an expectation that I had better notes and that I would help people more", she went on to explain that because she was a female that was the perception male peers had of her.

Holly

Holly holds a master of science in biological sciences and is currently working at a Pain Management Clinic. According to Holly when asked about the challenges she experienced while in her STEM degree program, she explained that the most challenging part of getting her degree was the work-school-life balance. "While completing my degree, my responsibilities included

my full-time job as a clinic manager, part-time job as a teaching assistant, responsibilities at home such as cooking, cleaning, and remodeling, and completing my schoolwork on time."

Rachel

Rachel is a doctor of veterinary medicine and obtained her undergraduate STEM degree in biology and went on to veterinary school. Rachel reported that the field of veterinary medicine is now predominately female but that she chose the field out of her desire to work with animals. In response to the question of gendered experiences she replied, "I feel like I would have gotten a little bit more respect if I was a man."

Sabrina

Sabrina is a medical doctor and has her own private practice. The stress of the requirements of her residency during her STEM degree program is described by Sabrina on one of her most stressful days, "I sat down against the wall and cried my eyes out", she went on to explain that she had so many things in her personal life to take care of that the time demands took its toll. Sabrina felt as if it was impossible to ask a student to work overtime, when she was already giving 100% to what she was doing for her patients, but not her own home.

Results

This and the following sections discuss the results of this study's data analysis. Data was retrieved through structured individual interviews, a focus group, and reflective writing responses. The individual interviews and focus group were video and audio recorded and transcribed via the use of Microsoft Teams. Individual interviews were conducted between 40 minutes to an hour and the focus group lasted for two hours. All three data collection methods were triangulated to identify emergent themes within and between the participant's responses. Open coding of all data was conducted using van Manen's (1990) holistic, line by line and

reflective approaches. After coding of the data was conducted, themes were identified through the careful reading, re-reading, highlighting and reflection of the data retrieved. The themes supply a written account of the essence of the lived experiences of the challenges that the female STEM research participants had while in their degree programs. The emergent themes found during analysis of the three data sets (individual interviews, focus group and reflective writing) are listed according to the corresponding research question it addresses (see Appendix G).

Triangulation of the data was achieved by the reading, re-reading, hi-liting of the three data sets: individual interviews (see Appendix D), focus group (see Appendix E) and reflective writing responses (see Appendix F) of the data retrieved from the research participants. The data was then cross-examined between the three sets of data to identify the similar meanings of words and phrases within and between the data. The transcripts from all three data sets were carefully calculated by the numbers of accounts that similar words and phrases were present within and between the three complete data sets as shown in Table 3 below.

Table 3

Open Codes Table

Code	# of Responses	Total # of Responses	Emergent Theme
Perceived Gender Bias In Program	Interview: 33 Focus Group: 22 Reflective Writing: 4	59	Silent Gender Bias

Experiences of Gendered Role Expectations	Interview: 4 Focus Group: 11 Reflective Writing:7	22	Gendered Role Expectations
Perception of not belonging due to Being a female	Interview: 5 Focus Group: 3 Reflective Writing: 3	11	Impostor Phenomenon
Negative Faulty Experiences	Interview: 2 Focus Group: 3 Reflective Writing: 6	11	Faculty Relations
Perception of Unique Female Program Bias	Interview: 20 Focus Group: 2 Reflective Writing:16	38	Program Requirements/Demands Time/Academics/ Responsibilities
Degree Choice Was Important	Interview: 20 Focus Group:2	22	Strengths/Interests

	Reflective Writing:0		
Family Support Was Important	Interview: 19 Focus Group: 4 Reflective Writing:0	23	Family Support
Peer Support Was Important	Interview: 14 Focus Group: 3 Reflective Writing:0	17	Peer Support
Faculty Support Was Important	Interview: 13 Focus Group: 5 Reflective Writing:0	18	Faculty Support
#Coded Responses		**221**	

Analysis of the research participants' individual interviews illuminated similar phrases and words as those identified in the focus group and participant's reflective writings. Similar codes were discovered and compared within and between the focus group and the reflective written responses. Given the nature of the individual intervews, the research participants were provided an opportunity to openly discuss their initimate details of the challenges experienced while in their STEM degree program.

The focus group was analyzed and compared to the individual interview data and the reflective written responses, which yielded phrases and words also found in the focus group and the written responses. The focus group, which was completed after the individual interviews, allowed the research participants to reflect on their individual interviews and thus prepared them to recall and share their experiences with one another during the focus group. Coding of the focus group data, provided similar codes to those also found in the individual interviews and the reflective written responses.

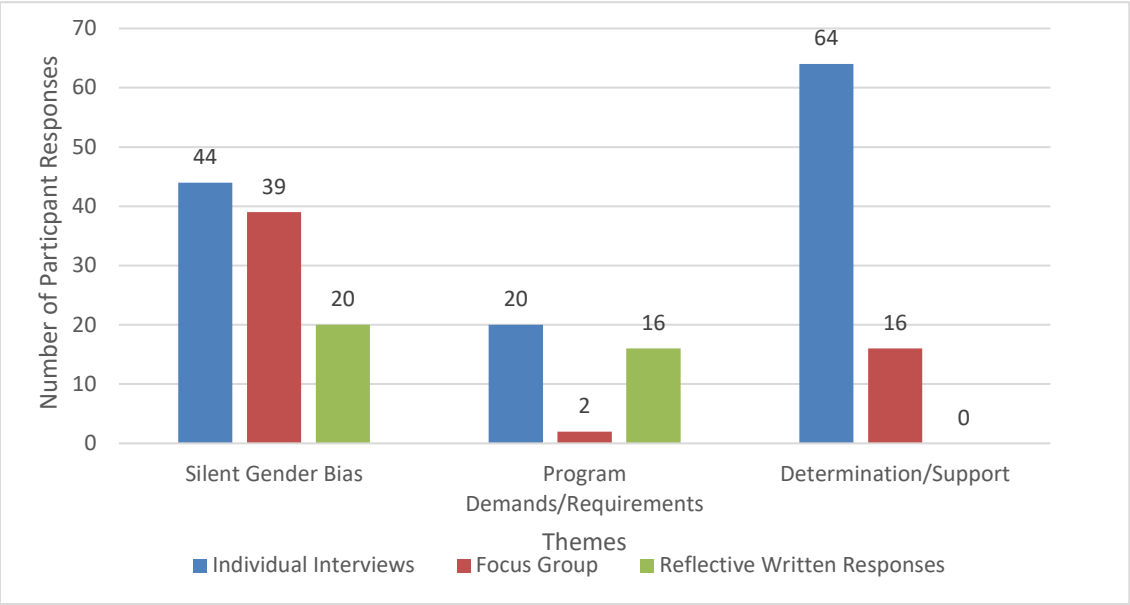
Written reflective responses were also analyzed by identifying similar phrases and words as those found aross all three data sets. As with the individual interviews and the focus group, coding illuminated similar codes to those found within and between the three complete data sets. The written response prompt provided the research participants with a time to reflect on and produce an intimate account of their time as a STEM degree student. Themes emerged from the analysis of the data sets and the most prominent themes are discussed below.

Theme Development

Transcripts from the individual interviews, focus group and the reflective written responses were triangulated within and between, by the reading and hi-liting of similar words and phrases, which produced the calculation needed to identify the emergent themes. Figure 1 below displays the calculation of the times that each related word and/or phrase were stated in each set of data.

Figure 1

Emergent Themes from Open Coding



As a result from the open coding of my research data, I was then able to identify shared emergent themes triangulated across all three data sets. The dominant themes that emerged from the three data sets were: silent gender bias, program requirements/demands, and determination/support. In addition to the three major themes identified, sub themes were also identified and are described below. The challenges that the research participants reported were also accompanied by self-efficacy based on their interests and abilities and the support received, to complete the STEM degree of their choice. The essence of those experiences of self-efficacy to complete their degree are also provided below.

