

## **ABSTRACT**

BAYATI, NILOUFAR. Exploring Parental Factors That Influence Female Students STEM Major Choice: A Phenomenological Study Exploring Female STEM Students' Experiences. (Under the direction of Dr. Cameron Denson).

Women remain underrepresented in STEM majors, particularly in engineering, technology, and computer science. This issue is problematic given the rapid advancement in technology. The aim of this research is exploring the lived experiences of females in engineering programs to understand how parents impacted their STEM pathways. Through one-on-one semi-structured interviews with female engineering majors and using the hermeneutic circle to analyze, this study identified several key parental factors that shaped participants' decision-making processes regarding STEM domains.

The findings revealed that parents of participants had confidence in their daughters' abilities and held high academic expectations during their school years. Parents also impacted their daughters' perceptions by serving as role models in STEM domains. Moreover, parents' encouragement toward STEM and support during school was impactful. Experiences and opportunities related to STEM that parents provide for their daughters from an early age was an important finding across all participants. This study highlights the critical role of parents in shaping STEM interest and identity through the environment they foster, experiences they provide and messages they send to their daughters.

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Exploring Parental Factors That Influence Female Students STEM Major Choice:  
A Phenomenological Study Exploring Female STEM Students' Experiences

by  
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## **DEDICATION**

To my sister whose love gives me energy to persist when challenges arise. As some plants need each other to grow, I believe we need each other to grow and thrive so to my sister “Narges Bayati”. I do not think I would be who I am without her love and support. To all the people who gave love and support.

## **BIOGRAPHY**

Born in a small city in Iran and raised in Tehran, Niloufar started to realize the importance of the environment in ones' development. As the eldest of three siblings, she felt a quiet sense of responsibility towards them, though she never considered herself a perfect role model. She acknowledges the weight of this role but is grateful for the lessons it has taught her, trying to be a better person and eventually a role model.

She had the unique privilege of being the first in her family to step into a college classroom, as her parents didn't have the same opportunity. So, she was thrilled for the opportunities and wanted more people to have the same opportunity she had to be the first in her family to pursue a college degree.

From a young age, she had a passion for science and mathematics, and she tried her best to assist peers in understanding these subjects, which shows the beauty of teaching.

As time passed, she pondered the paths she might take, and the thought of studying abroad seemed appealing. She believed that certain educational systems abroad could offer her a chance for personal growth, with the hope of subsequently empowering others. With hope and determination, she found herself at NC State in the U.S., pursuing her master's degree. The journey was far from easy; being a first-generation immigrant came with its own set of challenges. But with patience and resilience, she navigated through them.

At NC State, amidst a community of supportive and kind people, she further realized the subtle ways in which the environment can influence cognitive development. She endeavored to combine her growing interest in STEM education with her passion for human development. As she moves forward, she hopes to contribute, even if in small ways, to the fields of research and teaching, aiming to positively touch the lives of others through her work.

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## CHAPTER ONE: INTRODUCTION

### Overview

The underrepresentation of women in STEM fields is a persistent and well-documented problem that has gained attention from researchers, policymakers, and industry leaders alike. Despite efforts to promote gender equity, women remain significantly underrepresented in the majority of STEM fields, particularly computer science, technology, and engineering (de Brey et al., 2019; National Science Board, 2022). Furthermore, this gender disparity is concerning especially in light of the recent transformation of the workforce, which demands reskilling and lifelong learning due to the proliferation of advanced technologies in the physical, digital, and biological realms (Rotatori, Lett & Sleeva, 2021).

As newly developed technologies transform the nature of work, individuals are required to possess new sets of skills, increasing the demand for labor that can meet those requirements. Unfortunately, the current education system is not keeping up with the demands of the 4<sup>th</sup> Industrial Revolution (American Association of Community Colleges, 2018; Briggs & Buchholz, 2019; Rotatori et al., 2021; Schwab & Samans, 2018; Sousa & Rocha, 2019), exacerbating the underrepresentation of women in STEM fields.

However, the problem of underrepresentation of women in STEM fields goes beyond just the shortage of the STEM workforce. The lack of diversity in the STEM workforce not only hampers the competitiveness of the U.S. economy in a global context but also limits the potential of talented individuals (National Science Board, 2022). Research has revealed that gender diversity has a positive effect on the financial performance of companies, including those in STEM industries. A study by Catalyst (2004) and Hunt, Layton and Prince (2007) demonstrated that companies with a greater proportion of women in top management had better financial

outcomes; recent studies by Hunt et al. (2018) and Rovers (2013) also suggested a positive correlation between more women in leadership roles and improved profitability and stakeholder relationships. Consequently, promoting greater gender diversity in STEM fields can lead to more dynamic work environments and potentially improved financial performance.

Given the underrepresentation of women in STEM fields, it is crucial to identify and understand the factors that can promote greater gender diversity in these fields, and recent research has highlighted the importance of various factors, including mentoring, role models, STEM after-school programs, STEM informal environments like STEM camps, and parental factors, in shaping students' STEM attitudes (Abe & Chikoko, 2021; Allen et al., 2019; Buschor et al., 2014; Denson & Jones, 2020; Eccelle et al., 1993; González-Pérez et al., 2020). Yet, despite research showing the importance of parental factors in shaping STEM attitudes, their role has not been adequately emphasized in previous studies.

The present study aims to investigate the parental factors that influence the trajectory of female college students who select (and intend to enter) the STEM workforce. By identifying the parental factors that shape women's selection of a STEM major, this study aims to provide insights that could facilitate STEM major choice of women and increase their representation in this realm. This chapter provides an overview of the study, including its problem statement, purpose statement, and significance. Additionally, the chapter outlines the research questions.

## **Problem Statement**

The underrepresentation of women in STEM fields remains a persistent issue, despite efforts to increase their participation in these fields. One potential explanation for this gender gap is the influence of parents on female students' decisions to pursue STEM majors. While previous research has acknowledged the role of parental factors in shaping students' career aspirations

( Avolio, Chávez, & Vílchez-Román's, 2020; Buschor et al., 2014; Eccle et al., 1993; Jacob & Eccles,1992; Jacob, 1991; Jacobs, \*Chhin, & Bleeker, 2006), there is still a significant gap in our understanding of how specific parental factors shape female students' experiences and decisions in relation to STEM majors.

Having a better understanding of this phenomena will help to bridge the gap for shortage of skilled professionals in STEM fields which is a persistent and ongoing challenge, particularly in computer science, technology, and engineering (National Science Foundation, 2022).

This absence of a diverse workforce in STEM fields not only perpetuates social inequalities, but it also hinders the growth potential of skilled individuals and weakens the competitiveness of the U.S. economy on a global scale. Therefore, addressing the issue can help the U.S. to stay competitive in the global economy.

One of the solutions can be consistently encouraging and supporting female students in different ways to pursue careers in STEM from their childhood. The redirection of female college graduates to STEM majors may address the need for skilled STEM workers due to the fact women comprise approximately half of the population in the U.S. (U.S. Census Bureau, 2021).

