5-2021

Women in STEM: Exploring the Stereotypes

Doaa Khalil

MASTER'S THESIS

Women in STEM: Exploring the Stereotypes

_____

A thesis

submitted in partial fulfillment of the requirements for the

Leadership Studies

University of Southern Maine

By

Doaa Khalil

Supervised by:

Dr. Elizabeth Goryunova (Faculty Advisor)

University of Southern Maine

_____

May 2021

Table of Contents

Chapter 1. Introduction 4
Background About STEM 4
Research Problem 6
Purpose of the Study 8
Research Question 8
Chapter 2. Literature Review 9
Innovations and Female Representation 10
Women's History is STEM 11
Women's Achievements in STEM 13
Summary and Conclusion 15
Chapter 3. Methodology and Procedure 17
Research Method 17
Participants 18
Data Collection Procedures and Role of the Researcher 19
Data Analysis 20
Strategies for Validating Findings 21
Chapter 4. 22
Findings 22
Women's Representation & STEM Field Requirements 25
Underestimation from Others 37
Confidence in Self 42
The Impact of Women Mentors and Colleagues 47
What Women Need to Do in STEM 51
Summary 55
Chapter 5. 56
Conclusions 56
Answering the Research Question 59
Solutions and Recommendation 60
Ethical Considerations 63
Researcher's Perspective 63
References 66
Appendix 73
Informed Consent Form 73
Interview Questions 77

Abstract

STEM is an abbreviation for four different disciplines: Science, technology, engineering, and mathematics. Many great scientists started the path in the past and invented great theories to help set the foundation for our modern world. Today, innovations are continuing to rise. In fact, new developments are witnessed every day especially in the field of STEM. They are playing a significant role in influencing the current economy and the world's future vision. The only missing aspect of STEM and among those innovations is the presence of females. Historically, women's education has varied depending on the region, time period, and culture (Min, 2019). Despite the fact that the number of women in STEM has increased since the early 1990s, the gender gap persists, and decreasing the gap in STEM education is pivotal. Therefore, this research investigates whether the presence of the stereotypes that women face in STEM affects or contributes to their low representation in that field. A qualitative research method is used, where data is collected through a set of interviews with women working in STEM fields and related occupations capture various experiences and perspectives. The findings will help understand if a relationship exists between these two phenomena.

Keywords: women in STEM, stereotypes, gender gap, STEM education/career, low representation

Chapter 1

Introduction

Background About STEM

STEM educates individuals in four different disciplines: Science, technology, engineering, and mathematics. Admiration of these disciplines existed as far back as the oldest civilizations to explore and theorize many different sectors of science. STEM educational programs around the world have designed their learning structure based on real-world applications. In other words, they are built to teach practical skills that can be applied in real life. It is the past innovations that have laid the foundation for science today. In fact, many great scientists made advancements during the Dark Ages (fifth century to the fifteenth century), namely: Jabir Ibn Hayyan (the father of chemistry) wrote on alchemy or chemistry based on his own experiments; Muhammad ibn Musa al-Khwarizmi developed algebra; Muhammad Ibn Zakariyai al-Razi identified smallpox and measles; Abu Ali al-Ḥusayn Ibn Abdallah Ibn al-Hasan Ibn Ali Ibn Sina taught the canon of medicine; Abu Rayhan al-Biruni determined the length of the solar year, presented an explanation of the phases of the moon, and measured the radius of the earth using a new method (Beilby, 2011; Saliba, n.d.). Then, in the 11th century, Abu Ali al-Ḥasan Ibn al-Ḥasan Ibn al-Haytham invented camera obscura and the pinhole camera (Qomrah) (Norman, n.d.). According to Benson (2014), the Chinese also made many early innovations in STEM:

> [In 1232] the Chinese began experimenting with gunpowder-filled tubes. At some point, they attached bamboo tubes to arrows and launched them with bows. Soon they discovered that these gunpowder tubes could launch themselves just by the power produced from the escaping gas. The true rocket was born. (para. 6).

Following these innovations, during the Renaissance period, Leonardo Da Vinci invented an ornithopter flying machine (helicopter), an armored fighting vehicle (armored car), and the use of concentrated solar power (Prime Industries, 2015; Davinci Inventions, 2019; Hood, 2019). In the late 16th century, a Dutch inventor named Zacharias Janssen made the first compound microscope (Davidson & The Florida State University, 2015). Later, in the early 17th century, Galileo Galilei built a practical telescope and made new astronomical discoveries (Library of Congress, n.d.). In the same century, Isaac Newton formulated three laws of motion which are still adding to the physics, science, and math disciplines. Furthermore, the first hot air balloons were made in the late 18th century by Joseph-Michel Montgolfier and Jacques-Etienne Montgolfier. While there were many innovations in the 19th century, Humphry Davy invented the arc lamp (the first electric light), William Sturgeon invented the electromagnet, and Wilhelm Rontgen, a German physicist, discovered x- rays (Bellis, 2019; Woodford, 2008/2019). In addition to all great innovations in the 20th century, Albert Einstein came in the early 20th century to develop many theories including a groundbreaking one called the General Theory of Relativity (English, 2019).

The scope of innovation was not bound to earth. Genuine curiosity led people to explore space. In 1957, the Russian Satellite was launched into space which motivated the Americans to create the National Aeronautics and Space Administration in 1958 (Marick, 2016). President Kennedy pushed for innovation in the areas of STEM in 1961 which put the first American on the moon. With the advocacy of STEM education, big achievements were established in the science and technology world – among the many were the first cell phones and personal computers (Marick, 2016).

Like other industry sectors, STEM plays a significant role in the economy (Sassler, Michelmore, & Smith, 2017). Different countries have strived to compete in the global economy since they recognized the predicted consequences they could face when lacking innovations (Hallinen, n.d.). Today, in the United States, students are required to learn science from first grade to twelfth grade. Before entering college, every high school student must complete a minimum of three classes of math and science such as algebra, calculus, chemistry, biology, and physics. In addition, there are schools that offer classes such as coding, robotics, nursing, or mechanical engineering. These classes are designed to develop students' skills. However, despite all the great innovations and creation of educational programs, women are not represented in STEM.

The most recognizable historical STEM contributors have been seemingly male. However, one shouldn't assume that women didn't have a firm hand in these innovations and others. Instead, writers and creators of history could have failed to record their presence—a practice of their time.

Research Problem

STEM and creative innovations have taken over the world. However, there is a noticeable gender disparity in STEM disciplines (while there are gender non-conforming individuals in STEM, this research focuses on male-female binary genders since STEM is historically known as a male-dominated field). With this in mind, women's education has varied depending on the region, time period, and culture (Min, 2019). Thus, in the Roman Empire, education was reserved for two groups only: privileged young men and religious devotees. Min (2019) states that the only way for women to get educated was by entering a convent. In the Roman Empire, the nuns were the most intellectual females since they studied arithmetic, geometry, and

astronomy. During the Age of Enlightenment, women from wealthy classes started to pursue an interest in physics. In the 19th and 20th centuries, women were finally able to access higher education in several countries across the world including the United States and some of the European countries. For example, the United States opened Georgia Female College in 1836, Mary Sharp College in 1853, and Elmira College in 1855 (Encyclopedia, 2020). Moreover, the United Kingdom created Bedford College for women in 1849; Russia offered higher education courses to women in 1878; Norway started to admit women in 1884; Japan established Japan Women's University in 1901; German universities opened doors to women in 1901; China began to enroll females in colleges in 1920; a Lebanese university started to accept women in 1921; Egypt admitted female students to Cairo University in 1928; Turkey equalized higher education to both men and women in 1930; Kuwait opened universities to women in 1966 (Balding et al., n.d.; Guzeva, 2018; Japan Women's University, n.d.; Lebanese American University, n.d.; Lee, 2006; Talhami, 2012).

In college, the number of men pursuing STEM is greater than the number of females choosing STEM. In spite of the fact that the number of women in STEM has increased since the early 1990s, the gender gap persists. Different factors have played a role in high school females not pursuing STEM degrees. One such factor is the underestimation of women's ability to perform the work, which is a challenge many women faced in the past. This includes NASA research mathematician Katherine Johnson who was not only a leader, but also the first woman to calculate space trajectories to help put an astronaut into orbit around the earth. Johnson had to work hard to prove to her male colleagues that she could contribute (Stofan, 2020). At the beginning of her journey, Johnson's perspectives were not the first to be taken into consideration. It took her significant effort, time, patience, and commitment to continue working in a field she

admired. Johnson's persistence led her to be one of the contributors NASA depended on when successfully launching the first spacecraft to the orbit. Perhaps, the problems Johnson faced are similar to the challenges women are currently facing in the male-dominated STEM workforce.

Purpose of the Study

This study aims to explore the gender gap in STEM. This research focuses on the following question: Does the presence of the stereotypes that women face in STEM affect their low representation in that field? To answer this question, the researcher investigated the stereotypes women face in STEM which helped the researcher understand the reasons that are causing the female underrepresentation rate in STEM to continue. Through qualitative research, the researcher developed interview questions and conducted interviews that further explored the research question and discussed challenges that evolve from these stereotypes.

Research Question

The research question this study aims to investigate is: Does the presence of the stereotypes that women face in STEM affect their low representation in that field?

Chapter 2

Literature Review

The world becomes more technologically advanced every day. These advancements affect everyone. All of the scientific discoveries that humans are making and the solutions that engineers and specialists are developing define the present and shape the path of the future. This is what makes STEM education highly encouraged. In fact, the science field has become a way for countries to compete globally since innovations affect economies significantly. As mentioned earlier, the space race is a great example that supported the race of science. The true fact about science is that there is no end to innovations. While there are many studies about STEM and women in STEM, they do not incorporate research on whether the presence of the stereotypes that women face in STEM affects their low representation in that field. Therefore, this study hopes to provide some insights to help explore this topic.

With respect to the previous statement, the review of the literature is going to introduce previous studies that have been conducted around the topic of women in STEM. This chapter will provide information for the reader to get a sense of the background of women in STEM. It incorporates the following sections: Innovations and female representation, women's history in STEM, and women's achievements in STEM. These topics played a role in leading the researcher to develop the aforementioned research question. The gender gap in STEM is discussed within these sections. The reader is exposed to previous studies on women's representation in STEM and some of the challenges that prevent women from pursuing STEM education or STEM careers. In addition, the researcher provides details about some of the achievements women have accomplished in the past to help pave the way for the future of science and women's education.

Innovations and Female Representation

The world is expecting many creative projects and developments in the future and this is what makes many countries compete to have the best innovations in STEM. From this researcher's perspective, innovations in STEM lead countries to prepare students and communities on how to solve problems, make sense of information, and know how to gather and evaluate evidence to make decisions. It is about understanding complex challenges to be able to solve them today and tomorrow. The results of this education will allow a country to invent new ideas and develop existing ones to improve their country. Countries are encouraging STEM education, and adults who are entering college immerse themselves in majors that set the stage for future career attainment (Robnett & Thoman, 2017). While the number of STEM enrollments is low (National Center for Education Statistics, 2020), there are still individuals who graduate with STEM degrees and end up developing successful careers. The reason why some individuals, specifically women, do not end up in STEM fields is because gender plays a role when it comes to occupations (Universitat Pompeu Fabra, 2019; Ignatova, 2019).

The world is considered to be technology-driven. The United Nations (2019) states that "skills such as critical thinking, problem-solving, and the ability to innovate are increasingly important for openly embracing change and responsibly shaping the future" (para. 4). Therefore, the United States of America is one of the countries that is working on fulfilling more STEM achievements. For example, American space agencies such as NASA and SpaceX have been active in achieving many successful milestones in the field of aeronautics in recent years. These advancements show that innovation never stops. In 2019, two astronauts performed an All-Women Spacewalk. Although this was the 221st spacewalk performed in support of the space station assembly, it was the first time it was conducted by women (Dunbar, 2020). This event

raises many questions about women in STEM that the researcher will elaborate on later. For example, what is preventing women from participating in more historical achievements? What challenges are women facing in STEM that their male counterparts are not?

As innovations in STEM expand, the low representation of women in STEM persists today. A study by Sharon Sassler, Jennifer Glass, Yael Levitte, and Katherine Michelmore (2017) emphasizes that the decline in female representation in STEM education and professional careers has been coined “the leaking pipeline”. In reality, the proportion of women in the STEM field has grown over the past three decades. However, graduates appear less likely to transition into STEM jobs following degree completion than earlier cohorts (Xie & Killewald, 2012). The gender wage gap could have played a role in leading fewer women to show interest in STEM and pursue STEM careers. Xie and Killewald (2012) study shows opportunities in the science field have grown rapidly. Additionally, Michelmore and Sassler (2016) point at the persisting gender wage gap among women in STEM occupations. For example, women, in 2017, made an average of 20% less than males in STEM fields (Min, 2019). In other words, women made 80 cents for every dollar that men made.