Theme 1: Silent Gender Bias

All ten research participants described experiences of a silent gender bias while in their STEM degree programs. Silent gender bias is defined as any experience that one perceives to be gender bias but is not explicitly recognizable as gender bias. Another term for silent gender bias

was defined by Bruce et al. (2015) as covert discrimination, which includes subtle nuances like double-standards, discouragement, or biased referral opportunities.

Sub-theme (a): Gendered Role Expectations

Research participants described experiences of being misrecognized in their degree roles because they are a female. One participant explained that during her rotations in the hospital during her medical school tenure, she was wearing her scrubs and she was recognized as a nurse rather than a physician, due to her gender. Sabrina described this experience , “When I walked in to a room of a patient they would call me nurse. There was expectations that because I was a female, I wasn't a doctor.” Rachel had a similar experience of a gendered expeciation as a female veternarian, she said, “And this is just maybe from my experience, but I feel like I would have gotten a little bit more respect if I was a man. It’s from that kind of point, like, that doctor-client mentality.” Megan also expressed perceiving that her male classmates were expected to perform better, “Seeing my friends who are primarily male in that class succeeding much faster when it came to ecology, I think often the guys in the class were expected to do better than the women.”

All of the research participants acknowledged that when they decided to enter a STEM degree program, that it would be male-dominated or used to be a male-dominated field, with that exception being the diagnostic medical sonographer and veterinarian medicine. However, they felt it was disappointing yet important for them to be recognized outside of a constructed gender role, like being a female medicial doctor or veterinarian, or perceiving that male STEM students are expected to perform better than the females.

Sub-theme (b): Language and Behavior

A sub-theme to silent gender bias is language and the experience that the research participants described due to the comments or behaviors of a professor or fellow male

classmates. Melody explained that she was an outspoken woman during her tenure as a STEM degree student, so that she would ensure she could not be ignored in a male-dominated classroom, "….if they wanted to pretend like I didn't belong….you know, I was just another woman, like, trying to take up their time, I was gonna do it because….I deserved their attention just like any other person." This affirmed the importance for a female to be able to use her voice to gain the respect and attention in a male-dominated classroom. The language and behavior of a male professor can have long-lasting negative affects on a FHES. For instance, Rachel recalled an incident with one of her male professors during her neurology rotation when she did not know the answer to the question she was posed by that professor.

> He actually literally punched me in the shoulder. And this is with my other colleagues. My classmates are all circled around….I hated neurology, hated it. And I think it had a lot to do with that. You know, it had a lot to do with that negative experience with that professor.

Rachel further elaborated about her expectations going in to her program and the reality of her veterinary program like this, "I didn't feel like there was a difference being a female versus a male. I never felt there was any adversity compared to the other students. The guys just got more attention, because there were so few numbers." Although veterinarian medicine is now predominately a female STEM field, it was observed that the few males in her program received the majority of the professors attention.

More related to the language side of this sub-theme was the report of the seasoned male professors, lectures, and the antiquated curriculum being used for the program. Megan's description of her reality in her STEM degree program was like this, "I expected to find a program still new but….somewhat structured. And a mix of having a lot of field experience and

like a lot of like traditional lectures just….a very typical science program." Megan was disappointed that the curriculum and structures were antiquated. The majority of the professors were male and had been in their position for a long time and were still teaching the degree program with outdated material. Outdated higher education textbooks and material were often written using a male lens and patriarchal views (Lindquist et al., 2019), which contributes to the challenges females experience in STEM degree fields of study.

Sub-theme (c): Impostor phenomenon

Some research participants described experiences of not feeling as if they belong because of the program consisting of predominately male faculty and students. Being able to identify with and connect with female faculty and students was minimal but described as important to most research participants. Rudina described her experience while in her STEM degree program, "I ended up going to therapy for anxiety which helped a lot, you know [with] the feelings of like imposter syndrome. There's nothing my program could have done to make me feel like I belonged anymore."

Although Indie reported that she did not experience gender bias or discrimination while in her STEM degree program, which was predominately male, she did report a sense that her and her few female colleagues were competing against their male colleagues in the program. According to Indie, "I could say that we [females] probably all had a lot to prove. You know, as far as the women in the group, it seemed like we were in general, a lot more competent." Indie's experience of the reality versus her expectations of her STEM degree program was described as follows, "My expectations were more general knowing that there were gonna be a like a few [women]." Indie said she was pleasantly surprised that in chemical engineering there were a few more women in the freshman classes compared to other engineering degree progams. "When you

broke it down by major, that's where you saw the difference. Like engineering, there were 1 or 2 women in the freshman class, whereas, for chemical engineering it was more like maybe 5 to 7."

Kennedy provided a different perspective on her experience as a female STEM student. Kennedy explained that in Shiraz, where she grew up, it was considered normal for girls to study math and computer programming from an early age. "When I was in high school you could choose the major of science or math, but I remember my parents went around telling me that math was for male and not female." Although she was interested in pursusing a math degree, she was discouraged in Iran. "So, when I came to the United States from Iran in 1994 to pursue a Bachelor of Computer Science, I was surprised by how few American women attended the University."

Sub-theme (d): Faculty Relations

Participants reported that their relationships with their professors made an impact on their experience as a STEM student. The impact can either come from a negative experience or positive experience with their professors. For this section I am focusing on the negative influences that difficult faculty relations had on some research participants. The benefits of positive relations with faculty are discussed in the section entitled determination/support.

Melody recalled an experience when she asked for clarification from her physics professor "it altered my approach to the class and made me second guess my interactions with professors in the future." Melody went on to elaborate on the event, "When my physics professor made an off-handed comment to me during an experiment. The experience lasted maybe five minutes, but definitely marred my time at that institution." Melody explained that when she asked for the clarification of the experiment he got loud and exclaimed that she wasn't in high school, which left her embarassed. "He spoke loud

enough for everyone to hear. I don't remember anyone pausing to stare, I felt like the center of attention in a negative way. It took a lot for me not to cry or leave the room." This had a lasting negative view of her relationships with her professors throughout her time as a STEM degree student.

Faculty support is important in the retention of STEM degree students (Posselt, 2018), however, some research participants reported experiences of not feeling supported. Morgan describes her experiences in her STEM degree: "I recall not feeling much support from many of my professors. Most of them just seemed to want to push people along in the program." Morgan believed that some of her professors did not take her seriously when they learned she was going into education and not the medical field with her STEM degree. As mentioned, according to Bruce et al. (2015), this description of a silent gender bias left her feeling discouraged and what she felt was a biased referral opportunity.

It is important for females to identify as a higher education student rather than a female higher education student, but that is difficult when the majority of faculty members in STEM remain male. Being able to identify with a female professor helps connect female STEM degree students with their faculty. Farland-Smith (2015) suggest that providing a female mentor to female STEM students can help them feel empowered in their degree program. Melody reported difficulty in finding a connection with faculty, "I didn't have a single female professor in my entire masters program either, so I think that goes into some of it as well as, right like, there wasn't any faculty support."

Theme 2: Program Requirements/Demands

Participants describe that compared to their male colleagues, the program requirements and demands had more of an impact on them due to the expectations of female responsibilities at

home. Research participants reported experiences of perceiving their STEM degree program being more difficult than their peers who were in non-STEM degree programs. The majority of the participants describe how difficult the academics were, but also the amount of time the program required. Time away from family, their home, their friends and the amount of time required for studying, clinicals, and time in the field.