## **Purpose Statement**

The researcher seeks to investigate the parental factor that impacted females' STEM major selection and evaluate how their parents influenced their decision to pursue STEM majors, particularly engineering. To best understand, represent, and evaluate the research topic, the research will follow a phenomenological approach. Through a hermeneutic phenomenological study, as first introduced by Edmund Heidegger (1993), the researcher hopes to gain a better

understanding of how and which parental factors influence female STEM students' selection of their college major as described through their autobiographical experiences.

To participate in this study, female engineering majors who are intending to enter the STEM workforce will be recruited. Potential participants must be willing to share experiences about how their parents have impacted and influenced their STEM major choice. The current study may provide insights for educators, parents, and counselors on how to better support and guide female students to pursue STEM majors from an early age and throughout their lives.

### **Significance of the Study**

The significance of this study is threefold. First, with the rapid advancements in technology, there is an increasing need for a larger STEM workforce. Although the number of students earning STEM degrees has grown substantially in the last decade, the demand for the STEM workforce continues to exceed the supply. Therefore, the United States requires a comprehensive, enduring strategy to address the shortage of STEM graduates (Bottia et al., 2015). One of ways to fill this gap is attracting more women in the STEM domain and supporting them during their journey (Bottia et al., 2015).

Secondly, the role of parents in shaping their children's interest and motivation in STEM fields, particularly for girls, has been acknowledged by researchers and educational experts (Avolio et al., 2020; Eccle et al., 1993; Robertson, 2019; Young, 1994). The Eccles and colleges' parental socialization framework (1993) highlights the importance of the family environment in shaping children's academic self-concept and beliefs about their ability to perform academic tasks. The framework recognizes that parents can have direct and indirect influences on their children's motivation and interest in STEM subjects, particularly for girls. For instance, parents' attitude toward STEM fields can affect their children's perception of these subjects (Šimunović

& Babarović, 2020; Taskinen, Dietrich & Kracke, 2015; Acosta & Hsu, 2014). Considering the importance of family in shaping STEM identity among their children, it is crucial to consider family context when promoting children's self-concept, fostering a sense of self-efficacy, and providing opportunities to encourage their curiosity in STEM education. By understanding the experiences of females who entered STEM programs in regard to their parents, this study can help inform and improve support and guidance provided by educators, parents, and counselors, ultimately leading to a more diverse, inclusive, and talented STEM workforce that can solve complex global challenges and drive innovation.

Thirdly, the importance of promoting diversity and inclusion in STEM fields cannot be overstated, as it fosters a more equitable workplace while providing numerous benefits to society. Several studies have demonstrated the positive impact of gender diversity on the financial performance of companies in various industries, including those associated with STEM (Catalyst, 2007; Hunt et al, 2018; McKinsey's, 2007; Rovers, 2013).

The present study aims to investigate the parental factors that influence the trajectory of female engineering majors. The study aims to shed light on the role of parents in shaping the major choice and career paths of female engineering undergraduate students and provide useful information for policymakers, educators, and parents on how to encourage and support women to enter STEM fields and workforce. The ultimate aim is to increase the representation of women in STEM fields particularly engineering and computer science, thereby ensuring a diverse and inclusive workforce that can effectively address the challenges of the 21st Century.

## **Research Questions**

The objective of the current research is to gain a better understanding of how and which parental factors influence female engineering students' selection of their college major as described through their autobiographical experiences.

This study is guided by two research questions:

1. Which parental factors influence the decisions of women to pursue STEM majors?
2. What thematic beliefs do female STEM majors report that their parents hold regarding gender stereotyping?

## **CHAPTER TWO: LITERATURE REVIEW**

### **Overview**

The underrepresentation of women in STEM fields is problematic as technology continues to advance and new jobs emerge in these fields. The National Science Foundation (2022) reports that there is a persistent and ongoing shortage of skilled professionals in STEM fields, particularly in computer science, technology, and engineering.

Moreover, the self-reported demographics of the STEM workforce are predominantly men, Whites, Asians, and/or foreign-born, while women and minorities groups are significantly underrepresented in STEM occupations, despite the fact that more women complete bachelor's degrees than non-men (de Brey et al., 2019; National Science Board, 2022).

The focus of this review is on the underrepresentation of women in the STEM field, the advantages of having gender diversity in various areas, including STEM, and family roles in shaping STEM identity.

### **Lack of Females in STEM Domains**

Efforts to diversify the STEM workforce are essential given the shortage of skilled workers, particularly in the fields of technology, engineering, and computer science (National Science Board, 2022). Despite the significant demand for workers in these fields, women are underrepresented, making up only 28% of the STEM workforce (U.S. Census Bureau, 2021). This lack of diversity in the STEM workforce is compounded by the fact that women (from all racial and ethnic backgrounds) are less likely to earn bachelor's degrees in STEM fields than non-women (from all racial and ethnic backgrounds), and yet engineering and computer science

are two highly paid and rapidly growing fields (De Brey et al., 2019; National Science Foundation, 2022).

STEM fields display a gender gap in representation that emerges early in life and persists into adulthood. Basic gender stereotypes begin to form as early as two years old, according to Kuhn, Nas, and Brucken's (1978) research. This gender gap further manifests in middle school, where Legewie and DiPrete (2012) found that more than twice as many boys as girls intended to pursue science or engineering-related careers. According to Tai et al. (2006), it is emphasized that the significance of science exposure extends even before the middle grades and at an earlier age. Similarly, Charlesworth and Banaji (2019) support the notion that gender disparities in STEM enrollment and interest become evident during middle and high school years. This underscores the critical nature of these early transitions in shaping future involvement in STEM fields for girls. Therefore, it is of utmost importance to create an environment that allows girls to be exposed to STEM and other related fields, from an early stage. Parents can play a pivotal role in providing such opportunities through various actions. This can be accomplished through a range of formal measures, such as enrolling their daughters in STEM camps, offering them educational toys specifically designed to cultivate an interest in these disciplines, engaging in thoughtful and substantial discussions centered around science-related subjects, and establishing expectations and perceptions that actively endorse and motivate their daughters' endeavors in these fields. According to Deemer et al. (2014), numerous challenges hinder female students from pursuing STEM careers. The authors stated, "Both individual factors and contextual factors have been proposed as to why women either do not initiate pursuit of STEM careers or opt out of such careers prematurely." In light of the fact that parental factors fall under the broader category of contextual factors, this study specifically focuses on examining and understanding the



influence of contextual factors on the subject at hand. According to Avolio et al. (2020) literature analyses on the underrepresentation of women in the scientific field, it was found that the family emerges as a prominent social agent that has a strong influence on career aspirations. In a similar vein, Robertson (2019) found that family and cultural factors are among the important factors that influence female students' recruitment, retention, and success in STEM majors.

In addition, it is important to note the inclusion of more non-male students in STEM fields specifically in engineering majors yields a multitude of advantages for both companies and society at large. Subsequent sections will provide a concise overview of these benefits.