Women’s History in STEM

Women did not always have access to education in the past. As stated earlier, general education in the Roman Empire started with two groups of people with no female presence (Min, 2019). Then, education was differentiated among social classes. Wealthy people were given the advantage to get educated. Women who were members of rich families got the opportunity to pursue the field they enjoyed learning about. As the researcher cited in the introduction, women’s education depended on the region, time period, and culture individuals were in (Min, 2019). Sassler et al. (2017) study shows that historically, women demonstrated less interest in

STEM topics. This indicates that women were less likely to take math and science classes in high school. In the 1980s, women concentrated in the humanities or liberal arts fields (Sassler et al., 2017). As an example, many women pursued the institutional pathway since it helped them maintain a schedule that worked well with their children. It has been known that women and men link education and occupations differently. Generally, it took women time to get active and develop a campaign to equalize educational opportunities (Min, 2019). The number of women showing interest in STEM has increased since the early 1990s. Today, we see female nurses and doctors. Studies have shown that women are more likely to select the biological sciences as a jump-off point for later career decisions outside of the narrowly defined STEM fields (Sassler et al, 2017). According to Carli et al. (2016) research, "In biology, women's representation (46%) nearly matches men's . . . In spite of this progress, men continue to obtain a higher proportion of undergraduate and graduate degrees in physical sciences, mathematics, computer science, and engineering than women do" (p. 244); another study indicates male undergraduates outnumber females in physics and engineering majors. Females represent roughly 25% in physical science and 15% in engineering (Shenouda, 2014). In regard to STEM occupations, The Bureau of Labor Statistics (2015) combines computer science and mathematics into one occupational category and reports that only 26% of computer scientists are women. Interestingly, in the United States, 53% of women who start out in the STEM industry leave, and only 11% of women are engineers (Catalyst, 2016); Madsen et al. (2019) highlights:

> In the nation, 22% of women (vs. 7% of men) decide to leave STEM positions for family-related reasons, and only 15% (vs. 31% of men) leave based on pay or promotional opportunities, which can often be greater outside of STEM occupations as a career progress-es (para. 6).

In addition to these percentages and according to Makarova et al. (2019), STEM fields are not only male-dominated, but also associated with a set of attributes related to masculinity. Some of these attributes are being tough, decisive, complex, and act based on thinking rather than on feelings. These attributes, unfortunately, corner some fields like math, physics, and chemistry to be considered masculine (Makarova et al., 2019).

Due to all the different obstacles women face in the STEM field, women who are ambitious enough to pursue careers in STEM or STEM education are delaying marriage and limiting the number of children they want in order for them to have time to focus exclusively on work (Sassler et al., 2017). Women who are interested in STEM have to delay other responsibilities so they can have more time to achieve desired goals. Otherwise, women who are deciding to move forward with personal responsibilities are less likely to fulfill their professional dreams. Research conducted by Jennifer Glass, Sharon Sassler, Yael Levitte, and Katherine Michelmore (2013) states that women who decide to persist in STEM jobs post-marriage and childbearing are more likely to exit STEM jobs to a greater extent than they do for other professional jobs. This trend can be considered an additional factor that is causing the gender gap in STEM.

Women's Achievements in STEM

Many women in Middle Eastern cultures say that education is a sword that individuals can use to fight ignorance. With respect to all the innovations scientists developed in the STEM field, it is important to state that women have made significant discoveries and achievements that have positively affected the technological world. The achievements that women have made required many sacrifices, time, effort, patience, and passion. In reality, due to the low representation of women in STEM, men have been able to achieve more since they have better

access to opportunities. A previous study indicates that one potential challenge women encounter relates to their self-perceived likelihood of success in STEM (Robnett & Thoman, 2017). Expectancy-value theory refers to the positive expectations that are a powerful determinant of academic motivation and decision making. This indicates that individuals tend to pursue domains in which they perceive a high likelihood of success and avoid domains in which they do not (Robnett & Thoman, 2017). Wigfield and Eccles (2000) propose that people's success expectancies are being shaped by Cultural Milieu. In the United States and other countries around the world, the cultural milieu is infused with negative stereotypes about girls' and women's STEM abilities (Carli et al., 2016). In regard to gender differences when it comes to ability, Wang and Degol (2013) assert that the differences in hormone levels and mathematical strategies may influence the gender gap in spatial ability. However, there is little that can be gleaned from the current findings suggesting a link between biological factors and math ability (Ceci et al., 2009).

In addition, many studies show that if women and men enter the same STEM major, women will anticipate less interest or future success in college (Robnett & Thoman, 2017). This effect is due to women underestimating their performance as opposed to men overestimating theirs. However, Robnett and Thoman (2017) emphasize that there are women who perform well academically, they just have low expectations for success in STEM. Even with the challenges that women have faced in STEM in the past, they have been able to work to achieve desired outcomes and inspire young girls to pursue an interest in STEM.

Over 1000 years ago, one woman's investment led to the founding of the world's first university, the University of al-Qarawiyyin in Fez, Morocco (Mortimer, 2018). Fatima al-Fihri, who was born in Tunisia and hailed from a well-educated family, invested her wealth in

founding mosques and educational institutions to benefit her community which, gradually, led this establishment to blossom into the University of al-Qayawiyyin in the year 859 (Mortimer, 2018). This university was recognized by UNESCO and Guinness World Records. It offered a wide range of subjects, ranging from STEM to liberal arts classes. Despite the gender gap, this did not prevent passionate women from accomplishing goals and inventing new developments to affect the science world. Indeed, women kept the innovations going in addition to advocating for women's education in STEM. For example, Elizabeth Blackwell, who became the first woman in America to receive a Doctor of Medicine in 1849, spent her life championing medical education for women and careers for women in medicine. Following her path, a great discovery of the X and Y chromosomes was invented in the early 20th century by Nettie Stevens (The College of St. Scholastica, 2015; Encyclopaedia Britannica, n.d.). Despite the underrepresentation women have faced in STEM, they have not stopped learning and have been able to make numerous achievements. In fact, they worked significantly to attain great accomplishments in STEM. That's what Katharine Blodgett did. She was an expert in surface chemistry and engineering who became the first female scientist hired at the General Electric research lab in the 20th century (The College of St. Scholastica, 2015; Massachusetts Institute of Technology, n.d.). Her passion for science led her to develop the first system for creating non-reflecting glass.

Summary and Conclusion

In summary, STEM is a field that is expanding since the current world is depending on technology with the expectation for the world to rely on it in the future. Hence, this is leading countries to compete globally to be the first to accomplish significant achievements and lead by influencing the world through technology to enhance the economy and grow together as countries. With all these goals and dreams, the absence of women in STEM still persists today.

Although the number of women in STEM has increased since the early centuries, today, the gender gap still exists. Some researchers attribute this gap to biological differences in sex and gender. However, there is arguably more evidence that social and cultural factors are in play. The underrepresentation women face in STEM does not inspire females to pursue STEM education. Additionally, the wage gap is adding to the gender gap and leading it to continue. However, when women's achievements in STEM get highlighted, when challenges fade, when communities close the wage gap in STEM, and when women are given the educational opportunities to realize their dreams, the gender gap will slowly evaporate until it has vanished.

Chapter 3

Methodology

Research Method

This study utilizes a qualitative method design to explore the research question and form a better understanding of whether the stereotypes women face in STEM contribute to their low representation in that field. According to Almalki (2016), qualitative research is recommended when exploring and understanding the meaning individuals ascribe to a growing problem. It focuses on drawing meaning from the experiences and opinions of participants. Creswell and Creswell (2018) state:

> Qualitative methods rely on text and image data . . . Writing a method section for a proposal or study for qualitative research partly requires educating readers as to the intent of qualitative research, mentioning specific designs, carefully reflecting on the role the researcher plays in the study . . . using specific protocols for recording data, analyzing the information through multiple steps of analysis, and mentioning approaches for documenting the methodological integrity or accuracy—or validity—of the data collected (p. 153).

In addition, Rovai, Baker, and Ponton (2014) compose the idea that the qualitative research approach values individuality, culture, and social justice which provides rich content and context of information that is subjective in nature and ultimately, related to the topic. This leads to an understanding that qualitative methods produce significant amounts of highly detailed information that can allow all the researchers to drive effective conclusions on the proposed research question. Once the needed information is gathered, it should be collected, analyzed, and interpreted through a conclusion.

Thus, this research uses the phenomenology approach. Creswell and Creswell (2018) assert that the phenomenological approach attempts to build an understanding of the essence of experience from participants. In other words, this approach is aimed to describe, understand, and interpret the meaning of experiences of human life. Usually, rich information is gathered from a central phenomenon. One way this information can be collected is through interviews. Finlay (n.d.) recommends research to open dialogues with participants since they may be valued. Moreover, Finlay (n.d.) mentions, "The researcher's aim is to empathize with the participant's situation and offer further prompts geared to existential dimensions of that situation" (p. 1). As stated earlier, this approach and method aim to assist the reader to maintain an understanding of the purpose of the research which will inquire the results and conclusions of the collected data in addition to their interpretations once the data is analyzed.

Participants

The initial plan was to interview six to ten women who are in STEM and ten interviews were completed in total. Interviews ranged from 40 minutes to 60 minutes in duration. Women from different institutions and organizations were invited to participate in this study and contacted to set up virtual interview appointments. If a participant was not able to meet due to time or schedule conflict, the plan was ready to be accommodated to better serve that individual, which means the nine questions would be sent via email. The requirements for selecting participants were the following: Interviewees must have at least one year of experience working or studying in STEM. The hope of this study was to interview females, who have strong passion for what they do, from various STEM disciplines to ensure that perspectives from different individuals and females are included to help answer the aim of this study. The diverse population included female students, leaders, and other employees who would add to the research.

Data Collection Procedures and Role of the Researcher

The interview questions have been developed to serve the purpose of exploring the research question. Moreover, the questions were constructed to probe the experience of the participants as more of a discussion in which the participant was encouraged to give their perspectives on the topic. In this way, the researcher would benefit from different perspectives and experiences. After the development of the interview questions, the researcher got in contact with the selected participants to see if they would be interested in participating in the study. Once they agreed to participate, the researcher asked for consent from the participants. The consent form stated the purpose of the research, provided a description of the interview, emphasized that participation is voluntary, and declared commitment to participants' confidentiality. As stated in the previous section, virtual interviews were conducted. However, if participants face schedule conflict, then the interview questions were ready to be sent to them via email in addition to the permission form that would allow the researcher to use the collected information in the study. Further questions were asked if a participant decided to answer the questionnaire via emails. For the virtual interviews, the participants were asked for permission to have the interview recorded by phone or a computer. Hence, this piece of information was included in the consent form. In regard to the interviews, further dialogue or questions were developed if needed to further understand, clarify, or discuss a point when interviewing the participants. The researcher took notes in addition to the recordings. Once the interview was over or participants answered the questions via emails, the researcher created a folder and document the process by uploading the recordings and the answers, with the appropriate title assigned to each document. The researcher then created a document for each recording file and transcribe the recordings separately by using one of the features available online.

Data Analysis

As mentioned briefly in the previous section, before the data was analyzed, the researcher first created folders and subfolders that contained all the required documents: Recordings, signed consent forms, interview questions, transcribed script, and permission forms. In this way, all the needed documents were organized which benefited the researcher by saving time. The second step was to prepare the data for analysis. This happened by looking over the data to make sure all the needed information is acquired and no further collection is required. Transcribing the recording is included in this step as well. The researcher was open to using an online feature or program to transcribe audio files. As stated in the previous section, the text of each recording or email was copied into a separate document and reviewed later to confirm all the information is valid and accurate before the analysis process begins. In the reviewing process, the researcher organized the text and differentiated what was being asked and what was being answered. Then, the researcher identified themes that are emerging from each interview; that was happened by questioning what tones or themes are emerging from each interview transcript.

Once the previous step is completed, the researcher reviewed the different themes emerged from each interview, compared them, and generated six themes as general themes that overlap all the transcripts. The researcher represented them by using narrative passages to convey the findings of the analysis (Creswell & Creswell, 2018). The researcher then made sure the selected themes were true and applicable to all the different interview transcripts. Once themes were generated, the researcher used different colors to identify what information belongs to which theme. The result was compiled in one master document. Lastly, five themes are explicitly discussed in Chapter 4. However, the sixth theme (solutions) presented by participants and the researcher are provided in Chapter 5.

Strategies for Validating Findings

Coming up with a research question, collecting data, and analyzing them in a qualitative method requires validation strategies that can make a study more credible. According to Creswell and Creswell (2018), “Validity is one of the strengths of qualitative research and is based on determining whether the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account” (p. 169). In qualitative research, there are eight different validation strategies (Creswell & Creswell, 2018). In order for this study to be credible, the researcher used two of the eight different strategies. The first strategy is called Clarifying, and the second strategy is called Peer Review or Debriefing. Regarding the first strategy, the researcher provided comments in the Conclusions section to state how the interpretation of the findings is shaped by her background. In addition, further information on the researcher's background is provided in the Background of the Researcher section. This section is aimed to assist the reader with learning more about the researcher and why she is passionate about STEM and this study specifically.

Moving forward to the second strategy, the researcher located a peer who can review the study and ask questions about it to make sure the account resonated with individuals other than the researcher (Creswell & Creswell, 2018).

Chapter 4

Findings

The purpose of this qualitative descriptive phenomenological study is to understand women's experience in STEM and investigate the stereotypes in addition to exploring whether these stereotypes contribute to their low representation in STEM. Interviews were conducted for data collection to understand and learn from the diverse and rich background experiences each participant brought to the study. The recruitment process was initiated with local females who are in the researcher network and then got extended to the outer network. Ten participants, who are from various fields in STEM, were reached out to and conducted interviews with. After the interview data were collected, transcribed, and organized, the researcher analyzed the data and generated five themes to discuss in this chapter. These themes were carefully selected and ran across the ten interviews to ensure they are applicable across all of them. Five out of six themes are discussed separately in this chapter and is supported by the collected information from the ten interviews.