Sub-theme (a): Time Constraints

The amount of time that their degree programs required of them was mentioned by all participants. Participants recalled, the amount of homework, the time for clinicals and rotations, the amount of time for studying, were all challenges during their STEM degree program. As mentioned in her introduction, according to Morgan she felt as if her degree required much more time than her friends who were studying other degrees. Morgan felt as if the amount of coursework and time that she had to spend compared to her peers, made the degree attainment more difficult. Morgan also reported , “All of my science classes had labs and so I'd be taking a full semester of classes. But then I'd also have these labs. So it felt like double the amount of classes that you're supposed to be taking.” Rachel remembered how she would want to call her family for support and just talk because she would be up late studying, but realized they would not be awake, “Mostly I would stay up late at night studying and doing what I needed to do once everyone else is probably in bed, I put a lot of long hours into it.”

Sub-theme (b): Difficulty and Demand of Academia

All of the research participants recalled how difficult the demands of their STEM degree programs were for them. Difficulties included being away from friends and family, or the difficulty in the subject matter they were studying. Participants frequently mentioned the difficulty of the subject matter and the effect it had on them compare to their male colleagues.

However, the challenges of the difficulty and demands of the program were not all perceived to be less difficult for the males but the demands placed hardships on them as a female compared to their male colleagues due to gender-role expectations as described in Theme 2: Sub-theme (a) above.

Holly described her experience as a STEM degree student as such, “Completing my school work on time and to the best of my abilities, became my greatest challenge.” Holly went on to say that she observed a difference in the amount of stressors female students had compared to those of her male peers. “The males had jobs, but most only worked part-time and did not seem to have the same responsibilities nor stress as the females in my class had.”

The requirements of Kaia’s program as a diagnotice medical sonographer required completion of clinicals that could not be made up. Kaia described her experience of challenges as a STEM student, “The main challenge that I feel like I experienced was going through a STEM program as a mother. There was not much forgiveness when it came to missing lectures or clinical hours.” When her son became ill and was hospitalized she was not allowed to make up lectures and had to make up clinical hours. According to Kaia, “It definitely made me lose a lot of respect for my school and the program itself.” Kaia explained how the program she was in, was unforgiving when it came to the requirements of rotations, “It was hard, especially going through….my clinical rotation. Having young kids and things that I had to deal with that my male classmates didn't, because I was the mom and the female, it was automatically my responsibility.” Despite these challenges and with family supporting her, she was able to successfully complete her degree.

Rachel recalled the rigor of her veterinarian program, which did not allow for absences during any part of the program or she would have been dismissed, “After four months of

rigorous classes, labs, and studying, we had to endure one week of persistent testing on all the information we learned during that time. I remember being very stressed, tired, and anxious." Megan's experiences in her degree program left her feeling jealous of her friends who did not appear to be struggling with their academics like she was, "After sitting at the table with my friends all day, they both got up to go to a concert. This one last test felt like a culmination of my entire life and I was genuinely terrified I'd fail." Megan continued, "I vividly recall the day before my Spring Semester General Chemistry II final exam. The afternoon before the exam, I felt anxious enough to vomit, yet simultaneously numb – as if my brain were existing outside of my body."

Indie recalled a course in her degree program that she had difficulty in and how it made her feel, "Calculus did not prepare me in the least. I had never in my life received what would be equivalent to a C. I felt embarrassed, angry, disappointed in myself and overall upset. There was also a sense of disbelief." Indie further elaborated, that during her time as a STEM degree student majoring in chemical engineering, she struggled with the difficulty of the coursework, "Calculus II was such a difficult class and I ended up regretting not having retaken Calculus I. I will never forget when the professor handed back our first quiz." Indie recalled how frustrated she felt at making a C on her first quiz and could not believe how difficult the content was.

Program requirements for Alex while she was in med school did not allow for absences or it would result in dismissal from the program or taking the entire course section over. Alex reflected on her most memorable times during her STEM degree program, "One of the worst days of training came within my residency program for the internal medicine program. How are they allowed to say "oh you're working all night tonight by the way" and there be no way to say "no". Alex believed that the demands of the program were too

much and that she was expected to devote her entire life to her residency program. She explained that she still had responsibilities at home but that she felt like it didn't matter to the department heads over the medical program.

Kaia explained how the program she was in, was unforgiving when it came to the requirements of rotations, "It was hard, especially going through….my clinical rotation. Having young kids and things that I had to deal with that my male classmates didn't, because I was the mom and the female, it was automatically my responsibility."

Sub-theme (c): Home and Children Responsibilities

A recurrent word within most of the research participants was care. Care for their family and children was a frequent challenge during their STEM degree programs. Some of the themes overlapped, especially with gendered role expectations and program demands and requirements. This study illuminated the participant's responses describing a patriarchal view that females continue to be viewed differently in higher education and society, in the area of STEM. Rachel's experiences in her STEM degree program were self-reported as this, "My biggest challenge was being somewhat disconnected from my family and friends, that was the hardest. I came across many challenges in my degree program, but I believed it helped shape me into the strong woman I am today." Kaia explained the difficulties she faced with having the responsibilities of being a mother while in her STEM degree program, "It just makes it seem so much harder when I face the challenges that come along with raising a child during this time. I would notice my classmates with no kids, or that were male, were mostly stress free." Holly recounted how she struggled with the many responsibilities that she had to cover while finishing up her degree, "The most challenging part of getting my degree was work-school-life balance. While completing my degree, I had a full time and a part time job, as well as, responsibilities at home."

Theme 3: Determination/Support

Despite the challenges participants experienced while in their degree programs, all of the participants explained where their motivation to successfully complete their degree came from. Participants reported their insipiration to enter into a STEM degree was influenced by their strengths and interests, family encouragement, and the support they received from their family, peers and faculty, to make their decision. During times of challenges while in their programs, each participant explained how they overcame those challenges, some attributed their success as being fueled by their strengths and interests, while others attributed it to the support and encouragement they received from their family, peers, and sometimes faculty.

All of the participants expressed the importance of relational supports during their degree program. Such as Indie who reported on finishing successfully, "Maintaining these relationships with people I knew would help me, who had the same goals and work ethic." Rachel reflected on how she was able to complete her degree, "Strength in a way, is that usually if I go for something, I don't give up.". Melody explained her tenacity to finish, "I think it kind of goes back to that perseverance, like I just wasn't willing to give up, because I wasn't willing to sacrifice not being able to finish the degree.", Rudina explained her influence came from within, "Having a strong personality, in the sense of when I've decided in my life that things matter to me, I was able to push very hard despite adversity.", Holly recalled how peers can be helpful, "Being able to connect with your fellow students was that, and staying focused, and and having a goal and making sure you made it.", Kaia, the most recent STEM degree graduate recalled how she finished successfully, "I used as many family members to help as I could I use myself mostly I would stay up late at night studying and doing what I needed to do.", as mentioned previously

in her interview, Megan received support from her mentor professor, which helped her to succeed.

Sub-theme (a): Strengths and Interests

Research participants explained that their decision and persistence to complete a STEM program degree was based on their strengths and interests in their particular degree. For example, Rudina recalled why she decided on her STEM degree choice, "I've always been good at math and science." Rudina further explained about her determination to complete her degree, "I wanted it so bad and I loved math so much that I was willing to push through. Having developed a love for math and for logical thinking allowed me to keep pushing despite adversity."

Having a choice to do what they were interested in and not having the barrier of a male-only program requirement was important to all of the research participants. Kennedy explained her choice to obtain a computer science degree and a math degree, "I have degrees in math and computer science. I was always interested in math," Kennedy went on to explain further, "Since I was a very logical person in my first degree, my computer science degree, I tried to use what I really like, so since I was a people-person, I decided to become a teacher." Another participant, Indie, recalled that her success came from her interest in chemical engineering, "If I think back it just all kind of fell into place. And chemical engineering, at the time, just was of the science degrees was the most interesting to me." Indie went on to explain her choice of degrees this way, "So my dad, his advice was, as long as you get a degree in engineering and then get your MBA, you can really do anything you want. I enjoyed chemistry, and the chemical industry was an interest to me."