### **Benefits of Females in Work Domains Including STEM**

The promotion of diversity and inclusion in society provides numerous benefits to society. When a company fosters diversity, it benefits from a broader array of talents and this in turn leads to a more creative and dynamic work environment, where employees bring their unique perspectives, talents, and experiences, and ultimately increase revenue (Catalyst, 2004, 2007; McKinsey, 2007; Rovers, 2013; Hunt et al., 2018). Catalyst (2004) analyzed the financial performance of 353 Fortune 500 companies between 1996 and 2000 and found that companies with higher gender diversity in their top management teams had better financial performance than companies with low gender diversity in top management, as measured by both Return on Equity (ROE) and Total Return to Shareholders (TRS). These companies were categorized as "Aerospace & Defense, Consumer Discretionary, Consumer Staples, Energy, Financials, Health Care, Industrials, Pharmaceuticals, Information Technology/ Telecommunication Services, Materials, and Utilities" (Catalyst, 2004, p. 4). The researchers therefore recommended that companies hire and promote a greater proportion of women in top management positions, including women in STEM leadership roles.

In another study, McKinsey (2007) examined the relationship between diversity and the financial performance of a company. Diversity Matters study analyzed proprietary data sets from 366 public companies in Canada, Latin America, the United Kingdom, and the United States. The study focused on financial results and the composition of top management and boards. They showed that companies in the top quartile for gender diversity were 15% more likely to have financial returns above their respective national industry medians. The study further indicated that companies in the same industry and country exhibit different levels of performance, implying that diversity serves as a competitive advantage that causes a shift in market share towards more diverse companies. Building on their findings, the most recent study by McKinsey on workplace diversity reaffirms the connection between diversity and financial success for large companies on a global scale (Hunt, Prince, Dixon-Fyle, & Yee, 2018). Upon further analysis of the business case for inclusion and diversity (I&D), Hunt et al. (2018) have discovered that there is a strong connection between diversity and business performance. This is supported by a significant correlation between a diverse leadership team and financial success, which has been validated on a larger and more diverse data set than previously examined. They have also found that having a more gender-diverse executive team is positively linked to profitability, with companies in the top quartile for gender diversity typically also experiencing top financial performance compared to similar companies of the same domain. It is important to note that the researchers reported how companies that are the most successful in profitability and diversity tend to have more women in revenue-generating roles rather than in staff positions on their executive teams. Overall, their extensive analysis confirms the importance of diversity and inclusion in driving business success.

In addition, an updated study conducted by Rovers (2013) finds that having women on a company's board can be viewed as a natural outcome of an innovative and contemporary organization that strives for high performance at all levels, which is consistent with previous research by Singh and Vinnicombe (2004). Additionally, the study suggests that having women on the board can improve a company's relationships with various stakeholders throughout the organization, leading to an enhancement in the company's reputation. These findings emphasize the importance of promoting greater gender diversity on boards and the potential benefits that can arise from having a diverse range of perspectives and experiences in boardrooms. The recruitment of more women in STEM fields can be a promising approach to increase the representation of women in the STEM workforce.

These fields are critical drivers of innovation, economic growth, and competitiveness in the global marketplace. Therefore, recruiting more women in STEM fields can help increase the representation of women in the STEM workforce, promoting diversity and inclusion in these industries. The result of this research may provide insight for recruiting more women in STEM fields by taking into account family and their influence on STEM interest.

### **Female STEM Career Pathways**

While it is widely recognized that having more women in STEM and leadership positions can be beneficial for both society and organizations, the low representation of women in STEM careers remains an ongoing issue, as reported by the National Science Foundation (2017). This underrepresentation starts early in life and continues throughout women's adult lives and career trajectories. This section will explore the factors that account for underrepresentation of women in the STEM domain as influenced by the environment, specifically parents.

Gender stereotyping is a persistent issue that begins in childhood and continues throughout adulthood. Research conducted as early as the 1900s has shown that basic stereotypes start forming as early as the age of two (Kuhn, Nas, and Brucken, 1978). The researchers also showed that boys are more likely to believe that they will become bosses and take care of outdoor tasks, while girls believe they will become homemakers and take care of household chores. These stereotypes impact students' expectations and achievements, affecting the decisions they make as they grow older and become adults. More recent research study by Hartung et al. (2005), revealed that emerging at 3-5 years old, children demonstrate a basic understanding of various professions and the existing hierarchical structure of career positions. The knowledge and understanding children acquire about different jobs and employment has a significant impact on the decisions they make as they grow older and become adults, and eventually influences their professional paths. However, a review by Hartung et al. (2005) revealed that these attitudes are often based on stereotypes and a lack of comprehensive information. Therefore, it is crucial to convey the appropriate message to children at an early stage. Yet, who are the primary individuals around children, and what role do they play in this aspect?

While there is not a sole factor that contributes to the formation of stereotypical thinking, family is a crucial element that impacts children's perceptions of career choice (Abe & Chikoko, 2021; Acosta & Hsu, 2014; Robertson, 2019; Rani, 2014; Šimunović & Babarović, 2020). For instance, according to Lummis and Stevenson's (1990) study, mothers' perceptions of gender stereotype thinking may transfer to their children and influence their interest and performance, as evidenced by their findings. The study found that mothers in three cultures Taiwan, Japan, and the United States held similar beliefs about their children's abilities with respect to gender. Even

though small differences in these three cultures were found, biases about their children's ability in reading and math were evident in all three countries. Mothers tended to rate girls higher in reading ability, even though boys showed that they could read and comprehend just as well.

Conversely to the reading ability, mothers held the belief that kindergarten boys had superior mathematical abilities compared to girls, and this assessment was made prior to any formal teaching of reading or math. This biased perception may have an impact on the way boys and girls direct their effort during elementary school. Girls who receive strong encouragement in reading may develop a preference for it as an activity, while boys may seek encouragement in other areas, such as mathematics. It is uncertain whether these beliefs predict differences that arise later in life or contribute to them.

Therefore, more research is needed to determine if parental beliefs about their daughters' mathematical or STEM capabilities impact the decision-making process in females in engineering. While the majority of research focuses on identifying barriers that prevent females from pursuing STEM majors and careers, this particular study will examine the parental factors that may have motivated or helped females to pursue STEM pathways.

### **Parental Socialization Framework**

A theoretical framework appropriate for this study is the parental socialization framework proposed by Eccles et al (1993). Based on this framework, it is crucial to recognize that the influence of the family extends beyond just academic achievement, but also plays a significant role in the development of children's academic self-concept and beliefs about their ability to perform academic tasks. This framework places significant importance on the social context that shapes children's beliefs and experiences, particularly the role of family members. It is crucial to

consider the family environment when promoting children's self-concept and fostering a sense of self-efficacy, as well as providing opportunities to encourage their curiosity in STEM education.

Eccles et al. (1993) highlighted the potential influence of gender as a social factor on parents' perceptions, which can impact their children's developing self-concepts independent of their actual performance. Their research demonstrated that parents' beliefs have a strong impact on their children's experiences and self-concepts across different activities.