Before diving into the themes, the researcher spotlights how the ten participants landed on STEM education and/or STEM career. Each of the volunteered participants was asked at the beginning of the interview to share their background in STEM to form a better understanding of how these women pursued STEM education and/or career. In other words, the researcher hoped to learn what drove these women or what motived them to get into the STEM fields. The essence is to discuss interest and stereotypes in the conclusion chapter and investigate whether stereotypes in STEM contribute to women’s low representation in this field.

For an explicit understanding, a visualize diagram of women’s interest in STEM is provided below:

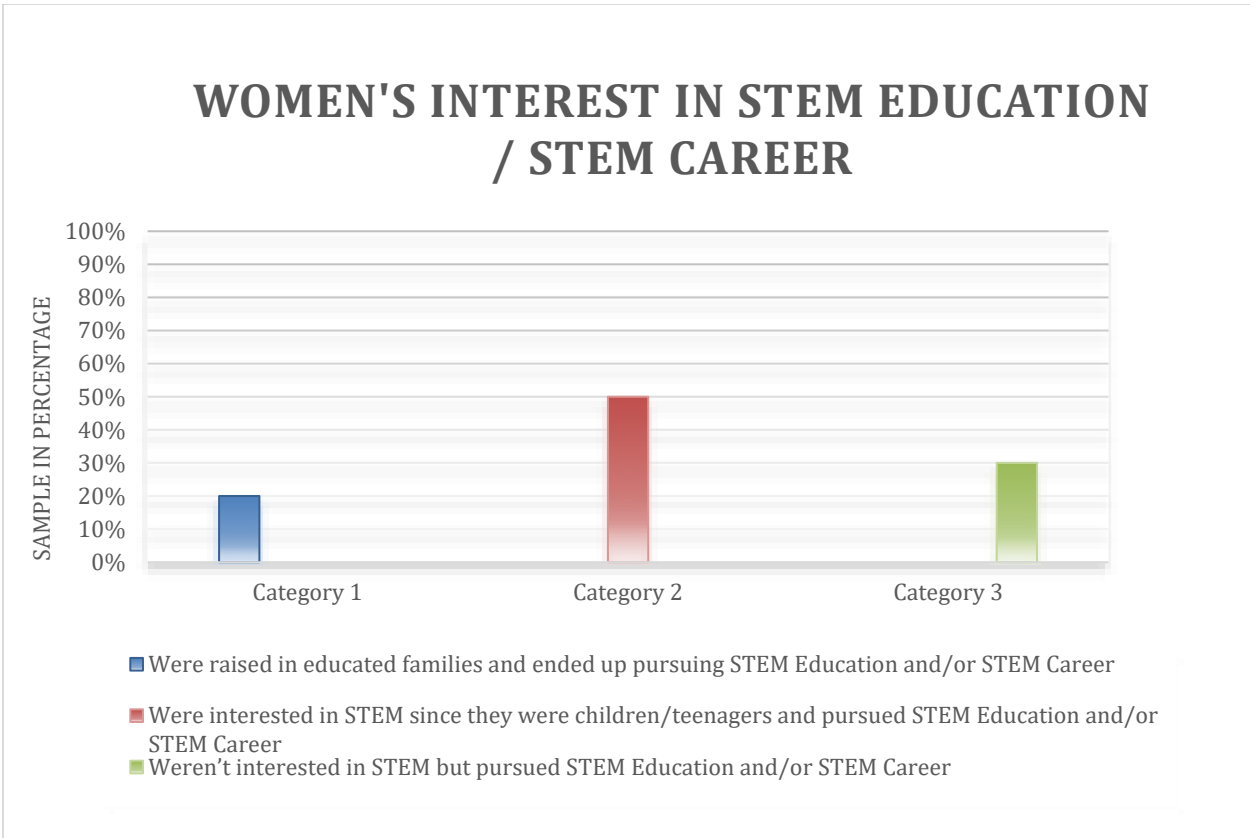

Figure 1: Women's Interest in STEM Education / STEM Career

As noted above, the chart is categorized into three groups and provided the sample size in percentages. Category 1 (colored in blue) represents the number of participants who were raised in an educated family and ended up pursuing STEM Education and/or STEM Career after that; Category 2 (colored in red) indicates those who were interested in STEM since childhood and adolescence, then, they proceeded with STEM Education and/or STEM Career; Category 3 (colored in green) refers to women who were not interested in STEM in their childhood or in school, but landed on either a STEM Education or STEM Career.

Category 1 (blue): In this category, two participants out of ten were the only ones who shared that their influence of STEM fields came from the environment and the families they were raised in. One participant expressed that her parents were educated and held higher positions in their fields. They were supportive and encourage STEM education. Like any child,

she used to enjoy playing with dolls, but when she reached her teenage years, she realized her strength in math. One step after another, she got pushed into STEM education. Once she started taking classes, she started seeing the beauty of it. Another participant stated that she was raised in a family where one of her parents was working in a STEM field. As she grew up and took physic and math classes, she discovered her passion for STEM and resulted in it applying and seeing it everywhere, even in ballet.

Category 2 (red): This category represents five women out of ten who stated that their interest in STEM evolved when they were children and/or teenagers. Three of the five participants were passionate about STEM when they were kids. One of the three asserted that she loved exploring and had a sense of curiosity. Another participant shared that while she was interested in STEM as a child, she needed opportunities in order to move on. A unique story is that the third out of these three women stated that she always saw herself working with animals or psychology since she was a child, but never thought how she could fit in math because the mental image she had of a mathematician was a man. Hence, this participant found more passion in STEM as she started taking classes in high school. However, she did not see herself working or pursuing a STEM degree or career because of the stereotypes and the culture of that field, especially with women.

In addition to these three women, two participants expressed that their interest in STEM evolved in their adolescent years. One of the two women stated that she discovered her passion for STEM as she began taking classes in high school. The second participant indicated that she was not a traditional girl who used to enjoy playing with dolls, which was not common in the environment he was in; she enjoyed playing video games and exploring machines.

Category 3 (green): This last category expresses that the remaining number of participants (three) were not interested in STEM education and career. One of the three shared with the researcher that she was not interested in STEM; however, her college advisor was the individual who motivated and encouraged her to pursue a STEM degree. As soon as she started taking classes, she began to see the beauty of numbers and her interest started to escalate; this passion led her to land a STEM career after graduation. While the second out of the three participants were enrolled in STEM, she did not have a passion for it. She had to adjust her plan and start taking courses from different fields until she found the field that resonated with her. From there, she dove into the subject and now is pursuing an advanced degree in her field. She stated that she loves her field and always finds a way to be creative in it. Moving on to the last participant in this category, she expressed that she has never imaged herself being passionate about STEM because she thought this field was not for women. She did not pursue a STEM degree and never occurred to her that she will end up with a STEM career in the future. The journey began when she started with an entry job position in a STEM field. Once she started learning the field, she adored it; she was able to connect her non-STEM undergraduate degree to her STEM career. Additionally, as a creative individual, she applied creativity when needed since it is necessary for any STEM field.

Since an explicit description of Figure 1 has been provided, five themes will be discussed in the following order: Women's Representation & STEM Field Requirements, Underestimation from Others, Confidence in Self, The Impact of Women Mentors and Colleagues, and What Women Need to Do in STEM.

Women's Representation & STEM Field Requirements

Due to the diverse information collected from interviews, the researcher divided this section into two groups in the interest of understanding the findings better.

Women's Representation

While women's representation in STEM was presented in the Literature Review chapter, this study has discovered new findings in regard to women's representation in STEM. Participant 2 shared that women's representation in the medical field varies. For example, a good number of women in the veterinary field have been observed, whereas, in radiology, the field is male-dominated. Additionally, Participant 2 stated that women are absent or poorly represented as individuals move up levels or pursue leadership positions in STEM, especially in the medical field. Participant 9 indicated that while women are fairly represented in human biology, particularly at the undergraduate level or in the pre-med track, men are the majorities in graduate level courses. Participant 9 shed light on an essential point, which was that the majority of the faculty in the department were males whereas the adjunct were females. Interestingly, Participant 10 indicated that we may see more women pursuing medical field because they are the caregiver and enjoy helping their community.

In addition, Participant 3 indicated that because of stereotypes and fear to go into male-dominated fields, women's representation in classes that heavily depended on soft skills (such as math, engineering, computer science, and information technology or programming) is low. Seconding this statement, Participant 6 and Participant 8 indicated that there are few women in their professional fields, which are coding, technology, and engineering dependent. Participant 6 and Participant 3 added that women are not only a minority but are absent in their field's leadership positions. When it comes to physic classes, Participant 1 expressed that women's representation in entry-level of physic classes is "fine", but the representation rate decreases

significantly when students move on to the hard and theoretical courses of that field. Furthermore, Participant 4 added that it is always unfortunate to be happy when an additional woman joins a team or their work gets highlighted in STEM because this is something that should automatically be part of the STEM culture. Thus, while increasing female representation in STEM is essential, the feeling of being content can speaks volumes. On the other side, Participant 7 questioned why young girls show interest in STEM (and probably are fairly represented) at a young age. However, when they reach puberty, some girls lose interest, and representation decreases as they move on with education or career. Yet Participant 5 stated that low representation can bring challenges and struggles to the minorities who are in the field and could cause or lead them to leave their education or career.

STEM Field Requirements

The findings of this section will be separated into subsections; the reader will be exposed to some stereotypes as well as explore STEM requirements:

Personality.

Speaking (communicating) in STEM can be difficult and challenging, especially in a male-dominated field (Participant 6). Participant 9 mentioned:

> I think men will dominate conversations more often in a group setting, and they feel more comfortable like just jumping in there and taking up a bunch of space. I think women are often, especially earlier in their career, more hesitant to jump in there like that and do get out like interrupt somebody and take the floor.

Therefore, many of the participants recommended the following: Participant 2 indicated that the STEM field requires someone who can speak loud to get their voice heard and have their perspectives at the table. Participant 3 motioned that statement and noted that STEM and

specifically chemistry is considered a competitive field. Men tend to speak loudly and be the first to initiate or take over conversations (Participant 3; Participant 10). Hence, getting interrupted and not having time to have a voice may put an individual in an uncomfortable situation. Participant 10 expressed:

> I didn't want to interrupt others when they were talking…this is kind of important to me. But I saw that one of my male … would like to interrupt me a lot and that made me mad because I remember I read all the time about women getting interrupted by men, even if the men aren't as knowledgeable as the women. And like that just frustrated me like the principle of it.

As a result of personal experience, the difficulty of women to speak in STEM and men willingness to listen led Participant 10 to stay conscious, not be competitive, but acknowledge that sometimes "you have to be very conscious about all the dynamics and how you might be prepared to act or react." Therefore, without a host or a conversation leader, some women may not get the chance to speak out their ideas. Thus, Participant 3 insisted that women need to be brave, speak, and ask questions when needed. Speaking of questions, Participant 3 reflected on a personal experience and voiced that some women may hesitate to ask questions in classes or at work since they think that asking questions can lead the other side (men) to derive that they (women) are less knowledgeable in their field. Hence, this is an invalid interpretation. Adding to the previous point, Participant 8 recommended women to be extroverted in STEM to not only raise voice, but to highlight issues, problems, or questions women may have in their field. Interestingly, Participant 8 stated, "Every time I wanted to voice something, I somehow did that, except when I realized that person is not listening to me." There are many meanings and

interpretations hidden between this participant's words that hint at a challenge women may face in STEM.

In addition to facing difficulties with participating in conversations or feel included in STEM, women may need to adjust their personalities to fit the environment they are in. Participant 2 quoted, "I come from a background of, you know, you need to be a lady, you need to be polite, you do not interrupt. And if I stick with all of that together, I can find it very difficult to have a voice in a meeting." Thus, she started interrupting people when needed to get her points across. The point that Participant 2 was trying to make is that women are usually expected to be demure and softly speaking. However, females may need to twist or adjust their characters or personality when working in a male-dominated field. In addition to this suggestion, Participant 6 asserted that women need to have thick skin in STEM. Otherwise, women may find it difficult to face the different challenges in STEM or proceed with their STEM education or career. Many participants in addition to Participant 1 corroborate with that statement. Additionally, Participant 1 shared that there are stereotypes that assume or claim women in STEM to be more masculine; however, "I think we're almost pressured into acting more masculine just to fit in" (Participant 1). Adding to this point, Participant 1 stated being male and tough is the norm in STEM. Thus, fitting into this field can be difficult and may require a change in attitude, which can be difficult for some. Participant 4 insisted that changing her attitude or hide part of her identity as a female was not comfortable. However, based on her personal experience, she did not feel people would take her seriously if she did not acclimate herself. For Participant 7, she indicated that she tried to be conscious of the STEM environment, not fit any of the stereotypes or become an individual she does not want to be, but to respond to the field she is in. Of note, Participant 7 and Participant 2 (specifically Participant 7) were the least to adjust

their identities due to the fact that the way they were raised and grew up played a role in leading their personality types to be conducive to STEM environment. This statement may lead to an understanding that there are stereotypes in STEM. In reality, that is true; the majority of the participants believe that there is a discrepancy in gender in the field of STEM. However, their impact on females and how much exactly women have to adjust depends on that individual's background, the environment they were raised in, and age or the number of years they have spent in the field. In consideration of stereotypes, Participant 7 claimed that while there are many stereotypes about the STEM field, a few individuals she has met do not fully fit into these stereotypes. Nevertheless, there are many stereotypes that are assumed to be true and are reported by the majority in this study; Participant 9's understanding of STEM is that many of the boys in the field do resonate with the stereotypes (such as playing a video game and spending the day coding). However, not many girls resonate with it.