Rachel recalled her interest in becoming a doctor of veterinary medicine, “My mom had a like a little booklet that and she would put….little memories or landmarks or pictures in it. It said, what do you want to be when you grow up? And I put veterinarian.” Kaia, described her interest and determination for becoming a diagnostic medical sonographer, “…. it was challenging navigating through it all, but I just knew that if I kept pushing through that it would be worth it. I have a lot of determination when it comes to….my goals, so I wasn't gonna give up.” Megan talked about her reason for choosing a science degree in Ecology, “I guess the answer is, I found math very difficult and I found science with math pretty difficult, but when I got to college…. making sense of ecology, just came very naturally easy to me.” Morgan’s reality versus her expectations in her STEM degree program are described like this, ”The reality is that I'm a lot more prepared to teach biology than I am all of the things in the integrated sciences, because I'm overall like more interested in biology.”

Sub-theme (b): Family Support

The majority of research participants reported that their parent(s) supported and encouraged their decisions on choosing a STEM degree program. Rudina reported that both of her parents were instrumental in influencing her to pursue a STEM degree, “….so I am super fortunate to have a very strong and tough mom and a very good dad. some of my earliest childhood memories are my dad trying to teach me mathematical concepts like long division at age 6.”

Morgan recalled how she decided on her choice to pursue a science STEM degree and then a teaching degree, “I got my undergrad degree in integrated sciences and biology.” However, Morgan explained that she desired to work as a teacher and teach high school science. Some of her family members told her she would not be able to make as much money as a teacher

than working in a STEM field. However, when she told her dad that she wanted to teach he made the comment, “oh my gosh, you're gonna be such a good teacher.” This was all the encouragement and influence she needed to pursue a teaching certification degree after obtaining her STEM degree.

Megan described how her mom influenced her decision to study science, “My mom was a stay at home mom and she was really invested in taking us to the zoo. She made sure we went outside and explored our natural surroundings.” Holly, who holds a master’s in the biological sciences reported, “Neither of my parents had a degree past an associates and they sort of pushed me to to do more than what they've done.” She went on to say that she was always interested in sciences, biology, health and she was really intrigued in those subjects.

Melody, who holds a Juris Doctorate and is an attorney for the Department of Justice, explained her interest in a STEM degree choice in economics this way, “I wanted something that had more stability in a profession, something that I could get a job that I could keep. That's part of the reason why I got a STEM degree, so I could support the Juris Doctorate.”

Sabrina had a different take on her family influence and her decision to become a medical doctor,

> My dad is a dentist and I enjoyed the sense of community that he had with his patients and the people near us. I took an anatomy class and fell in love with that and how amazing the body is. And so that's the reason I chose medicine.

Rachel holds a doctorate in veterinary medicine and described her choice to pursue her STEM degree, “Pretty much I've always wanted to work with animals my entire life.” She went on to tell how her family has always been so supportive, no matter what. Rachel’s sister influenced and supported her choice to pursue a doctorate in veterinary medicine because she

herself is a veterinarian. “So that kind of helped me go along in that direction, because she did it and I had a little bit of an inside on what goes on in vet school, and what you have to deal with a little bit.”

Sub-theme (c): Peer Support

Participants said that their peers were an important source of support during their time as a student and how valuable it was to have those relationships. Rudina reported on the manner in which her peers helped her through her STEM degree program, “Spending good time with friends who are honest about their struggling, without realizing that I'm not alone in this, those are all the things that help me keep going despite waking up everyday with kind of a desire to quit.” Rudina described her reality versus her expectations as a female STEM student as such, “I thought there were gonna be a lot more women. I was really hoping for more women. That was the expectation, the reality is, what I haven't found in quantity, I've found in quality.” Rudina went on and said that she enjoys her feminist-at-heart girlfriends and was disappointed that she did not find the numbers of female peer students she expected.

The importance of peer support for FHES’s is evident as Indie described her sense of discomfort while in her male-dominated engineering program. Indie talked about her need for peer support while in her STEM degree program, “These environments that may not feel comfortable to us. They may feel difficult or challenging. It’s hard if you don't get out of your shell. you have to find those people with common ground, but also the common determination.” Indie believes that it is important to find peers within your degree program to connect with and have a common interest in, when feeling challenged.

Sub-theme (d): Faculty Support

Two of the participants reported that they were successful due to the support they received from a professor or other university faculty. These participant's shared the importance of having a faculty professor or faculty advisor who was supportive in helping them to pursue the STEM degree of their choice. Also, how they perceived their professors in the classroom had an impact on how supported they felt as a female STEM student.

Megan explained her experience when she was registering for her STEM degree, "the faculty advisor was just this really bubbly woman and like I was talking to her and she….was just like so kind and so encouraging and really really supportive." Megan also disclosed a valuable relationship she had with her male mentor professor who helped her be successful while pursuing her ecology degree, "Through his support, you know, I think his support in what I was interested in, the field, is really how I was able to succeed in the ways that I did." Sabrina was happy that the classes were smaller when she was in her medical program and enjoyed her professors, "the professors were eager to teach and you could tell a lot of them were happy to be there ….they were there because they really enjoyed teaching smaller classes."

Responses to Research Questions

This section offers answers to the research questions for this study. The research questions consist of a central research question, followed by two sub-questions aligned with the themes emergent in all three data sets. Appendix H provides a matrix of how each theme is related to this study's research questions. Participant en vivo responses to each research question

are provided for clarity of of support of my interpretation of the essence of the participant experiences based on the findings of my research.

Central Research Question

How do female higher education students describe their lived experiences in their STEM degree programs? All ten participants were in different STEM programs of study and in different universities within Georgia. However, the essence of their experiences are much the same as the others. Participants described experiences of gender bias which was not explicit but a silent gender bias. Participant's perceptions of a gender bias were noted between and within all three data sets: individual interviews, focus group and their reflective written responses. Sub-themes identified within the study are gendered role expectations, language/behavior, impostor symdome and faculty relations.

The partcipant's statements below help to describe the essence of the experiences of a silent gender bias while in their STEM degree programs. Statements reflecting the essence of the participant's personal experiences, such as Kenndy stated, "I was thinking that math was not for women", Indie said, "I could say that we probably all had a lot to prove, as far as the women in the group", Rachel recalled, "I feel like I would have gotten a little bit more respect if I was a man", Rudina explained, "it's a very strange sense of entitlement, like they all deserve to be there [men]", Megan said, "I think often the guys in the class were expected to do better than the girls", Megan went on further to explain, "there's nothing my program could have done to make me feel like I belonged anymore", Morgan reflected, "I feel like a lot of the men in my classes cheated their way through", Holly recalled, "they would focus more on the success of the male students in there just based on the who the professor was teaching the class", Melody reflected,

“I think it could be that, you know, he wouldn’t have treated a man the same way” and Sabrina reflected, “there was expectations that because I was a female that I wasn’t a doctor”.

Sub-Question One

How do female higher education students describe the influence their personal history had on their choice to pursue a higher education STEM degree. Across the three data sets, family, strengths and interests were the top answers in each participant’s reason to choose a higher degree in STEM. The essence of the participant’s experience was described in a reflective mode, looking back in to their memories of how they were influenced to pursue a degree in a STEM field. Nine out of the ten particpants credited their family members for having an influence on their decision, and the importance of the need for support. Kaia talked about how support from her family influended her, “I feel like growing up I've always been surrounded by a bunch of strong and powerful women and they have shown me that women can truly make an impact on the world and we can go after things just as much as men can in that field.” She went on to say, “I always knew that I could pursue anything if I put my mind to it and didn't give up.”