Furthermore, the authors suggested that modifying parents' attitudes and viewpoints can have a substantial impact on the development of children's self-concept and consequently lead to a positive transformation in the system. They argued that parents tend to hold varying beliefs about their children, depending on their gender, resulting in the provision of distinct activities that align with gender roles.

It can be suggested that the gender-role socialization that takes place within families could be a contributing factor to the ongoing gender disparity observed in STEM fields. Therefore, it is important to identify factors among family dynamics for children in the STEM domain and see how we can implement those among other families in order to provide girls with the opportunity to take the STEM career pathway. Multiple studies have emphasized the significance of parental influence on individuals' career paths and the messages they convey to their children. The following research findings highlight the importance of parental impact:

Acosta and Hsu (2014) conducted a study that investigated parental influence on their children's attitudes and beliefs towards science and scientific literacy. The study investigated how parents transmitted their values about science to their children and how this value affected their children's beliefs and attitudes towards science. The results indicated that parents who placed a high value on science education were more likely to pass on this value to their children.

Furthermore, this parental value directly impacted their children's interest and motivation in science, as well as their overall academic performance in the subject. The same result was found in other studies which examined how parents' attitudes and values attached to the STEM domain are positively related to their children's attitudes and values of STEM (Abe & Chikok, 2021; Breakwell & Beardsell, 1992; Perera, 2014).

Perera (2014) found a positive relationship between parental attitudes towards science and student science achievement across 15 countries even after controlling for other important factors such as student gender, socioeconomic status, and school location.

Interestingly, the study found that the positive association between parental attitudes towards science and student science achievement was consistent across different socioeconomic backgrounds. In other words, students from lower socioeconomic backgrounds benefitted from positive parental attitudes towards science to the same extent as students from higher socioeconomic backgrounds.

## **CHAPTER THREE: METHODS**

### **Overview**

The aim of hermeneutic phenomenological study, initially introduced by Edmund Heidegger (1993), is to gain a better understanding of the “lived experience” of the people who experience the same phenomena. Using hermeneutic methodology, the aim of this study is to explore the “lived experiences” of female engineering majors whose parents had an impact on their decision making. Participants in this study will include female engineering majors who intend to enter STEM careers and their parents had an impact on their STEM decision making process.

This chapter outlines an overview of the overall research design methodology. The initial part of this chapter presents the justification for the utilization of qualitative research methods. Furthermore, the study's research questions, participants, procedures, and the process is elaborated upon and will be followed with data analysis procedure. Lastly, it includes a discussion of ethical considerations to the study.

### **Study Design**

According to Forman et al. (2008) and Hammarberg, Kirkman, and de Lacey (2016), qualitative research is an approach that aims to explore and comprehend meaning rather than employing "measuring" techniques. Hammarberg et al. (2016) further elaborate that qualitative methods are utilized to address inquiries concerning experiences, meaning, and perspectives, predominantly from the participant's standpoint. For the investigation on how parental factors influence the career choices of female STEM majors, a qualitative design was selected to obtain in-depth knowledge about this specific group and phenomenon. The objective of this study is not



to measure the extent of parental impact on female students' decision-making, but rather to investigate how and which parental factors influence their trajectory. This objective is best achieved through the implementation of a qualitative research method, specifically by gathering data through interviews.

However, there are different strategies for qualitative research that researchers can use, including phenomenology, ethnography, grounded theory, case studies, and narrative research (Creswell, 2013). While these methods share certain characteristics such as utilizing purposive sampling, conducting interviews for data collection, involving the researcher as the primary data collector, and employing written narratives (Butina, Campbell, & Miller 2015), they differ in their natures. The selection of a particular method should be based on the researcher's knowledge of the topic and the most suitable approach to address the research question(s).

For this study, the researcher's best knowledge suggests that employing a phenomenological approach would be a suitable option to address the research questions. Creswell (2014) explains that phenomenology aims to uncover the essential nature of human experiences associated with a specific phenomenon, as described by the research participants. Thus, phenomenology could provide a solid foundation for this study. Patton (2002) describes phenomenology to develop a worldview by putting together the phenomena experienced in a way that can be digested by the rest of the world. Similarly, Moustakas (1994) defines phenomenological research as providing comprehensive descriptions of experiences, rather than measurements or scores. Therefore, the most suitable approach to address the research questions is employing a phenomenological methodology.

## **Phenomenological Approach**

There are two main approaches to phenomenological study: transcendental phenomenology and hermeneutic phenomenology. In Husserl's transcendental phenomenology (also sometimes referred to as the descriptive approach), the researcher's goal is to achieve transcendental subjectivity—a state wherein "the impact of the researcher on the inquiry is constantly assessed and biases and preconceptions neutralized, so that they do not influence the object of study" (Lopez & Willis, 2004, p. 727). To understand any of these approaches to phenomenology, it is useful to remember that most approaches agree on core defining features that constitute the phenomenology (Neubauer, Witkop, & Varpio, 2019). According to Neubauer, Witkop, and Varpio (2019), in the transcendental approach to phenomenology, the researcher approaches the study without any preconceived definitions, expectations, or assumptions. They take on the role of a "blank slate" or a "tabula rasa," and rely solely on the participants' experiences to gain an understanding of the essence of the phenomenon. However, in a hermeneutic phenomenological approach, Koch (1995) acknowledges that pre-understanding cannot be fully eliminated or "bracketed" as it is an integral part of the researcher's background and context.

In hermeneutics phenomenology, the researcher seeks to uncover the meanings embedded in common life practices, rather than merely describing core concepts and essences of human experience (Lopez & Willis, 2004). Hermeneutic research was introduced by Heidegger, a scholar who challenged some of Husserl's assumptions about how phenomenology could guide meaningful inquiry. Heidegger built on Husserl's work and introduced his own ideas (Cohen, 1987). Heidegger's (1962) philosophy emphasizes the importance of the relationship between individuals and their lifeworld, which is the world in which they live and the context that shapes

their experiences. He uses the term "being-in-the-world" to illustrate the idea that humans cannot separate themselves from their environment.

Lopez and Willis (2004) describe hermeneutic phenomenology as an approach that takes a different approach than the descriptive method. Hermeneutic approach, instead of rejecting the use of a theoretical orientation or conceptual framework in inquiry, acknowledges their value as important components of the interpretive process. To uphold excellent research practices, anchoring a study on a theoretical framework requires the researcher(s) to be aware of and intentionally navigate any personal biases due to alignment with the framework. The researcher must then accommodate as best they can for these biases and be predictive and accountable for any potential effects of their biases (Peoples, 2020; Lopez & Willis, 2004).

The researcher approaches it from a hermeneutic phenomenological perspective for two main reasons. Firstly, based on my constructivist epistemology, I believe that individuals actively construct knowledge based on their experiences and interactions with their environment (Piaget, Roberts, & Piaget, 1973). This means that individuals engage with their experiences and environment to actively construct knowledge rather than passively receiving knowledge from the external world.

Secondly, my personal background and experiences have also influenced my choice of major as an educator. My family encouragement and recognition of my ability and potential for teaching and explaining concepts effectively has been a significant factor in my decision to pursue a career in education even though their impact was indirect, and I was not said to be an educator.