When it comes to women's personality in STEM, most young girls are raised on the idea that girls have to be smart/too smart to enter STEM (Participant 2). Interestingly, while the field requires soft skills (math, coding, etc.) and technical skills (Participant 7), many women who have those skills are described as hard-working, and not brilliant like their male counterparts would be (Participant 9). Another example includes, Participant 6 who asserted the need for soft skills in STEM and that females must have background knowledge in order to be part of this field. However, she mentioned that "I think that soft skills do bring them [women] to the table. It may not be what keeps them there, but I think it at least brings to the table" (Participant 6). Thus, this could inform us that while soft skills are required to enter the STEM field, they may not keep them there because the field is like a puzzle and women have to put all the pieces together to be able to proceed with success.

Due to this ideology and mind of thinking, some women end up fulfilling stereotypes of being tomboy, geeky, and tough. These are things that not all women are interested in being in order to fit in the STEM field (Participant 1; Participant 2; Participant 7). Additionally, Participant 6 recommended females to have thick skin in STEM because "you have to get a lot of knocks because of the stereotypes." Participant 10 expressed that if she is the only woman in her field, she would be self-conscious, speak up and be assertive. However, if everyone is quiet, she would be "very conscious about all the dynamics and how you might be prepared to act or react" (Participant 10). At the same time, she assured that females may take these roles to show their colleagues that they are not different and that they have understood the field and its requirements (Participant 10; Participant 4).

The most important keys in STEM that women need to know about or include as part of their personalities are to stay motivated, push ideas, and have a passion to continue in this field (Participant 2; Participant 5). A supported example was brought by Participant 6 who shared a personal story and stated that she developed interest/passion once she dove into the field and learned more about it. Participant 6 was able to shine in her field because she was able to adjust her personality and link it with her degree, even with all the challenges her field brought. Her suggestion is that without passion, it may be difficult for women to face obstacles and continue in STEM.

Dressing.

Twisting or adjusting identity in STEM is not sufficient. According to this research's participants, many found themselves adjusting their style as well for the sake to fit the environment or the culture they are in. Based on previous experience at work, Participant 3 stated that females have to stay conscious about the way they dress. She added, "You have to

dress like a tomboy to kind of be taken seriously" (Participant 3). She notes that wearing makeup and dressing up in a way that individuals are seen to be too feminine can lead their counterparts to not take them seriously (Participant 3; Participant 4; Participant 10). Females may get questioned when dressing up. Participant 6 mentioned that in one of her conversations with her new supervisor, he asked her whether she always wears skirts to work or was that just to meet him. She expressed that, "I knew right then that I was not really going to be treated seriously." In addition to this example, Participant 3 shared an experience she faced in her career:

> If I go and dress a certain way, I kinda get questions. I, sometimes, go to work and all dressed up, you know, I want to wear a dress; I wear heels, you know, and my colleagues will be like you came all dressed up, are you ok.

Similarly, Participant 4 called on a personal experience when she was pursuing her undergraduate degree. She confirmed her interest in wearing makeup and getting dressed up. However, she noticed in her first week of classes that most of her female classmates did not wear any makeup and used to come to classes wearing pants or trousers. Thus, she had to change her style and stop wearing flashy colors to prevent students from not taking her seriously. She shared that she was trying to present herself as someone who is committed and serious about the program (Participant 4). Participant 5 indicated that STEM requires a professional look and as long as she dressed professionally, people do not reject the style; however, she stressed, "But I do like a lot of times women in this field, we definitely have to play ourselves down like feeling too flashy" (Participant 5). Additionally, Participant 2 stated that she used to lean more toward the tomboy look in school; when she transferred to the professional life and through time and many years of experience in the STEM world, she moved away from dressing in that style. Participant 9 acknowledged the fact that it is not because STEM women are adjusting their

dressing style, but because of the cultural stereotypes that females cannot be girly and smart at the same time. From this perspective, Participant 8 shed light on the fact that dressing and acting like men is what most women think they should do in STEM because males are the majority. Therefore, most females think that in order to be smart/good at math and engineering, they have to dress in a masculine way (Participant 8). Yet Participant 7 was the only one that stated she goes with styles that are easy and fast since she is busy most of the time and does not have much time to dress up.

Effort and Time in STEM.

In addition to attitude and style in STEM, this field requires massive effort and time. STEM is a competitive field (Participant 3). Thus, many individuals in the field dedicate their time to work. Reflecting on this point, some think that because it is a competitive and sexist field, it is not one recommended for females (Participant 3; Participant 5). That's what was told to Participant 3 when she began pursuing her undergraduate degree. Since STEM is a male-dominated field with a low representation of women, Participant 3 expressed, "I had to do double the work to prove that I am capable of being a scientist … I have to work harder to prove that I am capable of doing my work." Similarly, Participant 10 stated that women put more effort to show that they have understood their job/field and know how to work in it. Participant 6, Participant 4, and Participant 1 added that adding more hours or doubling the work is constant in STEM, especially if females want to prove themselves and be stubborn. Participant 1 shared:

> It's almost like you have to work twice as hard, just to make it look like you were doing the same amount of work as a white male colleague … I think there's a subset of women who see the lack of women in the field and make a point of trying to stay in STEM just to prove that they can, and that makes me sad.

Thus, this can bring us to an understanding that there are many factors to why women double the work or put more time or effort in STEM; this is something that should be spotlighted as well. Moreover, from one hand of the equation, we observe women trying to prove themselves in their field, and from the other hand, we notice the presence of a cultural pressure that could be leading women to double their effort in STEM. Participant 8 acknowledged:

> When it comes to women, although it is underrepresented, still we are much better. We're doing way more work than most of the men because if we don't do our work, then everybody would say oh she's a female; that's why she is not doing that. So that's why we are working twice as hard to get to that point whereas they might have achieved it.

Hence, putting more time into work may not give individuals the flexibility to have a social life as previous studies indicated (Participant 7; Participant 2). Moreover, individuals may not have time to create the work – personal life balance (Participant 7; Participant 2). Participant 9 and Participant 2 stated that most of the males that worked with them had a partner who had a light job and took care of their children. Participant 5 stated that she constantly felt like she had to do more work to prove to her supervisor that he made the right decision by hiring her.

Doubling the work requires time. However, there are other responsibilities in STEM that require time. Participant 9 expressed that in one of her experiences, her counterpart expected her to be available even after work and over the weekends (such as answering colleagues' emails); this did not resonate with her and was a reason to switch her job. Additionally, Participant 6 stated that she had to pick up more hours for the sake to understand her field and learn about it especially since her educational background was not STEM-related, which created a conflict and added to her schedule more time to learn about the field. Similarly, STEM requires individuals to keep developing and updating their knowledge constantly (Participant 4). Therefore, women may

find it difficult to put more work than expected and not end up reaching the life-work balance (Participant 4).

Challenges.

There are many challenges in STEM; the ones that will be mentioned in this section are taken from participants' responses. There are many interpretations that are hidden between the lines about the challenges females may face in STEM. One could be from the extra time or work individuals have to put in this field. Another one could be the fact that due to the low representation of women in STEM, most of the STEM fields hire women in positions where they can be visible to the outside world or do the outreach for the sake to show diversity. Both of these challenges can lead women to quit or be close to quitting in STEM (Participant 1). Participant 5 shared that being the only woman or one of the minorities in the field is a challenge in itself and male colleagues could compete with women if they feel threatened by their presence (Participant 8); she stated, " I do think a lot of women get tired of being the only women in spaces, like a person can only take but so much" (Participant 5). She added, "because every day I know that there are stereotypes associated with me being a woman … I do find like I'm experiencing more obstacles than my counterpart would." Another challenge is that "STEM is not a field for women", which is something that individuals may suggest to women who are thinking about entering the field (Participant 3). Participant 3 expressed that this was one of the challenges she faced in her journey which reflected negatively and caused stress. Speaking of stress, Participant 1 reflected on a previous experience and mentioned that it can be very frustrating when women are expected to not complain when they have female mentors; quoting, "I'm not even allowed to complain about my advisor, as a woman, because I'm considered like, so lucky to be a woman with a woman advisor. Oh, and I feel very guilty when I complain about

her." (Participant 1). Hence, this is incorrect because in this case, men should not complain in STEM since they are highly represented and act from a point of privilege. However, in real life, we see men complain about their work and mentors. Many may view STEM to be an analytic, competitive, and complex field (Participant 5, Participant 3, Participant 9); unfortunately, they do not perceive women to fit this type of culture, which can be a challenge by itself to many women (Participant 5). To this extent, women may not get the needed training on time. Participant 6 mentioned, "the staff that were doing [job] really took a long time with me to do training, that I don't think that I would have gotten if I had been a male of that age." In fact, Participant 9 shared that "researchers are less willing to mentor female candidates with the same exact resume as male candidates." Not just that, but some of women's achievement/effort in STEM are not highlighted or recognized (Participant 8; Participant 9); women's ideas many get taken and credited by men (Participant 1; Participant 6); that was an issue Participant 1 faced in her journey. Additionally, a great challenge that is facing many women is the educational piece -how to apply the learned skills in schools to the real world (Participant 6). This is important to women because they need to learn about the application of their roles and skills in STEM. There are not many examples in STEM. Thus, females need this step in their journey. Participant 8 shared that women "can't just jump into emptiness" and enter journeys they are not much familiar with its culture and environment, especially if there are consequences.

Therefore, there are many challenges in STEM. Some may lead women to quit or change education/career (Participant 1; Participant 7). Additionally, some women may get afraid to take risks or face those challenges (Participant 3; Participant 4). Moreover, wages in STEM were already discussed in Chapter 2; the number of challenges faced in this field may not be satisfying especially with payment in this field.

Underestimation from Others

The second theme was clearly overlapping between all participants. Underestimation was/is common in STEM, especially because it is a field that depends on soft skills. In other words, there is a negative connotation associated with a women begin a mathematician, statistician, engineer, physicist, or scientist; this could be one of the reasons why "we're not seeing a lot of women pursuing these degrees [and careers] at the moment" (Participant 5). Similarly, Participant 2 and Participant 6 stated that men in their field did not think that they were capable of their jobs because they were females; to their understanding, if you are not a man, you cannot do the job (Participant 2; Participant 8); Participant 4 added that her field is more for men because they could understand it more. In other words, people (men) do not have confidence in women's ability (soft skills) in STEM because they think females do not fit the field, which can lead to underestimation (Participant 3; Participant 4; Participant 6; Participant 10). They might even refuse to listen to women (Participant 8). For example, Participant 6 provided an experience where someone asked her "I'd like to speak to your supervisor, which was at that point in time code for, you can't possibly know what you're talking about are doing. So, I need to talk to your male supervisor." Asking for male approval at work can be stressful and uncomfortable to women (Participant 4). For that reason, Participant 6 stated that women need to have thick skin in STEM in order to continue and stay. Moreover, in STEM, women get questioned twice as often as a man would (Participant 3) because women viewed as not analytical and can not face the stress that comes with STEM fields (Participant 5). Interestingly, a popular stereotype in STEM that women are those who dedicate more time to personal life, which may lead them to dereliction in their work; this can hinder females' professional growth (Participant 5). However, Participant 2 asserted that women are multitaskers; they always get

work done, especially those who are used to responsibilities since they have children or other obligations. Seconding that, Participant 8 assured, “that those few women who are in this field, there are about twice as better than those men.”

Underestimation can stick to females and lead to a negative impact (Participant 2). Participant 8 stated that “my supervisor used to play with my insecurities and that experience is still in my head, and I’m still trying to recover from that insecurity. . . [However,] I started questioning myself and always think about what I say.” Additionally, Participant 9 explained, “they [(men)] would make like a comment or something that sticks with you that seems like it's downplaying.” Participant 8 affirmed, “my supervisor, he used it to play with my insecurities . . . [and] I'm trying to recover from that, you know, still, I'm trying to recover from that insecurity.” Individuals could try significantly to distract their attention from those negative impacts (such as feeling hurtful), but not all the times which can lead to many consequences; one of them is low on productivity (Participant 8). Participant 3 provided an additional example of a time where she was recommended to switch her major since STEM is a way more competitive field and her advisor assumed that she was not capable or could not handle the field she was in; she was encouraged to change to biology because it was common for girls than boys and that she would not have to feel uncomfortable in classes (the fact that some think women are not capable of math or soft skills, individuals encourage women to pursue non-STEM degrees (Participant 8)). To be advised to change major or field because of perceived ability can be disappointing and depressing to many females; they would think that they do not have what it takes to be in STEM fields or they are not sufficient for that field (Participant 9). Going back to Participant 3, she was informed that she was not going to pass and no universities would accept her in that field; she acknowledged that if she had taken his advice, she would not have entered university, received a

degree, and became a scientist (Participant 3). Participant 5 added that **“**During my time in undergrad, it was definitely an uphill battle. I've had professors tell me, look, if you can't do this, then maybe you should change your major.” Her professor communicated that regardless of her personality and gender, this field would not have been easier (Participant 5). Participant 1 stated that there was an “unspoken thing where everyone felt like I was treated differently”; there was an unconscious bias against her because of her gender (Participant 1).