Sub-Question Two

How do female higher education students in STEM programs describe their reality versus their expectation going into the field. Despite the challenges faced by the research participants while in their degree programs, they all reported reasons for their determination to keep going to completion. Participants described in especial terms and phrases their intrinsic desire to complete their STEM degree programs successfully or receiving support from family, peers or faculty. Nine out of the ten participants responded that their reality versus their expectations of their degree programs was about what they expected. All ten participants faced challenges unique to their gender but had the determination to continue and successfully complete their degrees. The

essence of their reality for the participants was how they expressed the importance of having support during their experiences of challenges in their programs. Sabrina provided this intimate recollection, “I remember my mom saying to me, do not let one class stand between you and what you dream of.”, Morgan recalled a time when she called her mom during a time when she was struggling, “And I was like, I just wanna drop out. Like, this is so stupid. Like, just overwhelmed and my mom would be like, Nope, you're so close.”

This section provided an intimate description of the essence of the research participant’s experiences while in their STEM degree programs. Each participant’s individual background and life circumstance created a variety of answers to analyze. The analysis of the three sets of data for this study illuminated three emergent themes within and between the participants responses to this study’s research questions. The emergent themes each had sub-themes (see Appendix G) which were also shared between the research participants and the essence of each were provided.

Summary

The data retrieval, analysis of the data, and completion of my study provide an intimate description of the essence of each research participant’s experiences of challenges faced during their time as a female STEM degree student and their strategies of determination that led them to successfully complete their program. Eight of the ten research participants acknowledged that they knew their STEM degree program was mostly male-dominated when they enrolled, they challenged themselves because of their interest in their degree choice. Two of the ten research participants chose a STEM degree based on their interest in the field, but did so despite the fact that the field is now mostly a female dominated degree. The prominent themes and sub-themes that emerged from my study are as follows: Theme 1: silent gender bias; Sub-themes: (a)

gendered role expectations, (b) language/behavior, (c) impostor phenomenon, (d) faculty relations. Theme 2: program demands/requirements; Sub-themes: (a) time constraints, (b) difficulty of program, (c) home and child responsibilities. Theme 3: determination; Sub-themes: (a) strengths and interests; (b) peer support, (c) family support, (d) faculty support.

CHAPTER FIVE: CONCLUSION

Overview

The purpose of this hermeneutic phenomenological study was to understand the challenges female higher education students (FHESs) experience in science, technology, engineering, and mathematics (STEM) programs of study. The following chapter describes my interpretation of my research findings and how those results compare to previous research of the experiences of female STEM degree students. The implications for policy and practice by higher educational STEM programs are provided as well. The theoretical and methodological implications are discussed. My study limitations and delimitations are discussed followed up with my recommendations for possible future research.

Discussion

Results from this research study illuminated the essence of the experiences of challenges for female STEM degree students while in their programs of study. Participants successfully completed their STEM degree programs despite wanting to quit or give up at times. The determination of participants to continue until completion came from their interests, strengths, family and peer support, faculty support and having a self-efficacy (Badura, 1977) to reach their academic goals. Challenges experienced by the participants were described as: a sense of either not belonging due to underlying gender biases or the perception that their male peers were expected to perform better and had a sense of entitlement, challenges due to the time constraint and demand requirements of the program, the difficulty of the academics, faculty and peer relations, family and child care obligations. Despite the challenges the participants experienced, they were determined to complete their degree program and credited their success to intrinsic motivators and support from peers, family and faculty. The next section provides a discussion of

the interpretation of the findings of this study, the implications for policy and practice, the theoretical implications, the limitations and delimitations and my recommendations for future research.

Interpretation of Findings

The use of Van Manen's (1977) methodology for this hermeneutic phenomenological study conducted to explore and interpret the challenges that female STEM degree holders experiences while in their degree program. The theoretical frameworks for this study were Bandura's (1977) theory of self-efficacy and the post-modern feminist theory (Sharma, 2019). Participant experiences as a female higher education STEM degree student were shared openly during their individual interviews, with the focus group and in their reflective written responses. During the analysis of the data retrieved from the participants of this study, the themes emerged as prevalent and similar phrases and words shared between and within the data sets. In this section I provide a brief summary of those themes accompanied by the sub-themes, based on information reported by the research participants.

Summary of Thematic Findings

Research participants shared intimate, open accounts of their challenges while in their STEM degree programs. Participants shared their desires to enter their fields of study were based on their strengths and interests for the subject and the support they received, be it biology, human medicine, mathematics, chemical engineering, veterinary medicine, computer science, sonography, it was their choice because it was what they wanted to do. They knew that there were going to be challenges but each participant had the determination to complete and meet their personal endeavor as a STEM degree holder. Participants provided intimate accounts of the support they received during challenging times while in their programs.

Awareness of Silent Gender Bias

The most predominant theme that emerged from this study was a silent gender bias experienced by all of the research participants. This theme was categorized into three sub-themes, (a) Gendered Role Expectations, (b) Language and Behavior, and (c) Impostor phenomenon, to help create a clarity and understanding of the essence of the participant's experience.

The essence of the research particpant's lived experiences indicate that there continues to be events of a silent gender bias towards females in male dominated fields of STEM study. Despite the advances, recruitment events for females to enter into the STEM higher degree programs, the experiences of gender bias still exist in higher education degree programs. As reported in this study, female STEM students used terms such as "entitlement", "expected", "respect", when referring to their male counterparts in classes. Participants also used terms such as "prove", "impostor", "singled-out", when referring to how they perceived themselves compared to their male peers in class.

Despite feeling like an "impostor" or having to "prove" themselves compared to their male peers or feeling "singled-out" by a male professor, these participants were determined to finish and they did. Having the determination to complete against these challenges is supported by the theoreticial framework I used for this study and that is Badura's (1977) theory of self efficacy, "Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences" (p. 194).

Importance of Personal Strengths and Interests

The background of each of the ten participants was diverse and therefore their responses to this question were diverse too. Eight out of the ten partcipants agreed that their family

member(s) had influence on their degree choice and supported and encouraged them to enter into a STEM degree field. Participants described having family that provided opportunities for them to pique their interests in the STEM field from a young age. The next most predominant theme was the determination of the STEM degree holders, their Strengths and Interests, their Peer Support, their Family Support, their Faculty Support, were consistent within and between all participants abilities to successfully complete their programs.

For example, Megan recalled how her mom helped to fuel her interest in the sciences, "We went to our local museum often for their IMAX movies so that was an experience that I had growing up and they were very encouraging of me exploring that field." Rudina credited both her dad and her mom for providing a home environment that nurtured her talents and interest in the STEM fields of study, "My momma's impact, she was always very feminist forward, very encouraging of us pursuing education and being a strong woman to my sisters and I growing up."

This question and the answers are supported by the theory of post-modern feminism in that females are now encouraged to pursue degrees that in the past were primarily male-dominated. "Being stereotyped as less competent by society implies that girls and women need more encouragement to develop a secure self-efficacy" (Tellhed et al., 2016, p. 93). It is encouraging to note that the research participants received support not only from the females in their lives but also their dads, to pursue the degree of their choice.

Reality Versus Expectation of Program

Most of the research participants responded that their reality going into their STEM degree program was closely aligned to what their expectation of the experience was going to be. Another predominant theme of this study was the demands of the program and the requirements of the program, which fell into three sub-themes, time constraints, difficulty of academia, home

and child responsibilities, again, breaking the demands and requirements down into categories helps to create an understanding of the theme.