However, it is important to note that while my personal experiences have influenced my choice of career, as a researcher, I am committed to maintaining objectivity and being aware of

how my background and experiences may impact my research. I strive to remain open-minded and impartial in my approach to data analysis and interpretation, taking into consideration the perspectives and experiences of all participants in the study.

In this study, the researcher will use a hermeneutic phenomenological approach to explore the participants' experiences related to their STEM major choices and how their parents influenced those decisions. The focus will be on understanding the essence of their experience, which will help to address the research questions appropriately. While there are different approaches and definitions of phenomenological study, Peoples (2020) asserts that phenomenological research questions should follow one rule. "The inquiry must always be about experience as lived" (p. 27). Therefore, the research questions of this study were guided by this rule and seek to capture the "lived experience" of the participants.

### **Research Questions**

The research questions guiding this study are:

1. What parental factors influenced the career choices of female STEM majors?
2. What thematic beliefs do female STEM majors report that their parents hold regarding gender stereotyping?

### **Role of the Researcher**

Qualitative research involves collecting in-depth and comprehensive data from participants, with the researcher serving as the primary instrument. Depending on the research design, data can be acquired through various methods, such as interviews, focus groups, observation, and object analysis.

The researcher must plan, execute, analyze, and present the data collection methods for the study. As the researcher in this study, I sought an appropriate design to accurately capture and describe the essence of the lived experiences of female participants who chose engineering majors for their college pathways.

The fourth chapter of the report focuses solely on presenting the study's results. The findings were written in the first person and supported by extensive quotes from participants, placed to reinforce the interpretive conclusions.

## **Setting**

The setting for this study is a public research-based university located in the east south of the U.S. The university is recognized as one of the top engineering schools in the United States and attracts a diverse student population, including a significant number of female STEM majors. However, despite these efforts, women continue to be underrepresented in engineering classes at this university and many other universities across the U.S.

There are several reasons for selecting this university as the setting for this research. Firstly, the researcher has prior experience as an instructor at this university, specifically teaching a STEM course in Engineering. While teaching this course, the researcher observed a disparity between the number of male and female students attending the class. This sparked an interest in exploring the factors that influence female students' decisions to pursue STEM majors and careers, particularly in engineering.

Secondly, the Institutional Review Board (IRB) process for this university permits the collection of data from participants, and the researcher has completed the Collaborative Institutional Training Initiative (CITI) certificate to ensure ethical data collection and preservation. This allows for the collection of robust and reliable data from female STEM majors

by emphasizing on Engineering aspects in this setting which can contribute to the overall understanding of the experiences and factors, specifically parents, that influence female students' STEM career pathways.

By focusing on the experiences of female STEM majors regarding their parents, this study has the potential to contribute to ongoing efforts to promote diversity and inclusivity within the STEM domain, particularly the field of engineering.

## **Participants**

The participants in this study were purposefully selected to meet the study's criteria and increase its reliability. This study also uses snowball sampling techniques to find more participants with similar backgrounds to meet the criteria.

Purposeful sampling is a commonly used approach in qualitative research because it allows researchers to efficiently identify and select information-rich cases while making the best use of limited resources (Patton, 2002). Creswell and Clark (2011) also noted the importance of identifying individuals or groups with significant knowledge or experience related to a specific phenomenon for research purposes. In this study, the participants were female students pursuing majors in engineering fields with the intention of entering the STEM workforce and their parents played a role in the decision-making process in regard to selecting STEM pathways.

Phenomenological research typically involves a small sample size and focuses on in-depth exploration of individual participants' experiences. Creswell (2013) and Polkinghorne (1989) recommended that the typical range is between 5 and 25 participants, with 10 participants being a commonly used sample size. However, the appropriate sample size may vary depending on the research question and the level of detail required to achieve a comprehensive understanding of the phenomenon being studied. Creswell (2013) emphasized the importance of

considering the quality and richness of the data collected when determining the appropriate sample size for a phenomenological study.

Creswell and Poth (2018) also stated that there is no specific answer to the question of how many participants are needed for qualitative research. However, the number of participants required may depend on the specific qualitative research approach being used. Creswell and Creswell (2018) provide guidelines for two approaches, where phenomenological approaches may require 3-10 participants.

To achieve rich data and gain a comprehensive understanding of how female students experience their parents' influence on their STEM career decision-making process, this study will recruit 5 to 8 participants. According to Guest, Bunce, & Johnson (2020) data saturation serves as a measure to estimate and evaluate qualitative sample sizes. It happens when gathering more data does not yield any new emerging themes. Given (2015) also defines saturation as the point at which no further information or themes can be extracted from the data. To achieve data saturation, the researcher plans to recruit 5 participants initially and continue recruiting until no new significant emerging themes are found in the data.

### **Data Collection**

To ensure the selection of qualified participants, a survey will be distributed to potential participants who signed the consent form via email, which includes inquiries about their sex and current program of study, particularly whether they were enrolled in engineering programs. The survey also asks participants if their parents had an impact on decision-making processes regarding STEM fields and if they intend to enter the STEM workforce. Participants who were deemed eligible and enrolled in an engineering program will be invited to participate in one-on-one interviews with the researcher. To be eligible for this study participants should self-identify

as female enrolled in an engineering major who intends to enter the STEM workforce. Also, they would acknowledge their parents' role in their STEM decision making since that is the phenomena they are experiencing and will be uncovered to find parental factors.

To answer research questions and gain insights into participants' experiences, a series of questions for semi-structured interviews were developed. To provide flexibility in exploring participants' experiences, asking follow-up questions, and seeking clarification, a semi-structured interview approach was employed (Adams, 2015). To ensure that these questions were well-designed and relevant to the study, the researcher sought assistance from two experienced educational advisors who held doctoral degrees in education and were associate professors at NC State University. After a thorough review of the interview questions, the advisors provided constructive feedback to improve the face and content validity of the questions. The researcher considered their valuable insights and made necessary adjustments to the questions before obtaining IRB approval to conduct the study. Ultimately, the advisors' recommendations were instrumental in enhancing the quality of the research questions and ensuring their suitability for the study's objectives.

The interview protocol starts by recording key details like the participant's code name, interview date/time, and location. Interviews are expected to run 20- 30 minutes. The interview questions are listed in appendix 1.

## **Data Analysis**

The goal of this study is to understand and interpret the lived experiences of females in engineering who indicated parental influence on their STEM decision-making. To gain this understanding, the researcher will employ the hermeneutic circle process which involves iterative analysis moving between parts of data to the whole.



Following recommendations by Edwards and Holland (2013) participant interviews were recorded with prior consent to enable the interviewer to be fully attentive without extensive manual note-taking. Institutional Review Board approval was obtained, and participants signed agreements allowing recording.

Upon transcription, the data was analyzed using Peoples (2020) phenomenological approach. This began by repeatedly reading transcripts to gain immersion and familiarity. Upon reading the transcripts, significant features were identified to reveal essential aspects of the phenomenon. The researcher synthesized initial meanings into concise thematic statements embracing the essence of participants' experiences.