Many participants asserted these underestimations and stereotypes could cause women to work harder to prove others wrong (such as putting double the effort and time to prove their existence (Participant 4)); they could also contribute to automatically assume roles for each gender. Therefore, the absence of stereotypes would have led females to coast through work (Participant 5); as an example, Participant 8 shined in an experience where she was not underestimated by her counterpart. Yet their presence and association with being women could result in more obstacles for them than their counterparts (Participant 5). One of the challenges of quitting a STEM education or career is the pressure and stress females face in their field from their male co-workers. Participant 6 shared a previous experience with the researcher stating that in one of her STEM journeys, she got offered a position in a department that was missing females; she saw challenges and obstacles coming into her way in a field that is male-dominated and assumed to be hard to work in such a culture. She stated:

> Because it was such a male-dominated environment, I could see even in the interactions that they didn't take what I had to say seriously . . . even if I made a suggestion, I wouldn't necessarily get the claim for it, and I wouldn't necessarily be celebrated for it [this is something mentioned multiple times by different participants (Participant 1)].

Thus, she ended up rejecting the position and not pursuing it (Participant 6); we can conclude from this example that stereotypes evolve and are true in fields where women are poorly represented (Participant 8). Providing another example, several participants expressed that the surrounding community could discourage or warn individuals from pursuing a certain career or degree whereas in reality, they could significantly qualify for that field (Participant 4; Participant 6; Participant 8; Participant 10). In fact, once you dive into the field, you will observe women's trace and effort in STEM (Participant 1).

Participant 5 indicated that there were "roadblocks of getting him to trust that they made the right decision hiring me." Conversely, these underestimations or stereotypes can lead some women to accept and believe in them, which could result in leaving the field (Participant 3). For example, females may hesitate to ask questions or provide perspectives because they may be misunderstood by others. In other words, they lose self-confidence and start doubting themselves (Participant 4). Additionally, females may grow up thinking that they do not have to know math because they are girls and not supposed to know everything, which could come from culture or community (Participant 3; Participant 2). Speaking of that, society pushes women out of math and STEM in general. Therefore, by the time they get to college, they either do not have an interest in STEM or it is fractional (Participant 5). On the other hand, Participant 7 stated that both genders show interest in STEM in their childhood. However, females lose that passion as soon as they hit puberty. Participant 9 mentioned that women lean toward fields that are impactful; thus, people in STEM may need to work harder to pitch in the field to increase interest and representation.

Moving forward, people may picture males in STEM more than females, which is unfortunate. However, through time and as Participant 2 matured, she learned that there was

something amiss. The truth is that women are capable of soft skills and are eligible to work in or study STEM; they just need encouragement (Participant 2). Moreover, opportunities that are offered in STEM may not be fair. Participant 3 stated that she had to wait a long time to enter the field she admired. Participant 10 added that in a previous interview she had in the past where a hiring manager sat with her for ten minutes trying to explain her soft skills assuming that she did not understand them. Additionally, while career opportunities for women in STEM have increased, Participant 6 mentioned that "there have been instances where I've seen women were hired as sales people because they would sale people because they would bring money rather than because of their expertise in that area," and Participant 1 seconded that statement. Women are brought on not for science, but for the sake to show diversity (do work that men do not have time to do such as public outreach) (Participant 1). Surprisingly, hiring managers can recognize applicants' genders most of the time from the tone of the applications and the vocabularies they have used (Participant 9). For example, when the word "brilliant" is being used, usually males are the candidates. However, using "hard-working" indicates that females are candidates. Hence, this is not only a gender stereotype but an underestimation based on gender as well (Participant 9).

Stereotypes and underestimation (whether they are ability or style-based) exist in STEM. However, in order to proceed in this field, Participant 6 kept insisting on the need to "take up pushing him on mansplaining me on stuff and say, I'm well aware of that. I understand how this works." Additionally, Participant 7 mentioned that females should have the self-confidence to face people with courage whenever they get underestimated or questioned in STEM. However, Participant 8 added that stereotypical men are common in STEM, thus if they do not affect individuals, then "there's no point fighting over it."

Confidence in Self

Self-confidence is needed especially in STEM. Previous studies stated that women underestimate their own ability in most of the STEM fields. However, reasons have not been investigated. When interviews were conducted, the researcher was careful to ask participants questions to better understand the factors that are leading women to underestimate their own ability when entering STEM education or STEM career. Participant 1 mentioned, “I have been surrounded by very confident men in STEM who seemingly will never admit that they do not know something. If they do not know the answer, they'll just like, make stuff up and say it very confidently” to the point that they will convince those around them. Participant 1 voiced, “that is not how I speak. So just the fact that I will occasionally say, I don't know or I'm not sure … [will make] me look stupid.” This explains that vocabularies are important in STEM. Usually, women would not claim their knowledge or understanding of a subject until they are 99% sure of it (Participant 1; Participant 5; Participant 9). Therefore, most females end up expressing their knowledge to, “I am not sure or I don’t know,” which could be negatively interpreted by their counterparts. Men, on the other hand, have high self-confidence and usually voice strong opinions or use vocabularies that could imply their significant understanding of the field whereas those vocabularies do not necessarily reflect on the knowledge they have (Participant 1; Participant 5; Participant 6). Having a 99% of knowledge can play a part when applying to job positions (Participant 4; Participant 6; Participant 2). Participant 4 and Participant 6 shared that they did not submit an application for a job they mostly/fully qualified for. To their understanding, they had to meet the 100% qualification before applying whereas one of their colleagues applied to the job with similar knowledge and background experience. Thus, the interpretation of how to measure qualifications or knowledge varies from males to females. This

could be one of the reasons that is creating or increasing stereotypes against women in addition to how girls versus boys are socialized and taught to communicate/perceive things in different events (Participant 1). Due to the stereotypes in STEM, in return, women result in underestimating their own soft skills ability (no matter how hard they will work, they will always have low self-confidence. While contribution and effort are not recognized most of the time, some participants think that this may lead females to question seeking STEM education/career) (Participant 1; Participant 3; Participant 6; Participant 8). Some participants think the cause of these situations is due to women's low representation in STEM. They described this to be the factor that is causing the pressure for women and is leading them to have a low self-confident in their abilities (Participant 2; Participant 4). Speaking of pressure, most females do feel stressed in STEM due to the different thoughts that go in their heads. Participant 4 remarked:

> [women are] afraid that they might be wrong, especially when someone takes a challenge and some thoughts come to their head like, I cannot be wrong, I cannot. They question themselves saying I cannot show myself as a weak person. And these kinds of pressures can make them change their decision, instead of going into studying science, they would just go and study art . . . they're afraid that other males might tell them you don't belong here.

Reflecting on another personal experience, Participant 1 added:

> I think stereotypes that influence the way people view me. They could have caused a few of the struggles I've had in graduate school . . . I actually think no matter what you are doing, someone views it as wrong.

Yet Participant 4 stated that as a hard-working person, stereotypes were preventing her from moving forward and think that the effort she put in would never satisfy the field she was in.

Thus, in this case, females are not only being underestimated by others, but those negative feedback or skeptical comments are effecting women's self-confidence (Participant 3; Participant 9; Participant 10). Participant 1 insisted that when it comes to difficult or higher-level courses, women may review them as hard classes that may require skills that are not known. Participant 7 added that she came across many women and young girls who underestimated their own ability quoting, "I started to notice the patterns of girls saying, 'Oh, I'm not good at math and physics, that's hard. Oh, you must be really smart to understand that."

Doubting self or thinking about misinterpretation are not comfortable feelings to have at work, in classes, or during meetings that could lead to stagnation or discourage women to continue (Participant 1; Participant 3; Participant 4; Participant 5; Participant 9; Participant 10). Thinking about every interaction made and questioned asked can lead individuals to enter a spiral that they may not be able to get out of. Participant 1 mentioned:

> You waste so much energy thinking about every interaction you have and then wondering, did they say that to me because I'm a woman? Did they say that to me because I'm young? But just the energy it takes to constantly second guess yourself is exhausting.

She added that even after each presentation or a meeting, she would insist "what I'm saying cannot possibly be right, but they're just listening to me because they think it's fun to hear this young woman describing science to them" (Participant 1). This explains that women may get surprised when realizing skills or recognizing their professional knowledge. Participant 10 asserted that "I remember feeling surprised. I said, oh, I'm really good at these abstract equations when it comes to quantum chemistry, and all of that. My brain does well with that," which was surprising to her.

Those difficult words could stay with individuals and could cause a serious impact; including the termination of a journey (Participant 1; Participant 3). In other words, these negative vocabularies are leading females to feel they do not fit in or do not have a role (Participant 5; Participant 6; Participant 10). Participant 10 shared that with all the difficulties and challenges the STEM field brings, she is not confident in taking another experience in STEM. Motioning this, Participant 4 expressed that females may raise many questions and think about challenges before making a decision on entering STEM; yet "unless this female is a strong one, she would do it" because others may not be comfortable facing risks and the insecurities of the STEM field. Similarly, Participant 4's friend hesitated to pursue STEM education, although she was good at soft skills, because the surrounding environment warned her of the stereotypes and she did not prefer being a minority or the first one to face the obstacles as well as take risks in this field. Had she believed her ability and disregarded stereotypes; she would have shined in her field. An intreating point, Participant 9 claimed:

> Girls who got a B in the intro computer science class were less likely to continue on than boys who got like a B or a C. [Interestingly] boys would get a lower grade, but they would be like, you know, I really messed up this class, but I am a computer scientist, I spent all my time playing video games and coding, that's me. [On the other hand, if] girls would get a B; they would take it as evidence that they weren't good enough. They didn't fit the stereotype.

Speaking of inclusion, Participant 9 indicated that she was surprised about the number of individuals who were irritated, stressed, and emotional because:

> They didn't fit in or feeling like they weren't good enough or their work wasn't good/strong enough, which I think often links to both your own internal ideas about

> yourself and what you're getting from other people. [Thus,] I definitely think that both underestimation and then stuff that happens to women in STEM fields totally affects their confidence (lose faith) and their ability to stay in their profession (sense of belonging).

Participant 3 confirmed that by sharing that in a previous experience, she was depressed thinking she was not good for her field due to underestimation from others. Repeatedly, underestimation from others is not the only factor that is impacting women's interest in STEM, but stereotypes are contributing in regards to that as well. Thus, women tend to seek fields they feel more comfortable and welcomed (Participant 9).

While underestimating self is common across women in STEM, Participant 7 mentioned that females should have self-confidence, which will come with age and experience, to face people with courage whenever they are underestimated or questioned in STEM. Participant 8 and Participant 6 assured that females who go through different experiences in STEM, would have thick skin and become stronger, resilient, stubborn, tough, opinionated, and more manly (participants could be speaking about actions or men's personality in STEM). In addition to that, women should let go of negative comments, not fight for something that would not affect them on a personal/academic/professional level—especially when working with individuals in the field who believe in stereotypes, trust/stay confident in their ability, and take small steps if needed—even if their journey will take longer time (Participant 8; Participant 7). In addition to that, women should know that they are capable of soft and technical skills; they just need to change environments in order to shine in their field (Participant 7). Seconding this statement, Participant 1 shared the truth is that most women are capable of technical skills and could succeed at high-level courses, even if they seem challenging. Participant 8 added that the STEM field needs males and females. Therefore, women should have faith in their abilities (Participant

5; Participant 8). While Participant 7 stated that, “a big part of that [the ability to overcome challenges in STEM] was the confidence that males in my life gave me by saying, yes you can. It was huge”, the researcher may assure the importance of gaining confidence from self and not waiting for counterparts to give those encouragements (as they could boost someone’s level of confidence (Participant 7)) because their absence could have negative consequences in leading women to feel not included or needed in the field (Participant 8).

The Impact of Women Mentors and Colleagues

Women Mentors

While STEM is full of obstacles and difficulties that not many women could overcome, mentorship and examples are significant in a field like STEM, especially with the absence of female representation. Participant 2 started by mentioning, “I tend to gravitate towards wanting to mentor women” because while we may see confident women in STEM, they gravitate toward female mentors who can take their skills, experience, ability and transfer them to young and new coming females as well as train them in how to succeed in a male-dominated field (Participant 9). Participant 6 shared that having a female mentor who was supportive benefited her in STEM. Participant 5 added, “I met a woman in my field. She took me under her wing and actually changed my entire trajectory. She opened the door to other women who come in. [Through her] I was able to meet other scientist women and go to conferences.” She expanded on that, “I oftentimes feel like when you don't have people who look like you, who have similar backgrounds to you, it's very hard to relate to your coworkers on a social level” (Participant 5). Thus, by having that community, Participant 5 was pushed to strive in her field as well as start “interning very early in my college career.” Without a female mentor, she would have not been able to proceed with confidence and accept opportunities; Participant 5’s mentor wanted her to

grow but learn skills as well. Participant 7 added that female mentors were able to understand/support/motivate her in her STEM journey. In general, mentors act as supportive individuals who guide women along their paths. Usually, having female mentors are comfortable to others in the field. They do not only assist with educational and professional developments, but they also understand women's challenges better and help inspire/motivate other females to proceed (Participant 2; Participant 4; Participant 5; Participant 7, Participant 10). The majority of male mentors could not completely understand women's experiences in STEM and are not familiar with the challenges they face, which could create a difficult time for women to continue (Participant 4).