All of the participants reported that they knew going in to their STEM degree choice, that it would have its challenges. Most of the participants indicated that the amount of time and the difficulty of the academics was the greatest challenge. There were two participants who were mothers and reported that caring for their child presented the greatest challenge for them. Two participants stated that they had difficulty with the home, school and life balance, due to being married, having a household, having a pet to care for, presented challenges. Time away from their family, friends, home, child, pets, church families, were difficult but necessary due to the demands and requirements of the STEM degree program. Their time consisted of having to study longer than their peers who were not in a STEM program of study. In addition to studying more, having to do clinicals, rotations, and labs took up more time than that of their peers in other degree programs.

Implications for Policy or Practice

The emergent themes of this study discussed above, provided important information about the essence of the real-lived experiences of ten female STEM degree holders. Participants reported instances of being the recipient of silent gender biases while in their programs, challenges due to the demands and requirements that come with obtaining a STEM degree and participants share their determination factors to continue the program to a successful complete and degree obtainment.

Implications for Policy

The results of this research study provide an insight in the need for institutes of higher education to continue to amend and improve equitable practices in recruitment, treatment of, and

retention of, female STEM degree students. Specifically, the results of this study illuminated the need for improvements to the policies on diversity, equity and inclusion (DEI). for non-traditional students in male-dominated programs in institutes of higher education. Despite the opportunities to attend STEM degree programs and the outreach and support provided by institutes of higher education to potential female students, the essence of the experiences of this study's participants indicate that females continue to be challenged by silent gender biases, challenges with responsibilities at home and challenges with academic program demands and requirements.

The implications of the results of this study illuminate the importance for institutes of higher education to continue and improve opportunities for the betterment of female students in their programs (Alsop & Clisby, 2019; Sekścińska et al., 2016.) One recommendation is the need for creating an awareness of the challenges that female students are still experiencing unique to their male counterparts, based on their gender. This recommendation is relevant due to this study's research participants reporting feelings of "not belonging", "male students got more attention", "as females we felt like we had more to prove", "feelings of…impostor phenomenon." Faculty in institutes of higher education should continue to receive training, awareness and understand that female students continue to struggle with feelings of not belonging, compared to their male colleagues.

Implications for Practice

During the analysis of the three data sets for this study, participants reported the impact that their relationships with their STEM degree program faculty advisors and professors had on them during their tenure as a student. Those impactful moments were reported as either positive or negative in nature and the essence of their experiences was noted during analysis. One of the

key factors in a student's degree completion is feeling supported by faculty and faculty members who are involved in their higher education (Ghandi-Lee et al., 2017). While it is clear that relationships between female STEM degree students can have a positive or negative impact on their achievement. It is important to note the importance that student relationships with professors and faculty in higher education have an impact on students while in their degree programs. Each of the research participants for this study chose their degree programs based off of their strengths and interests and love for the subject matter. Therefore, it would be fitting for all faculty in higher education to provide the support and encouragement (Ghandi-Lee et al., 2017) of female STEM degree choosers. Support from faculty in higher education could be implemented by being aware of their classroom practices and their attitudes toward students. This awareness could be an important factor in the retention of underrepresented STEM students.

The recommendation based on the evidence from this study is for faculty to receive awareness training on the experiences that female STEM students are having while in their degree programs and training on how to provide support to those students. Institutes of higher education should provide a holistic approach to supporting the underrepresented students during the admission process and recognize not only the academic but the psychosocial strengths that applicants possess (Posselt, 2018). This does not indicate that females entering an institute of higher education with another degree program choice should not be afforded that same courtesy, as the results of this study may generalize to other degree programs.

Theoretical and Emiprical Implications

The following section discusses how the theoretical frameworks used for this study are applied to the interpretation of the results. In addition, the empirical implications of the results of this study are discussed below. Bandura's (1977) theory of self-efficacy and post-modern

feminism (Sharma, 2019), frame the results of this research study. Participants freely responded and shared intimate details of their experiences as a female STEM degree student. Their responses indicated they were determined to finish their degree and that despite facing unique challenges as a female in a sometimes male-dominated field of study, they were successful. This section will illuminate the connections between the research findings of this study and the theoretical and empirical literature provided in Chapter 2.

Theoretical Implications

The theoretical framework for this study was an integration of Bandura's (1977) theory of self-efficay and the post-modern feminist theory (Sharma, 2019). Both theories and how they framed this study are discussed briefly in this next section. Implications that arose as a result of this study provided concern for female STEM degree students and the challenges reported by the research participants. Those concerns were experiences of gender bias, unforgiving program demands and requirements and the need for support while in the STEM degree program.

Theory of self-efficacy. Bandura's (1977) theory of self-efficacy, posits that one's ability to persist was assigned a central role in analyzing changes achieved through fearful and avoidant behavior. Self-efficacy was recognized as a possible explanation for how people differ in their perceived abilities to accomplish their desired goals in the face of challenges: "Efficacy expectations determine how much effort people will expend and how long they will persist in the face of obstacles and aversive experiences" (Bandura, 1977, p. 194). Bandura (2012) also noted that "forms of self-efficacy are for navigating the journey, not just for reaching the destination" (p. 32). During the retrieval and analysis of each participant's reported experiences, their motivation was noted, and the essence of their experience was interpreted.

Research participants shared intimate accounts of the emotional toll it took on them due to the pressures of keeping up a home-life balance, the time constraints and demands of their programs, also shared the support they received from family, friends, mentors, advisors and professors, which was important to their journey. As STEM student's progress through their degree programs, self-efficacy is important, and a part of the higher education journey is productivity which requires the self-efficacy to complete….and finish the degree (Kuchynka et al., 2018). This research study affirmed the need for female students in a non-female dominated degree program, to have positive support from the faculty at higher education institute.

Post-modern feminist theory. The other theoreticial framework for this study was post-modern feminism which is concerned with language and social discourse's impact on society's understanding of women (Sharma, 2019). Acker (1992) found that problems in higher education are variously stemmed from gendered socialization, family versus career conflict, lack of investment in women's education, sex discrimination, career structures, capitalism, and patriarchy, which can be perpetuated by religious views.

Participants responses, the emergent themes derived and the descriptions of the essence of their experiences support the post-modern feminist theory. Participants reported being impacted by the demeanor of their male professors and their male peers while in their STEM degree programs. Other participants shared their experiences of being gendered by others based on the role that they were perceived to have been in the capacity of rather than their true role. One participant who was completing clinical rotations was often overlooked as the doctor but was rather identified as the nurse to her patients. In addition, this same participant went on to explain that her male colleagues who were working in the capacity of a nurse, were identified by patients as the doctor. Another participant who is a doctor of veterinary medicine experienced a

similar event. While conducting her animal patient care during vet school, she reported that she observed her male colleagues receiving more attention and appeared to have more respect than her, when she was acting in the same role.

What is striking about both of these accounts is that although advances have been and are being made in the inequity of gendered roles, is that in the past twenty five years, female STEM students are still having to prove their role identity. In addition, the female STEM students also struggled to earn the same recognition and respect as their male colleagues who are acquiring the same education and training as they have.

An interesting find from this study is that the research participants all mentioned that they were aware that in the past their pursuit of a STEM degree was a male-dominated field but that is changing. Each participant acknowledged the changes in the demographics of the STEM fields of study compared to ten or twenty years prior to their entry into their degree programs. Also of interest is that two of the participants reported that their STEM field degree of choice is now a female-dominated program. The diagnostic sonographer reported that there were no males in her program of study while she was completing her degree and the doctor of veterinary medicine reported that females were the majority of the students in her degree program, but that the few men in her program received the most attention. She went on to explain that while entering her veterinary program she was walking a hall of her school and it was lined with graduates of the same program and how, for many years, they were all males but now mostly females.