The aim was to move beyond superficial details and tap into profound, lived meanings within participants' descriptions as Peoples (2020) suggests. The goal was gaining insightful understanding of the phenomenon being studied. Peoples (2020), also, assert that the hermeneutic circle is a useful tool for understanding the process. The researcher in this current study will use the hermeneutic circle originally devised by Heidegger to understand the data.

### **Trustworthiness**

The researcher addressed trustworthiness using credibility, transferability and confirmability. To address credibility, the researcher asks for clarification during the interviews to ensure that the information was accurately captured. The researcher asks questions such as "Is that what you meant when saying this part?" or "Let me make sure I am capturing what you mean by that, ... is that right?" If participants confirm that the researcher is correct, the researcher moves to the next part. This member-checking as suggested by Connell (2016) is one of the techniques to establish credibility.

To help ensure transferability, the researcher provides a description of the context and the participants (Connell, 2016). Additionally, to establish confirmability, deidentified transcripts were shared with a university professor. The professor independently coded /themed portions of the data without seeing the researcher's analysis. The two analyses were then compared to identify divergent and aligned codes/themes. Interestingly, the independent coding was ~100% consistent with the researcher's analysis, supporting the validity of the developed themes.

Also, efforts were made to establish a relationship with each participant to build a sense of trust between the participants and the researcher. Ethical considerations include confidentiality of data, anonymity of participants and sites, and informed consent taken into account and was obtained by the IRB office before starting the recruitment process. Each participant will be given a brief description of the research study and a consent form that explains the research protocol.

### **Ethical Consideration**

This study received ethical approval from the university's Institutional Review Board after submitting detailed protocols outlining measures to protect participant rights. Any subsequent changes to recruitment, sampling, or methods necessitated additional IRB review and approval.

Participation was deemed low risk; however, careful steps were still taken to ensure informed consent and data privacy. All prospective participants received an invitation email with a consent form explaining the study's purpose, procedures, risks, benefits, confidentiality of data, and their rights as a participant. The form emphasized that involvement was completely voluntary and without penalty if withdrawn at any point. Signed consent forms were required from those interested in participating prior to data collection.

Per IRB guidelines, all interview recordings, transcripts, and notes will be kept confidential and destroyed after a 2-year retention period following publication.

## CHAPTER FOUR: RESULTS

### Overview

The aim of this study is to explore the lived experiences of female undergraduate engineering students in relation to their parents, in order to identify parental factors that influenced them toward a STEM trajectory. The research was guided by two main research questions:

1. Which parental factors influence the decisions of women to pursue STEM majors?
2. What thematic beliefs do female STEM majors report that their parents hold regarding gender stereotyping?

To address the research questions, a hermeneutic phenomenological study was conducted using interviews to understand female engineering students' lived experiences regarding parental influences on their major choice. This chapter will outline the result and key findings that emerged from this phenomenological research.

### Participant Descriptions

There were seven participants who volunteered to take part in the current study and turned in their signed consent form. The survey was sent to all the participants who agreed to participate in this research. The participants filled out the survey to see if they met the criteria as described in the sections above. Among seven participants, six participants met the criteria and were invited to schedule an interview with the researcher. All 6 participants scheduled the interview with the researcher. In the following section each of the six participants will be described since it will help with data analysis and making meaning of the data provided by each participant.

*Participant One:*

Participant 1 (P1) in this study was a self-identified female majoring in engineering. While participating in this study, she was a junior level engineering student at one of the well-known universities in the southeast of the U.S. She identified racially as White/Caucasian whose parents were born in America and have an American background. P1 reported coming from a middle-income family background. In the initial survey, P1 indicated her intention to pursue a career in a STEM field after completing her engineering degree. She also acknowledged that her parents had played an influential role in her decision to choose a STEM major.

*Participant Two:*

Participant 2 (P2) was a female junior level engineering student who racially identified as White/Caucasian. She reported coming from a middle-income family background, with parents who were born in the United States. P2 indicated her intention to pursue a career in a STEM field after graduation. She acknowledged that her parents had an influence on her decision to choose to study engineering and pursue a pathway in STEM.

*Participant Three:*

Participant 3 (P3) in this study was a self-identified female in the survey. P3 was a sophomore engineering student in the southeast of the U.S. who identified as a White/Caucasian female. She has American-born parents. She also mentioned coming from a middle-income family. P3 plans to pursue a STEM career and reported her parents impacted her STEM pathway choice.

*Participant Four:*

Participant 4 (P4) racially self-identified as a White/Caucasian female. She is an engineering student in senior level. Her parents were foreign-born giving her a non-American cultural background. P4 also comes from a middle-income family and acknowledged that her parents had an impact in her STEM decision making process. She mentioned that she has intention to pursue a STEM career in the initial survey.

*Participant Five:*

Participant 5(P5) was an engineering student at senior level. She self-identified racially as Hispanic/Latina. She self-identifies as female in the survey. She has American-born parents who influenced her STEM trajectory. P5 wants to pursue a STEM career and stated her parents impacted her STEM pathway decision.

*Participant Six:*

Participant 6 (P6) in this study was a self-identified female majoring in engineering. She was a senior engineering student at one of the well-known universities in the southeast of the U.S. She identified racially as White/Caucasian whose parents were born in America and have an American background. P6 shared in the initial survey that she is coming from a middle-income family. P6 indicated her intention to pursue a career in a STEM field after completing her engineering degree. She also acknowledged that her parents had played an influential role in her decision to choose a STEM major.

## Results

To answer the research questions of this phenomenological study as listed below.

1. Which parental factors influence the decisions of women to pursue STEM majors?
2. What thematic beliefs do female STEM majors report that their parents hold regarding gender stereotyping?

The researcher employed the "hermeneutic circle" introduced by Heidegger to analyze the data. The researcher closely read through each transcript multiple times to become familiar with the participants "lived experiences" as conveyed in their own words. The researcher approached the data in a reflexive, iterative manner, moving back and forth between the specific lines of text and the transcript as a cohesive whole.

In the initial read-throughs, the researcher documented emerging codes(features) and interpretations line-by-line, allowing the data to speak for itself without imposing external frameworks. These preliminary features notes were then synthesized into themes and refined through subsequent readings the full context of the participant's broader narrative.

The following section outlines the themes emerging from the data analysis as they relate to the two research questions under investigation. First, the major themes arising from the data pertaining to the first research question will be presented. This will be followed by discussion of the prominent themes or related to the second research question that emerged from the analysis.

The findings related to the first research question will be outlined as follows.

### *Participant One:*

Participant 1(P1)'s interview revealed several parental factors that impacted her decision to pursue an engineering major. The first major theme emerging from the interview was her parents' strong positive attitude towards STEM fields. She emphasized how both her mother and

father valued STEM disciplines. They even supported her in non-STEM subjects like English so she could focus more wholly on building her STEM knowledge and skills without falling behind on the path to an engineering career.