An important point to mention, Participant 1, Participant 8, Participant 10 indicated that a few of the current female mentors can be perceived as assertive or hard on others due to the difficult experiences they went through, especially with being a minority (the only one) in the department. Additionally, they "could just be seeing more potential in her female students, so they push them further" (Participant 1). This is for the sake to prepare them for the STEM field (Participant 1; Participant 8; Participant 10).

Before diving into the details of how it feels to have more females in the STEM field, several participants shed light on an interesting point about mentorship. Starting with Participant 1 shared that, in the past, she had a male mentor who advised her in one of her journeys; yet he was a good supporter, she indicated, " I don't know if he treats me differently because of my gender. There's never been a time where I questioned it, which is a good sign." Participant 8 added that her male supervisor was very supportive of her; he gave her opportunities and allowed her to grow in her field. Seconding that, Participant 9 and Participant 7 insisted that their male mentors supported them when they were going through a special experience of their lives.

Moreover, Participant 10 shared that her male mentors "made a very, like, strong point of being encouraging to female and minority students; being very vocal about that"; they were encouraging. Consequently, and out of curiosity, the researcher started questioning how males could be good mentors to women in STEM. Asking about Participant 1's male mentor's partner profession, they had "a Ph.D. in STEM and also a very successful STEM career." Similarly, Participant 10 and Participant 7 indicated that their male mentors' partners pursued STEM education and career; they were successful and able to understand the journey as well as listen to them. Yet Participant 8 assured that her male supervisor had a mother who was educated in STEM; thus, his mother's personality and experience changed "a lot in him." While the family could influence someone's perspectives, other experiences in life would affect individuals as well. Participant 9 claimed that her male mentor had a wife who was in STEM—he had a knowledge of how it is to be a woman in a male-dominated field. Adding to that, her supervisor:

> Tended to mentor a lot of women because he was a leading voice in this field . . . [so] by the time I had him at the end of his career, he was like, super experienced, had mentored probably 100 women in different ways (Participant 9).

The conclusion that good male mentors are those who usually have a significant year of experience working with women or have female family members who have higher degrees or positions in the STEM field. This could go back to the fact that these men have already witnessed the challenges a family member went through. Thus, they know how to support females in STEM. However, similar to Participant 5, a few participants indicated that no matter how supportive a male mentor is, they would not fully feel or relate to the challenges women go through in STEM.

Women Present in STEM

Moving forward, while mentorship is important, the researcher was careful to follow up with questions asking participants how they would feel if there were more women in STEM or what would they add to the field. Participant 1, Participant 3, Participant 5, and Participant 10 started with having more women in STEM will encourage and inspire other females to pursue STEM degrees or careers. Participant 1 stated that her female teacher led her to have a great passion for STEM and pursue the field in college; her teacher introduced her to the beauty of the field. Moreover, the representation (as mentors and coworkers) would not only change the feel of the atmosphere in STEM fields and reconsider stereotypes and obstacles that exist, but external pressure will be also released and women would not need to raise voice, adjust personality, double the work or put more time for the sake to bring perspective to the table, prove their existence and demolish those stereotypes (Participant 1; Participant 3; Participant 5; Participant 8; Participant 9; Participant 10). To put it differently, women would voice each other's concerns alongside understanding/respecting/listening to each other's initiatives and recognizing achievements (Participant 8; Participant 9; Participant 7). Hence, this would lead females to feel more comfortable/included/safe in such environment and opinionated alongside not worrying about questioning self, what to say and how would a counterpart interpret words (Participant 1; Participant 2; Participant 3; Participant 4, Participant 9; Participant 10). Participant 3 reflected on a personal experience stating that in a conference she attended in the past, women were more comfortable/secured to ask questions and present ideas just by seeing other females in the room. Thus, having more females in a field will "make future women have an easier time in the industry" (Participant 1). In like manner, Participant 2 expressed that "watching other women do the job was inspirational." She added that while human biology is a soft skills field, women's representation at the undergraduate level is fair. From Participant 2's perspectives, females'

representation in human biology is what motivating other women to pursue this field. To put it differently, seeing various examples (role models) of women in the field is leading others to connect and relate cases as well as observing successful stories of women in STEM (Participant 2; Participant 3; Participant 5; Participant 6; Participant 8). Hence, we see more men in STEM because they have diverse and many cases/examples they could relate to (Participant 8). In addition to that, having more representation will add a unique culture and environment looking at the field from a different lens and will also lead individuals to highlight women's achievements and recognized them (Participant 6; Participant 3).

Women's Absence in STEM

Women's absence in the field may lead young females to not have an interest or not find a related example that they could assimilate with or do not have individuals who could offer them valuable advice (Participant 8). In other words, women may not have role models if they are absent. Thus, we need to present role models and create an image of women in most of the STEM fields. Participant 8 claimed, "when I was a kid, I was not sure what type of a model I am looking for". To point out, women do not pursue degrees or careers that are empty of those with similar backgrounds stressing that their uniqueness (being the only female in the field) will create challenges for them (Participant 3). Some obstacles could lead individuals to switch fields fearing that counterparts would not understand their perspectives, take them seriously, or credit/celebrate achievements, which may lead to serious interactions (Participant 6; Participant 8). In addition to that, women's absence from STEM increases stereotypes and result in having women fight challenges.

What Women Need to Do in STEM

With respect to all the challenges discussed above that could affect women's contribution in the STEM fields, participants affirmed that there are some suggestions of advice that women need to do or follow in STEM in order to proceed in this field. All participants recommended women to work hard, take advantages of opportunities, highlight their work, be stubborn/strong, have thick skin, face challenges, learn how to negotiate for pay that would resonate with expertise, be resilient, seek safe work culture, set boundaries to not allow others to take advantage of them, step out of their comfort zone, think out of the box, have faith/trust in self-ability in doing work (soft skills), and have confidence in one's own personality and style (by keeping their personality alongside adjusting it as needed, but not changing it) for the sake to continue in their field. Participant 6 added that relying on self and consistently teaching self about the field would make females succeed in STEM and will lead them to not allow others to underestimate them. Moreover, Participant 3 insisted that women should not fear STEM. They should train/teach themselves how to let go of stereotypes or ignore their negative influence, stop thinking about/believe in discouraging comments, and do not allow negativity to defeat them (women) (Participant 1; Participant 3; Participant 4; Participant 5; Participant 6; Participant 7; Participant 8; Participant 9; Participant 10). Stereotypes and negative comments could be barriers and prevent women from moving forward (participant 4). Therefore, women do not need to fight things that would not affect them; they indicated not all battles are worth fighting for, so if someone is not listening, then do the work and let it speaks on behalf of you (Participant 1; Participant 8). Additionally, calm down when obstacles are faced because individuals should not allow things to accumulate (Participant 10). These actions would decrease the effect and lead women to not be hindered by these stereotypes and challenges (Participant 5). Participant 8 shared that not taking comments personally always helps in STEM and elaborated, "If you try to

focus on the hurt, you will continue to suffer. So just focus on the lesson and do not let your insecurity last with you," so one could proceed quickly.

In addition, Participant 2, Participant 5, Participant 7, Participant 9, and Participant 10 insisted that women should learn how to be outspoken to ensure their perspectives and voices are heard and diverse mindsets are present. Yet, they need to keep trying and stay determined about their goals and when trying to either enter the field or deliver a point in STEM (Participant 3; Participant 5; Participant 6). Being outspoken would allow females to highlight needs and issues as well as talk about their insecurities (Participant 5; Participant 6: Participant 8).

Therefore, self-reflection in STEM is significant. Reflecting on experiences, strengths, and weakness is a way to fuel one's energy as well as allow them to realize the situations they are in and what actions need to be taken (Participant 2). Recognizing strengths and weaknesses could enlighten women or open their eyes to areas they have not realized yet (Participant 4). Participant 5 added that self-reflection is needed to remind women about the reasons why they are pursuing such a degree or career. Additionally, this process will give females the time to reflect whether the field they are in resonates with them. Participant 8 mentioned that she had to self-reflect on an experience she was going through and ended up realizing that her effort would not be recognized if she continued in that journey; thus, she started looking for better opportunities/job positions/cultural environments that are safer so she would not allow that experience affect her negatively (changing environment when is necessary is important to let individuals shine (Participant 7)). An important point to highlight or think about when self-reflection is reviewing self-actions to see if individuals are being privileged about their gender (as females), meaning they are using their gender as an excuse to not do work, perform well,

complete tasks. This, in return, is contributing to reinforcing the stereotypes, which could "ruin it for the hard-working girls" (Participant 8).

Lastly, women need to realize that STEM is full of creativity, without it, innovations would have not innovated. Thus, linking creativity to interest would result in leading females to enjoy their field (Participant 6; Participant 1). Participant 9 described it as "adding art to projects [(work)]." However, and unfortunately, the need for creativity is not clear to the public. Therefore, women need to raise awareness about its exitance and advocate for it (Participant 6).

Yet without passion added to the advice mentioned above, it would be difficult to continue in STEM and enjoy the field. Women should be ambitious and have the ability to consistently explore the field and have a deep interest in it; passion would act as a motivator factor that would allow females to overcome challenges (Participant 5). In other words, finding meaning in work and field is important for success (Participant 6). Participant 5 added, "You need to have a drive, whether it's coming from family, whether it's coming internally, or whether it's coming from having a community who's going to continue to push you and hold yourself accountable." Feeling empowered as well as empowering other females is significant to succeed in STEM (Participant 5; Participant 8; Participant 7). Encouraging one another and offering/seeking advice from mentors or coworkers is essential (Participant 10; Participant 7). Thus, creating a healthy relationship with people is crucial, especially since encouragement is needed, and STEM is not only about soft skills, it is also about people, which is "huge" (Participant 2; Participant 6).

In the end, failing or making mistakes in STEM does not emphasize that women do not fit or belong to this field, and staying "who you are" could influence counterpart perspectives on women in STEM (Participant 4; Participant 7).

Summary

In conclusion, there are many requirements in this field as well as stereotypes and challenges that could be difficult to accept or handle (Participant 3; Participant 4; Participant 9). Underestimation, low self-confidence, missing mentorship, and women absent in STEM could lead females to leave or quit the field. Staying in the field requires significant work/responsibilities/commitments in order to proceed and succeed. Not many are willing to accept those requirements and can find them difficult. Passion, courage, interest, motivation, and thick skin are needed, yet without guidance and advice, it could be hard to navigate in the field even with these characteristics. Interestingly, a low percentage of women (one-to-two participants only) were not as negatively affected by the stereotypes. Participant 2 and especially Participant 7 were the least to adjust their identities due to the fact that the way they were raised and grew up played a role in leading their identities to match or resonate with the one most individuals in STEM have. This statement may lead to an understanding that there are stereotypes in STEM. In reality, that's true. However, their impact on females/how much exactly women have to adjust identities depends on the percentage of women in the field, the access to female mentors, obstacles/challenges/requirements the STEM field carries, individuals background, the environment they were raised in, and age or the number of years they have spent in the field.

Chapter 5

Conclusions

The goal of this study was to investigate the stereotypes that women face in STEM and learn whether they contribute to women's low representation in this field. As a conclusion, what individuals could recognize from this study is that women's interest in STEM evolves differently. Some women develop interest from childhood, others are influenced by family and end up pursuing STEM education/career. On the other hand, there are women who developed a passion for STEM after they entered the field. Among those three different groups, there is one thing in common, and that is influence/motivation. Each of the ten participants had a type of influence/motivation/encouragement that led them to pursue STEM education and/or career. The study provided insights on women's representation in STEM as well as the field's requirements. The research covered Women's Representation & STEM Field Requirements, Underestimation from Others, Confidence in Self, The Impact of Women Mentors and Colleagues, and What Women Need to Do in STEM. Each of these themes was discussed in chapter 4 and supported with explicit examples. Beginning with representation, which was supported by the statistics provided in Chapter 2, the new findings expand that women are not fairly represented in all the biological fields nor all graduate-level courses. Human biology or pre-med courses are those that witness a good number of women in their fields. As mentioned in the Findings section, classes that are hard or complicated (according to many participants' perspectives such as theoretical classes) are low on women representation. Moreover, the research has also found that leadership positions in mostly all STEM fields are vacant from women.

Additionally, Chapter 4 discussed many requirements in STEM. Changing or adjusting personality including the way to speak, interact, and the way to act restricted under several traits. Similarly, wearing typical feminine clothing is significantly stereotyped in STEM; sometimes wearing a dress or makeup could signal a negative reflection of how committed an individual is. Women who have been raised in environments that prepared them for the STEM field did not face problems with dressing or personality. However, these women are considered the minorities in the field.

Time and effort are other factors that are discussed earlier. Women in STEM must anticipate putting more time and effort than their non-STEM fields. Developing/teaching self is an integral part of STEM. Yet, more time and effort were added for the sake to prove self and exitance in the field. Furthermore, other challenges identified in STEM are delays in training, not recognizing accomplishments, work is credited by others, and offered positions do not fit females' soft skills or interest. Part of that could be an underestimation, a theme that was significantly deliberated in the previous chapter. Women are highly underestimated in STEM, which was supported by participants' personal experiences or provided examples of other females in STEM. Women's ability and soft skills are unevaluated in STEM due to many reasons including the way women present (dress) themselves in the field, which means trust and confidence are problems most women face from their counterparts.