Research participants who reported experiencing perceptions and feelings of gender bias in their programs, being impacted by the language and behaviors of their male professors and peers, or feeling like an impostor, like they did not belong, were able to persevere.

This study supported the study by Farland-Smith (2015), which listed the following reasons why female students did not choose to enter a STEM field of study: a lack of female identity in STEM, gender stereotyping of females who are interested in STEM, limited family flexibility in STEM activities early on, and females lacking a sense of belonging in STEM fields.

This study also affirmed the following: The future for underrepresented students in STEM studies continues to evolve, as equitable practices by institutes of higher education are implemented (Alsop & Clisby, 2019; Sekścińska et al., 2016) and as strategies to attract and promote participation by underrepresented females in STEM (Farland-Smith, 2015) continue.

Empirical Implications

The participants of this research study hold a STEM degree obtained within the past twenty five years at a university within these United States. The information that was received and analyzed provided a variety of experiences of challenges while in their degree programs, accompanied by their determination to successfully finish. The implication is that universities and their faculty continue to create unique challenges to their female STEM degree students. Participants reported their experiences of unique challenges due to biases, and at times, a lack of support or empathy for their home/life responsibilities.

The essence of those experiences and the interpretation of their experiences can help indicate how female STEM students are perceiving themselves in these programs, what challenges are the most impactful to them during their tenure as a STEM student and their determination to keep going. Results of this study indicate that female STEM degree students continue to experience gender bias from their male faculty and peers, or at least they report a perception of a silent gender bias. This study supports the strategies outlined by Farland-Smith

(2015) that can help educators to attract and promote participation of underrepresented students in the STEM studies:

1) Exposing underrepresented female students to the STEM studies in early education programs can help pique their interest in STEM.
2) Providing female role models for underrepresented students can help them feel empowered.
3) Share the history of females in the STEM studies primary to teaching solely about historical male figures in STEM.
4) Finally, keep a check on hidden biases toward either female or male STEM students and create a culture of acceptance.

Higher education students who perceive that the institution's faculty are invested in their degree completion are more likely to be successful (Posselt, 2018). In addition, these research participants reported feeling "anxious", "tired", "exhausted", "stressed", due to the program demands and requirements of their time. Participants reported that their work load consumed much more time than their peers who were not in a STEM degree program. Due to the demands and requirements of their programs, particpants reported the time took away from their time needed for home and child responsibilities, time away from their friends, family and church. This study also supports the empirical findings of Tellhed et al. (2016), that girls and women need encouragement when faced with gendered stereotypes and when encouragement is received, it develops their self-efficacy. The participants for this study ranged in from 25 to 51 years of age.ldest. The longest holding STEM degree participant graduated 25 years prior to this study and the youngest graduated in 2022. Institutes of higher education have made some progress in thwarting gendered issues, yet they still exist and warrant continued research attention (Schwortz

& Burrows, 2021). As suggested by Schwortz & Burrows, 2021, this study was conducted to illuminate the continuing gendered issues in higher education. This study therefore, provides the evidence that female STEM degree holders continue to face unique challenges due to their gender, as recent as 2022. In addition, this study provides evidence that continued attention must be given to reports of gender issues and making faculty aware that those experiences of bias occur.

Limitations and Delimitations

One limitation of this study is the participation rate for this study. Twenty-one potentional research participants were solicited, eleven committed to the study and of those eleven, ten actively participated. Ten participated in their individual interviews, seven participated in the focus group and nine participated in the reflective writing porition of this study. Ideally, each participant would have participated in all three portions of the study, but for reasons unknown, did not participate in its entirety.

This study was conducted retrospectively rather than with female STEM students who actively in their degree program, which presents another limitation of this study. Studying students while they are actively in their degree program may provide a perspective with different experiences than those who have already obtained a STEM degree. In addition, this study was limited to ten STEM degree programs, when there are some 300 STEM degrees recognized and listed by the Department of Homeland Security's website (https://www.ice.gov/sevis/students). This limited this study's range of STEM programs and the implication of this is that perhaps studying a wider variety of STEM degrees will provide more perspective on this research topic.

Another limitation of this study is that the convenience and snowballing recruitment limited the amount of participants I solicited for this study. Due to the limited recruitment, the

only identified and committed participants were nine white and one Persian-white female. A more purposeful solicitation of participants might have yielded a more diverse demographic of female STEM degree holders. Purposeful sampling in one identified university STEM degree program, soliciting for non-white female participants, or purposeful sampling for the study should also be considered for future research. In addition, this study did not include non-caucasion STEM degree holders, which presents another limitation for this study. This limits the perspectives of non-white females and their experiences of challenges and their perceptions of those challenges while in their STEM degree programs.

Delimitations were purposely placed on this research study in order to manage the data obtained so that it would be most relevant to this research study's purpose. I chose to conduct a hermeneutic phenomenological research study in order to explore and interpret the real-lived experiences of the research participants of this study. Research participants had the opportunity to freely explain their experiences of their challenges and their perceptions of those experiences.

Another delimitation of this research study was the theoretical framework that I chose. Bandura's (1977) theory of self-efficacy was chosen to assist in the understanding of and interpretation of the research participants experiences. The participants provided rich textural descriptions of their challenges and how despite those challenges, they found the self-efficacy to continue on to successful completion of their degree program. Also, this study was framed by choosing a post-feminist lens to analyze and interpret the research participants responses through. A post-feminist theory is concerned with language and social discourse's impact on society's understanding of women (Sharma, 2019).

Recommendations for Future Research

In reflective consideration of my study's findings and limitations, there were several questions that this research study did not cover, but should be considered for future research. My study was conducted with the participation of 10 race-reported white females. Future research consideration might be conducted by the solicitation of females who identify as non-white, to delineate any differences in reported challenges in their STEM degree program compared to those reported in this study of white female STEM degree holders. In addition, consideration should be given to studying the real-lived experiences of male STEM degree holders and non-white male STEM degree holders. Further study could be conducted to explore what female STEM degree holders experience when they enter the STEM workforce. Another suggestion is a study to compare and contrast the same groups, non-white female, male, non-white male, might be conducted to explore any similarities and differences in their experiences as a STEM degree student or STEM degree holder.

While this study was conducted using a hermeneutic phenomenological research method (van Manen, 1997; 2016) with the intent of illuminating and providing an interpretation of the essence of the participant's experiences, I might suggest that future studies might implement a transcendental phenomenological design (van Manen, 1990) to provide a rich textural description of their experiences. Another recommendation would be to conduct a research case study of a specific STEM degree program that has a higher than average female representation, such as the doctor of veterinary medicine or the diagnostic medical sonographer, to determine the best practices for recruiting and retainment of students.

Conclusion

This study was conducted to illuminate the challenges female STEM degree holders experienced while in their program. The research participants ($N = 10$) were STEM degree holders and the study was framed using Badura's (1977) theory of self-efficacy and post-modern feminist theory (Sharma, 2019). Research participants successfully completed their STEM degree program despite the unique challenges they reported based on being a female. It was the ambition of my research to build on the studies of female higher educational students endeavors. Clearly there are still needed changes to the socialization of females performing in what have historically been male-dominated fields of study.

Open coding of all data was conducted using van Manen's (1990) holilstic, line by line and reflective approaches. The use of triangulating the transcripts provided the calculation of the predominant words and/or phrases within and between the three data sets of this study. After coding of the data was conducted, themes were discovered through the consideration of the results of the calculation of the number of words and phrases in the transcriots, and again the careful reading, re-reading, hi-liting and reflection of the data retrieved.

The most profound takeaways from my research study on the challenges that female STEM degrees experience in their program are: (a) Female students continue to experience gender bias within and between their different STEM degree programs and, (b) female students continue to struggle with constraints on their responsibilities with a homelife and school balance. These takeaways are important because of the continued need for institutes of higher education to continue and improve the experiences of female STEM degree students while in their degree program.