The second predominant theme was her parents' strong support from childhood through adulthood. P1 frequently referenced her parents' full support in various aspects of her academic journey. As she stated:

I went further in high school and realized I don't want to do a classical education and my parents let me switch to a public school and let me do the STEM part and get it, I'll continue with my education. Doing my study my way and not letting anything else influence me.

This exemplifies how her parents empowered P1 to take charge of her own educational trajectory in pursuing STEM. As she summarized, "they were in full support of me."

P1 also noted her parents encouraged early STEM exploration starting in childhood. They consistently pushed her to engage in STEM activities like joining science clubs and asking teachers for additional learning opportunities even in elementary school. A key point was the emphasis on childhood exposure and how her parents nurtured involvement in STEM from a young age. Providing early STEM experiences like STEM camp in 7th grade and STEM-related toys were important factors shaping her experience and interest.

Additionally, P1 remarked how her parents expressed strong confidence in her STEM abilities, saying "they encouraged me to go on and do that if I wanted to do it like they knew I could do it."

At the same time, when the researcher asked about her parents' expectations during her school years, P1 mentioned her parents held high academic expectations, wanting her to earn straight "As" in high school as preparation for college. As she recounted, "They expected me to



get straight “As”. And high school and especially when I went to public school, my mom was like, you better get straight “As”.”

P1 highlighted another major theme - the influence of her parents' own experiences on the way they raised her. Specifically, the theme emerging captured how her parents' life journeys shaped the expectations placed on her and opportunities provided to her. For example, P1 recalled how when she struggled with physics, her father reminded her of his challenges with the subject that led him to drop out of college which was the same course physics. As she recalled:

When my dad dropped out of college, he was not studying, and it was physics that kind of pretty much knocked him out. So, when I went to school and I had struggles with physics, he was like you better get on top of it because you'll end up dropping out.

P1 also mentioned comparisons to her siblings, saying "There was a lot of, like why can't you do that? Your older sister did that." Overall, P1 emphasized how her parents' own backgrounds informed their parenting approaches with her. Their lived experiences and values consciously and unconsciously shaped the way they raised her.

#### *Participant Two:*

Participant 2's interview revealed several factors impacting her decision to pursue engineering, with respect to parents' influence. She mentioned her parents guiding her towards STEM pathways and emphasizing the importance of these fields from childhood.

The major theme and influence for P2 was her parents' high attitude toward STEM majors, specifically engineering. As she stated, "They recommended engineering a lot to me." She also mentioned, "I had also thought about going into the medical field, but they convinced me that that wasn't the best fit for me." P2 shared how her parents considered STEM majors and

were even biased toward it since they have a high perception of STEM majors, with respect to engineering.

P2 also discussed her parents actively encouraging her to focus on STEM subjects. They advised taking math and science courses and "looking at the engineering aspect of everything." She characterized them as "very encouraging" toward STEM and engineering specifically. It might be the reason that P2 finds non-STEM topics less appealing over time. As she said "actually like in elementary school I struggled the most with like, English, and language related subjects."

Another prevalent theme was her parents' abundant support throughout her academic journey. P2 referenced their assistance selecting and exploring engineering-focused universities, drafting college essays, and securing a STEM internship to provide career experience. She felt her parents created situations enabling her to maximize success in STEM fields.

For example, she mentioned:

And that really, made an impact on me and it kind of lasted from like. From elementary school till now. So yeah, and they always recommend that I always put myself in, they always help me like put myself in a situation that allows me to focus on that and maximize my success.

Additionally, P2 mentioned being exposed to STEM through conversations with her parents while growing up. For instance, she described how her architect father influenced her to practice spatial skills like drawing, sketching, and 3D modeling applicable in engineering. Her parents also provided related tools and books, which she believed had a huge impact on her major choice.

Finally, two additional central themes emerged from P2's interview. The first was her parents' high academic expectations for her performance. She discussed how they emphasized the importance of achieving top grades, always pushing her to get straight A's throughout school. Their high standards motivated P2 to put her education first.

Additionally, P2 described her mother, a chemical engineer, as an inspirational role model. Seeing her mother's passion and successful career in a challenging engineering discipline showed P2 that through dedication, she could also achieve great things in demanding STEM fields. She shared that:

Seeing her do I like, such a like difficult, major, cause I think the chemical is one of the hardest majors in engineering and seeing her like be so passionate about it and having that get her very far across in her career throughout her life till today. That kind of show me that like I can really do anything if I just put my mind to it So I have that like, even if something's really hard, if I like.

*Participant Three:*

In the case of Participant 3, there have been several factors that she believed have had an impact on her decision-making process regarding STEM.

Firstly, P3 portrayed her father as an inspirational role model based on his engineering career, showing P3 the potential paths STEM could offer. As an example, she stated "Yes, his I would say his definitely shaped my experience for sure his interest in engineering". P3 believed that her father, more so than her mother, cultivated her interest in engineering and motivated her to take this pathway. Having her father who had a background in engineering respectfully, was the most influential factor for her to pursue a field in STEM.

Additionally, she emphasized her parents' consistent encouragement and support for her interests. She explained how her parents, specifically her father, were always supportive of her and her decision. She shared "So, yeah, but both definitely very much encouraged and supported me. All throughout all throughout." This finding shows the support and encouragement that P3 was receiving from her parents while growing up.

Also, P3' parents expressed strong belief in P3's potential to succeed in STEM. Believing in her potential was one of the main themes that emerged from her interview. She explained how her parents believed in her ability to do STEM majors or whatever she is willing to do.

Furthermore, P3 noted frequent STEM-related discussions with her parents from an early age, sparking her budding interest in the field. Specifically, P3 mentioned, "I would say as early as like 10, 11 years old is when we really started talking about all inclusivity." She emphasized the importance of open communication channels with parents regarding potential college majors and careers. P3 also described having "a very open channel of communication with both her parents" where they would visualize and discuss the future of STEM fields and the professional opportunities a STEM degree could offer and job security in the STEM domain.

Moreover, P3's parents also provided hands-on learning opportunities to expose P3 to engineering machines and concepts or in general STEM. Based on the location P3 was growing up, she shared how she was exposed to different types of machines. Also, she explained her experience with her father that he provided her and how these experiences shaped her interest and understanding of engineering. As quoted by P3

In our garage at home, he had a lot of tools. So whenever, like I was saying, whatever, if he was ever working on a car or something, then I, he would always invite me out into his space, you know, and to learn and see what he was doing.

Another memorable experience for her was a high school project that she completed. As she stated

I chose to take an engine apart and put it back together, which my dad, I couldn't use him as my mentor, but he and I both agreed that my neighbor, who was a professor at the time for a college nearby to be my mentor.

Another theme emerged while P3 discussed how her parents set high academic standards for her during her academic years. Their expectations motivated her to focus on her studies during those formative years and graduate with honors in high school. P3 also added that she always took honor and AP classes and like the two first participants she showed that she mostly enjoyed math classes in contrast to non-STEM subjects.