Negative actions, words, and responses could affect women significantly. They are playing with women's insecurities and could impact one's health considerably. Hence, these stereotypes and the unhealthy work culture that involve not only challenges and many requirements, but negativity and discouragement, could either prevent/scare someone from entering STEM or lead current female students/employees to quit/leave the field. Moreover, they

could lead women to doubt themselves and lose confidence in their own ability, which is a bigger problem and a serious one to face in one's journey. By losing confidence in self could be interpreted by women that they are not good enough to fit the field or that they do not have "what it takes" to be in this competitive field, as some would describe it. Many participants claimed that there were various jobs they qualified for but did not apply because they either did not feel they 100% qualified or were told to not apply because of the challenges they could face. While many indicate that women underestimate themselves, this study actually opens a new perspective to show what is leading women to underestimate themselves. Vocabularies or women's creative expression can play a role here. Participants shared that when females doubt something or do not have 100% knowledge of it, they will express it as, "I don't know", which can be interpreted as a weakness or low on knowledge.

In order to face challenges, advice and encouragement needed, they could come from mentors or co-workers. Speaking of mentors, female mentors are absent in STEM yet are highly needed. They do not only provide mentorship but could relate to other women's experiences. In return, they could offer valuable advice and make significant suggestions. Additionally, female mentors could open opportunities and help other women to grow in their field. Participants who had male mentors struggled to make that connection and it was difficult for their mentors to understand their experiences. On the other hand, a few reported positive experiences with male mentors. However, some of these mentors had either a family member or partner who is active in STEM or has pursued STEM education/career. Others had many experiences working with women; thus, they are capable of understanding women's challenges.

In addition to mentorship, the absence of female co-workers is also playing into the equation. Not having someone to relate to or sharing the experience with can be difficult. Their

absence is putting women working in STEM on spot, leading them to double the effort and time to prove themselves and show counterparts that women can accomplish/are capable of. Thus, having more females in STEM will not only remove stereotypes and challenges women face in STEM, but will create a healthy, safe, and welcoming environment for many women.

When it comes to what women need to do in STEM to succeed and at the same time work on removing stereotypes/improving the STEM culture for women, it is thought that having passion is good, but not enough. Women need to trust themselves and have confidence in their ability in order to proceed. Females should learn how to forget and let go of negative comments, experiences, and words. They should concentrate on their success and just continue because if everyone quits, then nothing will change. Lastly, they should stay who they are (personality and style do not have to change; yet staying creative is essential in a field full of innovations) and seek advice when needed without thinking about what their counterparts would say or how would they be judged. Hence, proceeding without advice could lead individuals to leave the field. There are many examples of women leaving the field that this research touched on. Most participants shared that they declined an offer or rejected positions due to challenges that are derived from stereotypes that could be difficult to face and overcome.

Answering the Research Question

After seeking participants' responses on whether stereotypes contribute to women's low representation in STEM, the researcher, and many participants indicated that they play a role in preventing females from entering or continuing in STEM. Participant 4 stated, "These stereotypes are still affecting females' thoughts on pursuing what they want or the degree they want in STEM." She shared an example of a woman who rejected to proceed in STEM because she believed in stereotypes and thought she would not be able to do it. Participant 6 added that

culture trains women to be feminine and seek positions that are common for most females. Hence, anyone who gets out of the norm would face difficulties in this field. Participant 8 indicated that stereotypes can bring many challenges. These challenges could lead females to leave or show low interest in STEM. Participant 9 said, “stereotypes plus factors that we've talked about, like both internally, I think they affect people and then externally, I think they affect people.” Girls may not be interested in STEM and their professors may add to that by discouraging them and saying they do not have what it takes to be in this field. Participant 1 and Participant 3 seconded that and added that stereotypes are high due to the low representation of women, which reflects negatively on the image of women that already exist in STEM. Participant 10 mentioned:

> I definitely think like stereotypes exist and have an impact on whether women start to think oh this is the place where I feel safe and it does not seem like it would be too hard for me to try to get into this field or stay in it. I think those stereotypes probably also play a large role if women are trying to get into a male-dominated field.

Participant 7 stated that without stereotypes, women are more likely to enter STEM and succeed in it. Participants and the researcher agree that if this happens, fewer challenges and requirements would be present for women. Participant 2 agreed that stereotypes are affecting and being different could take courage to proceed. Lastly, Participant 5 mentioned, “I think if we're talking today, yes. I still think there is a negative connotation associated with a woman being mathematical.” With this, we conclude that the existence of stereotypes could fear women or lead them to leave the field since they tend to bring most of the challenges in STEM.

Solutions and Recommendation

In this section, the final theme that emerged from the interviews will be discussed. According to the researcher's interpretation and participants' responses, the solution to decrease stereotypes and increase representation is to raise awareness about stereotypes/challenges and women in STEM (Participant 2; Participant 3; Participant 5; Participant 6; Participant 7; Participant 8; Participant 10). The best way to execute this step is by encouraging current women in the field to set examples/be role models for other females and lead these events to deliver a better representation of women's journeys in STEM (Participant 3; Participant 4; Participant 5; Participant 6; Participant 8; Participant 9). Those events do not only educate the public about STEM/how impactful it is, but they should be hosted for the sake to share stories about women's accomplishments, challenges, experiences, and ideas to discuss the field; this series of events could positively encourage women to pursue fields they are interested in and push them to be strong (Participant 1; Participant 3; Participant 5; Participant 7; Participant 8; Participant 9). Additionally, these events could also raise awareness and eliminate stereotypes/not generalize them (Participant 6; Participant 8). For this reason, females should be encouraged to attend such conferences (Participant 3; Participant 8).

Events could include recognitions meaning to highlight women's achievement in STEM, which can easily happen by using social media; by doing that, society would gradually remove stereotypes that women are not capable of soft skills or do not have what it takes to be in this field (Participant 1; Participant 3; Participant 4; Participant 5; Participant 7; Participant 8; Participant 9; Participant 10). In order words, these events would reverse society's views (specifically men) on women. Yet highlighting achievements is another motivational factor/example for other females (Participant 5; Participant 6). Those highlighting events could be targeted to advocate for women in STEM and followed by workshops to discuss this topic

(Participant 1; Participant 5; Participant 6). An important point to keep in mind that everyone is capable of soft skills; individuals just need to receive the same resources, equal opportunities/training, fair education, and legitimate ability perception (job descriptions and vocabularies that resonate with one's ability) (Participant 4; Participant 5; Participant 6; Participant 7). This even includes money; speaking of money, many participants assured that women should not hesitate to ask for money when applying to jobs that match their expertise (Participant 5; Participant 6). Female mentorship is needed to guide women/offer advice/help balance personal-professional life in their journeys, to increase women representation not only in STEM but in STEM's leadership, and allow these individuals to shine in their fields (Participant 5; Participant 6; Participant 8; Participant 9; Participant 10).

Additionally**,** Participant 2 shared that in order to decrease stereotypes and train individuals in the field about women's challenges, females must "bring self into roles and allow people to see that." By motivating women to enter STEM, they will automatically influence other females to join the team, similarly to what could be currently happing in pre-med programs (Participant 3). In general, women are stronger together (Participant 1; Participant 3, Participant 5). For this reason, women who are in the field should consider looking for female STEM groups to learn that there are others who can relate to them (Participant 5).

To increase representation and raise females' interest in STEM, the community and current women should help educate others about the applications of degrees and possible career options they could pursue after graduation. An additional way to increase interest is by teaching both genders about STEM while breaking the cultural stereotypes that women need to learn about femininity or play with dolls whereas men learn masculinity or play with video games (Participant 1; Participant 3; Participant 5). This would train women and the society to undo the

mentally about both underestimating women's ability or underestimating self (Participant 5; Participant 7; Participant 8; Participant 10) as well as encourage these females to develop their soft skills ability (Participant 6; Participant 9).

Making a change in STEM is essential. However, without consistency and determination, change cannot be made successfully. Yet, change cannot happen without the teamwork of families, teachers, and society. Educating women and men how to work, encourage (by boosting each other self-confidence), support, and recognize one another is essential. Due to the low number of examples of women in STEM, society should shed light on educating females on how to apply skills and use degrees in STEM after graduation (Participant 6; Participant 10). Additionally, without connection with organizations that encourage women to pursue STEM, and networking with them, it would be difficult to increase representation and incite interest (Participant 6; Participant 8).

Ethical Considerations

With respect to following the ethical guidelines of the University of Maine Institutional Review Board, participants were treated according to these guidelines. Pseudonyms are used instead of participants' names. This helps in maintaining participants' confidentiality. Although identifiable risks for participants are not assumed to be faced in the study, however, there is a possibility to have a participant who is not willing to mention experiences or share stories with the researcher. Although the interview questions were carefully written to not put any interviewees in an uncomfortable position, participants had the alternative to answer a question from a more general perspective.

Researcher's Perspective

Doaa Khalil is a first-generation graduate student at the University of Southern Maine who is pursuing a master's degree in Leadership Studies. Khalil has a bachelor's degree in Mathematics. She is passionate about STEM and always encourages innovations and STEM education. She grew up in an environment where education and science were highly encouraged. In school, she loved math, science, and chemistry classes. The content these subjects hold continues to amaze her. Her passion and curiosity for science led her to think about STEM majors when entering college. Initially, her plan was to be a pharmacist, but unfortunately, she was not able to afford it. Therefore, she decided to pursue a major she is strong at, which is math. As a first-generation student, college was not that easy for her and the path she chose was not easy either. In college, Khalil majored in Mathematics with a Statistics concentration and minored in Business Administration and Education to learn how to apply her degree in both the business and institutional worlds. As a STEM student, she realized that as she dove into math classes and took high-level courses, the number of females was low. Moreover, this was the same observation even outside school and in other group work.

While Khalil was pursuing her bachelor's degree and trying to be active and involved to highlight the need for STEM education, During the same time, she had the opportunity to be trained in completing a Preliminary Design Review for a NASA Mars mission, writing a proposal for a space mission which centered around cleaning Earth orbit from space debris, and reviewing proposals with a NASA Chief Technologist. She was endorsed with certificates from NASA. Her endorsements were in Preliminary Design Review Document, project management/schedules, and JMARS Software. Following this experience, Khalil started serving as a Volunteer Ambassador for a NASA Lucy mission. Her responsibility is to educate students about STEM and the need to discover our universe. These experiences opened Khalil's eyes to

some of the innovations that are happening in the science world. At the same time, these experiences led her to notice a similar observation she noticed at school and other places. Women's representation was low and that led her and other females to work hard to be role models for themselves and succeed.

Khalil always questioned why? She was not sure if it was because of the challenges females face in STEM. Reflecting on her experience and talking with female friends from other STEM majors, she noticed that women usually work hard and do double the work to succeed in a male-dominated field. Thus, this is what led Khalil to take advantage of her master's degree to research the stereotypes women face in STEM and form a better understanding of why their representation in that field is so low.

Interestingly and while working on the research, Khalil observed a lack of women present at a conference she attended. While this opportunity was open to individuals in the field, a few women participated. As a woman, this did not feel comfortable and could put other women on spot; it could even prevent them from asking/answering questions. This experience reinforced Khalil's passion to proceed with this research.

References

Almalki, S. (2016). Integration quantitative and qualitative data in Mixed Methods Research---Challenges and benefits. *Journal of Education and Learning, 5*(3), 288-296. https://doi:10.5539/jel.v5n3p288

Balding, V., Bareksten, B., Domingo, P. B., Euler, C., Feuvre, N. L., Gomez, T. O., Hanmer, J., Lopez, C. M., Raevaara, E., Salcedo, M. B., Taskinen, S., Ve, H., Wigglesworth, D. (n.d.). Education and gender models in europe. *Women in the European Union.* Retrieved from http://www.helsinki.fi/science/xantippa/wee/weetext/wee213.html

Beilby, K. (2011). Top 10 ancient arabic scientists: The arabic golden age of science and technology advances. *The Science of Everything COSMOS.* Retrieved from https://cosmosmagazine.com/society/top-10-ancient-arabic-scientists

Bellis, M. (2019). The most important inventions of the 19th century. *ThoughtCo.* Retrieved from https://www.thoughtco.com/inventions-nineteenth-century-4144740

Benson, T. (2014). Brief history of rockets. *NASA.* Retrieved from https://www.grc.nasa.gov/www/k-12/TRC/Rockets/history_of_rockets.html

Carli, L. L., Alawa, L., Lee, Y., Zhao, B., & Kim, E. (2016). Stereotypes About Gender and Science. *Psychology of Women Quarterly*, *40*(2), 244–260. https://doi:10.1177/0361684315622645

Catalyst. (2016). Quick take: Women in science, technology, engineering, and mathematics (STEM). *New York: Catalyst.* Retrieved from http://www.catalyst.org/knowledge/women-science-technology-engineering-andmathematics-stem#footnote53_cncwx0a

Catalyst. (2020). Pyramid: Women in S&P 500 Companies. Retrieved from https://www.catalyst.org/research/women-in-sp-500-companies/

Ceci, S., Williams, W., & Barnett, S. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin. 135*(1), 218-261. doi:10.1037/a0014412

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches.* (5th ed.). SAGE Publications, Inc.