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APPENDIX A: IRB APPROVAL LETTER

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

August 10, 2022

Rebecca Keeter-Lee

Rebecca Bowman

Re: IRB Exemption - IRB-FY21-22-1218 THE LIVED EXPERIENCES OF CHALLENGES FACED BY FEMALE STEM DEGREE HOLDERS WHILE IN THEIR PROGRAMS: A PHENOMENOLOGICAL STUDY

Dear Rebecca Keeter-Lee, Rebecca Bowman,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(iii). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by §46.111(a)(7).

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,

G. Michele Baker, MA, CIP

Administrative Chair of Institutional Research

Research Ethics Office

APPENDIX B: PRE-SCREENING RECRUITMENT QUESTIONNAIRE

1) Did you graduate with a higher education degree in a field of science, technology, engineering, or mathematics (STEM)?
2) While in your STEM degree program, did you experience unique challenges as a female student?
3) If you answered yes, to both questions above, would you be interested in being a participant in a research study about female STEM students who experienced unique challenges as a female in the program?

If you would like to be considered as a potential participant in the research study, please answer the following additional questions:

a) What is your age?
b) What is your ethnicity?
c) What higher education STEM degree do you hold?
d) Are you currently employed and if so, where at and what is your position/title?
e) Have you obtained any certifications in addition to your STEM degree and if so, what are the certifications?

APPENDIX C: PARTICIPANT LETTER AND INFORMED CONSENT

Title of the Research Project:

THE LIVED EXPERIENCES OF CHALLENGES FACED BY FEMALE STEM DEGREE HOLDERS WHILE IN THEIR PROGRAMS:
A PHENOMENOLOGICAL STUDY

Researcher: Rebecca Keeter-Lee, M.A.T., Doctoral Candidate, Liberty University School of Education.

Invitation To Be a Part of This Research Study

You are invited to be a part of this research study because you meet the criteria sought for my study. Participation is voluntary and you can withdraw from this research study, without obligation or repercussions, at any time. Criteria for my study include, being a female and having completed a higher education degree in a science, technology, engineering, or mathematics (STEM) field.

Risks Involved in Participation

No risks are identified for participants who participate in this research study. Participation in this research study poses no risks that would not normally be encountered in everyday life.

Costs To Participate in this Research Study

There is no monetary cost to participate in my study.

Compensation For Participating to Completion of my study

Research participants who voluntarily participate in this research study until its completion will receive a $25 Visa gift card and will also be provided with valuable feedback on the findings of this research.

What Will Your Participation in this Research Study Require?

1) Participate in an individual interview with the researcher. The interview will take approximately 30 minutes from start to finish. The interview will be recorded.
2) Participation in a pre-scheduled virtual focus group with the other research participants. The focus group will be scheduled 3 days after the completion of your individual interview. The focus group will take approximately 1 hour from start to finish. The focus group will be recorded.
3) Participate in responding to a reflective written prompt. A prompt will be provided via email to each participant after the focus group. The reflective written prompt is to be completed and returned via email to this me within 3 days.

How Will My Personal Information Be Protected?

Your anonymity will be achieved with the use of a pseudo name. Data retrieved from my study: consent forms, audio and video recordings, notes, transcripts, emails, and letters, will be kept for 3 years. After that time, all aforementioned will be destroyed and disposed of.

Who can I contact if I have questions or concerns about this research project?

You may direct questions to the researcher, Rebecca Keeter-Lee, at [redacted]. You may also contact the chair of this research, Dr. Rebecca Bowman, Ed.D. at [redacted].

Participant Consent to Participate in This Research Study

If you have read and agree to voluntarily participate in this research study, and understand that you can withdraw with no obligation, please sign below. Return this form via email to rkeeter@liberty.edu.

☐ I am informed of and consent to, being audio/video recorded, as a part of this research study. (Please check the box if you agree)

_____

Printed Participant Name

_____ _____

Signature of Participant **Date**

APPENDIX D: OPEN-ENDED INTERVIEW QUESTIONS

1. Tell me about your current self.
2. Tell me about the influence your childhood family history had on your decision to obtain your degree in STEM.
3. Describe how your personal experiences influenced your education endeavors in the STEM field?
4. Describe how your strengths and interests influenced your persistence to complete a STEM degree program.
5. Describe how your religious beliefs influenced you during your time as a STEM degree student.
6. Describe your experiences with gendered norms or expectations within your STEM degree program.
7. Tell me about your positive experiences with the faculty in your STEM degree program.
8. Tell me about any negative experiences you encountered with faculty in your STEM degree program.
9. Explain when it was that you decided on your STEM degree choice and why.
10. Describe what your reality as a female STEM student was compared to what you expected going in.
11. Describe any challenges you are having or had while in your STEM degree program.
12. As a female, explain what effect your challenges had on your STEM degree progress.
13. How did you respond to those challenges?
14. How do you think you would have responded to your challenges if you were a male?

15. Describe positive changes you would implement to degree programs that would benefit future female STEM students.
16. Describe what strategies you utilized to assist in your completion of your STEM degree program.
17. Please provide any additional information you believe is important to the topic of the reality of the challenges female STEM students face in their degree programs.

APPENDIX E: FOCUS GROUP QUESTIONS

Open-Ended Focus Group Discussion Prompts

1. As female STEM students, what challenges did you perceive affected you more than your male counterparts in your degree program?
2. Did you perceive any differences in your relationships with female versus male professors and fellow students? Please explain.
3. Did you experience additional stressors because of the societal norms and expectations that are placed on females as students in STEM? Please explain.
4. What advice could you provide to other females who are facing similar challenges in the STEM degree program?

APPENDIX F: REFLECTIVE WRITING PROMPT

"Write a description of a challenging experience you recall while you were in your STEM degree program. Provide the following information in your descriptive account of the experience: Your feelings, mood, emotions, setting, the time of day/night, time of year, duration of time, during the experience".

APPENDIX G: EMERGENT THEMES

- Silent Gender Bias
    - Gendered Role Expectations
    - Language and Behavior
    - Impostor Phenomenon
    - Faculty Relations
- Program Requirements/Demands
    - Time Constraints
    - Difficulty and Demand of Academia
    - Home and Child Responsibilities
- Determination/Support
    - Strengths and Interests
    - Peer Support
    - Family Support
    - Faculty Support

APPENDIX H: OPEN CODING TABLE

Table 3

Open Codes Table

Code	# of Responses	Total # of Responses	Emergent Theme
Perceived Gender Bias In Program	Interview: 33 Focus Group: 22 Reflective Writing: 4	59	Silent Gender Bias
Experiences of Gendered Role Expectations	Interview: 4 Focus Group: 11 Reflective Writing:7	22	Gendered Role Expectations
Perception of not belonging due to Being a female	Interview: 5 Focus Group: 3 Reflective Writing: 3	11	Impostor Phenomenon
Negative Faulty Experiences	Interview: 2	11	Faculty Relations

	Focus Group: 3 Reflective Writing: 6		
Perception of Unique Female Program Bias	Interview: 20 Focus Group: 2 Reflective Writing:16	38	Program Requirements/Demands Time/Academics/ Responsibilities
Degree Choice Was Important	Interview: 20 Focus Group:2 Reflective Writing:0	22	Strengths/Interests
Family Support Was Important	Interview: 19 Focus Group: 4 Reflective Writing:0	23	Family Support
Peer Support Was Important	Interview: 14 Focus Group: 3 Reflective Writing:0	17	Peer Support

Faculty Support Was Important	Interview: 13 Focus Group: 5 Reflective Writing:0	18	Faculty Support
#Coded Responses		**221**	