Davidson, M. W., & The Florida State University. (2015). Zacharias Janssen. *Molecular Expressions.* Retrieved from https://micro.magnet.fsu.edu/optics/timeline/people/janssen.html

Davinci Inventions. (2019). Leonardo da vinci: An inventor ahead of his time. Retrieved from https://www.da-vinci-inventions.com/

Dunbar, B. (2020). Friday's all-woman spacewalk: The basics. *NASA.* Retrieved from https://www.nasa.gov/feature/fridays-all-woman-spacewalk-the-basics

Encyclopedia. (2020). Women's colleges in the united states. Retrieved from https://www.encyclopedia.com/children/encyclopedias-almanacs-transcripts-and-maps/womens-colleges-united-states

Encyclopaedia Britannica. (n.d.). Nettie stevens. Retrieved from https://www.britannica.com/science/cytology

English, T. (2019). 7 of albert einstein's inventions that changed the world. *Interesting Engineering.* Retrieved from https://interestingengineering.com/7-of-albert-einsteins-inventions-that-changed-the-world

Finlay, L. (n.d.). Variants of phenomenology and data collection [PDF file]. Retrieved from http://lindafinlay.co.uk/wp-content/uploads/2014/05/Variants-of-phenomenology-and-data-collection.pdf

Glass, J. L., Sassler, S., Levitte, Y., & Michelmore, K. (2013). What's so special about STEM? A comparison of women's retention in STEM and professional occupations. *Social Forces*, *92*(2), 723–756.

Guzeva, A. (2018). What Russia's first female 'college' looked like. *Russia Beyond.* Retrieved from https://www.rbth.com/history/329326-russia-first-female-education

Hallinen, J. (n.d.). STEM education. *Encyclopædia Britannica, Inc.* Retrieved from https://www.britannica.com/topic/STEM-education/STEM-education

Hood, E. (2019). A brief history of solar power. Endless Energy. Retrieved from https://www.goendlessenergy.com/brief-history-solar-power/

Ignatova, M. (2019). New report: Women apply to fewer jobs than men, but are more likely to get hired. *Linkedin.* Retrieved from https://business.linkedin.com/talent-solutions/blog/diversity/2019/how-women-find-jobs-gender-report

Japan Women's University. (n.d.). Abridged history of japan women's university. Retrieved from https://www.jwu.ac.jp/eng/outline/history.html

Kelley, S. (2016). Being more like men does not help women in STEM careers. *Cornell University*. Retrieved from https://www.sciencedaily.com/releases/2016/11/161102134506.htm

Library of Congress. (n.d.). Galileo and the telescope. Retrieved from https://www.loc.gov/collections/finding-our-place-in-the-cosmos-with-carl-sagan/articles-and-essays/modeling-the-cosmos/galileo-and-the-telescope

Lebanese American University. (n.d.). History. Retrieved from https://www.lau.edu.lb/about/history/#:~:text=Foundation%20as%20a%20Women's%20College&text=In%201921%20the%20American%20University,pursue%20bachelor's%20degrees%20at%20AUB.

Lee, W. Y. (2006). Women's education in traditional and modern china. *Women's History Review, 4*(2), 345-367.

Madsen, S. R., Goryunova, E., & Scribner, R. T. (2019). Utah women and STEM. The Utah women's Health Review, 1(1), 115-119.

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in stem fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. *Frontiers in Education,4.* doi: 10.3389/feduc.2019.00060

Marick. (2016, May 16). A look at the history of stem: And why we love it. Retrieved from http://marickgroup.com/news/2016/a-look-at-the-history-of-stem-and-why-we-love-it

Massachusetts Institute of Technology. (n.d.). Katherine blodgett. Retrieved from https://lemelson.mit.edu/resources/katherine-blodgett#:~:text=Main%20navigation,-Student%20Prize&text=With%20a%20master's%20degree%20in,Schenectady%2C%20New%20York%20in%201917.

Michelmore, K., & Sassler, S. (2016). Explaining the gender earnings gap in STEM: Does field group size matter? *Russell Sage Foundation. 2*(4), 194-215. https://doi.org/10.7758/RSF.2016.2.4.07

Min, A. (2019). The past, present and future of women in STEM. *PCS Edventures.* Retrieved from https://edventures.com/blogs/stempower/the-past-present-and-future-of-women-in-stem

Mortimer, R. (2018, March 8). Fatima al-fihri: Founder of the world's first university. *Manchester University Press.* Retrieved from https://manchesteruniversitypress.co.uk/articles/fatima-al-fihri-founder-worlds-first-university/

National Center for Education Statistics. (2020). Undergraduate degree fields. Retrieved from https://nces.ed.gov/programs/coe/indicator_cta.asp

Norman, J. M. (n.d.). Alhazen builds the first camera obscura. *Jeremy Norman's History of Information.com*. Retrieved from https://www.historyofinformation.com/detail.php?entryid=2414

Potter, S. (2020). NASA astronauts launch from america in historic test flight of spacex crew dragon. *NASA.* Retrieved from https://www.nasa.gov/press-release/nasa-astronauts-launch-from-america-in-historic-test-flight-of-spacex-crew-dragon

Robnett, R. D., & Thoman, S. E. (2017). STEM success expectancies and achievement among women in STEM majors. *Journal of Applied Developmental Psychology, 52,* 91–100. https://doi:10.1016/j.appdev.2017.07.003

Rovai, A. P., Baker, J. D., & Ponton, M. K. (2014). Social Science Research Design and Statistics. Watertree Press LLC.

Prime Industries. (2015). History of the helicopter from concept to modern day. Retrieved from https://primeindustriesusa.com/history-of-the-helicopter/

Saliba, G. (n.d.). Al-biruni: Persian scholar and scientist. *Encyclopædia Britannica, Inc.* Retrieved from https://www.britannica.com/topic/humanities

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. M. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. *Social Science Research, 63*, 192–208. https://doi.org/10.1016/j.ssresearch.2016.09.014

Sassler, S., Michelmore, K., & Smith, K. (2017). A tale of two majors: Explaining the gender gap in STEM employment among computer science and engineering degree holders. *Social Sciences. 6*(69), 1-26. https://doi:10.3390/socsci6030069

Shenouda, C. (2014). Effects of gender stereotypes on children's beliefs, interest, and performance in STEM fields. *Michigan State University*. Retrieved from file:///Users/firefly615/Downloads/Shenouda_grad.msu_0128D_12970.pdf

Stofan, E. (2020). Remembering katherine johnson: Nasa mathematician calculated mission flight paths and continues to inspire. *Smithsonian National Air and Space Museum.* Retrieved from https://airandspace.si.edu/stories/editorial/katherine-johnson-continues-inspire

Talhami, G. (2012). *Historical dictionary of women in the middle east and north africa.* Scarecrow Press.

The College of St. Scholastica. (2015). 12 historical women in STEM you've probably never heard of. Retrieved from http://www.css.edu/the-sentinel-blog/historical-women-in-stem.html

The United Nations. (2019). Design thinking in STEM: Education project combining STEM education, design based education and the challenges addressed by the SDGs. Retrieved from https://sustainabledevelopment.un.org/partnership/?p=35246

U.S. Bureau of Labor Statistics. (2015). Labor force statistics from the Current Population Survey. Retrieved from http://www.bls.gov/cps/tables.htm

Universitat Pompeu Fabra. (2019). Women are 30 percent less likely to be considered for a hiring process than men. *Phys.org.* Retrieved from https://phys.org/news/2019-03-women-percent-hiring-men.html

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review*, *33*(4), 304–340. https://doi:10.1016/j.dr.2013.08.001

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68–81. https://doi:10.1006/ceps.1999.1015

Woodford, C. (2008/2019). History of invention: A science and technology timeline. Retrieved from https://www.explainthatstuff.com/timeline.html

Xie, Y., & Killewald, K. A. (2012). *Is american science in decline?* Harvard University press.

MASTER'S THESIS

FINAL APPROVAL FORM

The University of Southern Maine

Leadership Studies

April 14, 2021

We hereby recommend that the thesis of Doaa Khalil entitled Women in STEM: Exploring the Stereotypes be accepted in partial fulfillment of the requirements for the master's degree in Leadership Studies.

Thesis Advisor (signature)

Second Reader (signature)

Accepted:

Leadership and Organizational Studies Department Chair (signature)

Appendix

Informed Consent Form
University of Southern Maine
CONSENT FOR PARTCIPATION IN RESEARCH

Project Title: Women in STEM: Exploring the Stereotypes

Principal Investigator:
Doaa Khalil, Graduate Student, University of Southern Maine
Contact Information: doaa.khalil@maine.edu

Faculty Advisor:
Elizabeth Goryunova, Faculty, University of Southern Maine
Contact Information: elizabeth.goryunova@maine.edu

Introduction:

- Please read this form, you may also request that the form is read to you. The purpose of this form is to provide you with information about this research study, and if you choose to participate, document your decision.
- You are encouraged to ask any questions that you may have about this study, now, during or after the project is complete. You can take as much time as you need to decide whether or not you want to participate. Your participation is voluntary.

Why is this study being done?

Today, STEM is playing a significant role in influencing the current economy and the world's future vision. The only missing part in STEM is the presence of females. Despite the fact that the number of women in STEM has increased since the early 1990s, the gender gap persists. In fact, women's representation in STEM is still low and stereotypes are continued to be faced today.

To form a better understating on why the gender gap persists, this qualitative study will explore participants' perceptions about whether the presence of the stereotypes that women face in STEM affects their low representation in that field.

Who will be in this study?

- Inclusion criteria include female adults (18 years of age or older) who have at least one year of experience in STEM.
- Exclusion criteria include anyone who is below the age of 18 and doesn't have a minimum of one-year experience in STEM.

What will I be asked to do?

Participants will be contacted via email to schedule a virtual interview on Zoom. Once time is picked and agreed on, the researcher will send a zoom link invitation with a meeting password to the interviewees. Interviews will range 40 to 60 minutes in duration. On the interview day, all participants are welcomed to join the interviews from anywhere they feel most comfortable at. During the interview, interviewees will be asked nine questions and the researcher will record the session to make sure validity is met.
NOTE: If schedule appears to prevent interviewees from live interviews, the researcher will accommodate the plan by sending the nine questions to participants via email. Participants will be asked to answer the questions and send them back once they are done.

What are the possible risks of taking part in this study?

There are no foreseeable risks associated with participation in this study.

What are the possible benefits of taking part in this study?

There are no benefits for participating in this study. The aim of this study is to explore participants' perceptions about whether the stereotypes women face in STEM effect their low representation is that field.

What will it cost me?

Participants are not expected to incur any costs as a result of participation in the research

How will my privacy be protected?

Participation in this study take place either via email or live interviews that will be on Zoom (Zoom interviews will have password assigned to them in order to ensure privacy and protection are met). All participants are welcomed to join the interview from anywhere they feel most comfortable at. If a participant is not able to meet online via zoom due to time or a schedule conflict, the plan will be accommodated to better serve that individual.

Participants' identities will not be disclosed to anyone and this applies to both email communication and live interviews. Participants' names and any identifying information will be deleted; pseudonym names will be used to maintain participants' confidentiality. Additionally, the recorded zoom sessions and consent forms will be secured and accessible only to the principle investigator of this study.

How will my data be kept confidential?

- Participants' names and any identifying information will be deleted and not included in the transcripts.
- The collected data will be secured in the researcher's office and accessible only to the principle investigator of this study.

- The Institutional Review Board may review the research records.
- All the recordings and copies of the participants' signed consent forms will be maintained by the principal investigator for at least 3 years after the project is complete before it is destroyed. The consent forms will be stored in a secure location that only members of the research team will have access to and will not be affiliated with any data obtained during the project.

What are my rights as a research participant?

- Your participation is voluntary. Your decision to participate will have no impact on your current or future relations with the principle investigator and the University of Southern Maine.
- You may skip or refuse to answer any question for any reason.
- If you choose not to participate, there is no penalty to you and you will not lose any benefits that you are otherwise entitled to receive. You are free to withdraw from this research study at any time, for any reason. If you choose to withdraw from the research there will be no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.

What other options do I have?

You may choose not to participate.

Whom may I contact with questions?

- The researcher conducting this study is Doaa Khalil. For questions or more information concerning this research you may contact her at (207) 252-8675 or doaa.khalil@maine.edu
- If you choose to participate in this research study and believe you may have suffered a research related injury, please contact the faculty advisor at (207) 999-6015 or elizabeth.goryunova@maine.edu
- If you have any questions or concerns about your rights as a research subject, you may call the USM Office of Research Integrity and Outreach at 207-780-4517 and/or email usmorio@maine.edu.

Will I receive a copy of this consent form?

You will be given a copy of this consent form.

_____

Participant's Statement

I understand the above description of this research and the risks and benefits associated with my participation as a research subject. I agree to take part in the research and do so voluntarily.

_____ _____

Participant's signature Date

_____

Printed name

Researcher's Statement

The participant named above had sufficient time to consider the information, had an opportunity to ask questions, and voluntarily agreed to be in this study.

_____ _____

Researcher's signature Date

_____

Printed name

Interview Questions

Field (Ex. IT, EGN, MAT, BIO, CHY, PHY etc.): _____

Q1: Are women in your field represented well, meaning is there a good number of women in your field compared to men? Why or Why not?

Q2: What is causing the low representation of women in your field?

Q3: As a woman, do you feel underrepresented in your field? How does it feel in either case?

Q4: What challenges and stereotypes did you face in your field as a woman?

Q5: How did you overcome them?

Q6: Did the stereotypes you faced bring most of the challenges?

Q7: Did these stereotypes and the low representation of women in your field stop you from moving forward with your job or degree? What made you move forward and/or stagnate?

Q8: Does the presence of the stereotypes that women face in STEM and in your field particularly affect the low representation of women in that field? Give an example of why and how these stereotypes affect the low representation of females in your field.

Q9: What do you think the solution is to decrease stereotypes and increase women's representation in STEM?