#### *Participant Four:*

Analysis of Participant 4 (P4) revealed several influential parental factors impacting her STEM trajectory. The most significant was having parents in engineering roles, which provided inspirational models. P4 chose the same major in engineering, as both her mother and father. As she explained, "Even though they had the same major, they were all doing different things from research to business to oil and gas. So that was a big part of why I wanted to do engineering in general."

P4 emphasized how seeing her mother succeed as an engineer and manager motivated her to believe she could also achieve her goals through diligence. Being surrounded by supportive role models reinforced this, as she noted "I just want to say that, I mean, growing up, I just see so many people around me and they're all, you know, doing what they like."

Another major theme was early and consistent STEM exposure facilitated by P4's parents' STEM careers. Spending time in their workplaces provided firsthand insight into

engineering environments. Her parents also brought work discussions home, which further immersed P4 in STEM from a young age. P4 also explored STEM through STEM camp and internship as well.

Additionally, P4 described her parents as thoroughly supportive and encouraging of her STEM interests. For instance, she mentioned,

When I decided I wanted to do STEM, they were very supportive of it and I guess examples of it would be you know whenever I was trying to decide what major they would sit down with me and talk through all the different disciplines that I can be involved with.

This guidance and support empowered P4's STEM ambitions. In terms of encouragement, she explained how her parents supported exploring diverse STEM activities like camps, internships, and engineering disciplines outside their own background and expertise.

Another theme arising from her interview was P4 noted her parents held high academic expectations rooted in their Middle Eastern cultural emphasis on diligence and excellence. However, they took a constructive approach focused on her growth. As P4 stated, "As long as I was on track to doing what I was supposed to do, everything was fine and if there was a struggle we would stop and think about why we're struggling and try to fix it." While setting ambitious standards, her parents also offered support to reach them, highlighting their support of her education.

A final theme emerging from P4's interview was her parents' active involvement and connection throughout her education. She emphasized that their support stemmed from remaining engaged in her interests and aspirations, not pressuring specific paths. As P4 explained

It's not about supporting or not supporting or telling you what to do. It's just being involved in what the children are doing. Because I think oftentimes a lot of times people parents don't know what the kids want to do and that's where you lose that connection and I think if everyone's involved with what the kids want to do.

P4 described how her parents' support arose from valuing engagement, not control. By prioritizing mutual understanding, her parents provided empowering support for P4 to explore her passions. Their active involvement and connection, without micromanaging, allowed P4 to feel understood and encouraged to direct her own journey.

*Participant Five:*

Unlike other participants who described a high parental attitude toward STEM regardless of gender, Participant 5 (P5) did not experience a highly supportive and strong attitude toward STEM from her parents since her parents did not consider these fields suitable for females.

As she stated, " they encouraged my brothers to do more technical stuff and Yeah." P5 noted her parents provided more technical activities to her brothers, reflecting a gender divide. However, her parents did supply some indirect STEM exposures through opportunities like museum visits and science clubs. P5 discussed, "They were always very willing to do anything academic related for us growing up." or she mentioned.

P5 also described how her accountant mother indirectly modeled comfort with math and numbers, countering broader math phobia. As she explained, seeing her mother enjoy math "kind of made me realize it doesn't have to be a bad thing." This normalized the fear of math even without direct encouragement. Therefore, the first theme emerging from P5's interview was indirect exposure to STEM fields.

However, P5's experiences were highly different from other participants in this exposure. While she received some foundational STEM exposure through activities like museum visits and science clubs, her parents did not intentionally provide direct STEM learning opportunities or support toward STEM, especially for their daughter. In contrast, other participants believed their parents actively encouraged STEM pursuits due to highly valuing STEM fields and conveying confidence in their daughters' potential in STEM. P5 did not perceive this same enthusiastically supportive orientation toward females in STEM fields from her parents. The encouragement she received appeared motivated by different reasons, as will be discussed.

P5 experienced her parents' encouragement toward STEM majors and retaining in STEM fields due to the financial security it will bring. Therefore, the second major theme emerging from P5's interview was parents' encouragement driving P5's STEM pursuit, as her parents emphasized STEM careers as financially beneficial. Their encouragement stemmed from wanting P5 to secure post-graduate employment.

Finally, P5 noted high academic expectations from her parents contributed to choosing rigorous engineering. As she remarked, "They always had really high expectations from me and my siblings academically...I think since I'm in engineering that kind of translates into the like overachiever mentality."

*Participant Six:*

The most impactful factor for Participant 6 (P6) was having her mother as a role model in a STEM field. As she stated, "I will say, I, if my mother wasn't an engineer. I don't know if I would be in engineering currently." Beyond modeling a STEM career, P6's mother understood the importance of early STEM exposure given her own background.



P6 explained that "because my mom was an engineer, the choices made around my schooling and the STEM programs I was put in were important to my development and career goals." Her mother ensured P6 had opportunities to build critical STEM thinking skills from a young age. As she stated

Because my mom Again, like I guess to part of my schooling just choices like we're decided by them and the fact that I was put in those programs that encouraged me like STEM thinking and stuff like that. We're important to my development as a student and my career goals as well.

This relates to the second major theme of early STEM exposure. P6 described participating in hands-on STEM activities starting in elementary school, saying "I remember building like a really simple circuit for a lighthouse when I was in fourth grade." She attended schools focused on science, math, and technology, which continued into middle school.

For instance, P6 took engineering-style classes using project-based learning with focus on the engineering design process, noting "we made little Maglev trains" and other technical builds. This early integration of engineering design principles was formative in shaping her interests and pathway. In summary, P6's mother recognized the value of early, immersive STEM learning and purposefully cultivated these experiences for P6 over many years.

In P6's interview, it was evident that her parents did not place excessive pressure on her when it came to her grades and accomplishments. While they actively engaged in her academic journey and supported her, ensuring she stayed committed to her studies, they were not rigid about demanding straight A's during her school years. Therefore, low academic expectations and pressure was a theme for P6.

Another prominent theme that emerged from P6's interview was the support and encouragement she received from her parents regarding her interest in the STEM field. She explained how her parents' guidance and support played a pivotal role in helping her discover her own path. P6 expressed:

Yeah, they supported me and continue to do so. They always emphasized that it wouldn't be easy, and that pursuing STEM isn't a walk in the park. There are certainly easier majors out there, or something might just 'click' better. But they consistently encouraged me to challenge myself, which was significant for me.

Another theme for P6 was her parent's belief in P6 potential and being successful in STEM. Her parents' self confidence in her ability to be successful at anything she wants was an important factor in shaping her experience. As she stated, "And always told me that I was capable of a completion whenever I put my mind to, which is definitely good to keep in mind."

The findings related to the second research question will be outlined as follows.

#### *Participant One:*

Participant 1 (P1) mentioned there were no gender stereotypes present while she was growing up. She never witnessed any differential behavior from her parents toward her or her siblings based on gender. However, she did note experiencing sexism during her college years from influences beyond her parents.

The first principal theme emerging from P1's interview was the absence of gender limitations in her childhood. She emphasized how her parents treated her and her siblings of different genders equally. Specifically, they provided the same toys and activities regardless of gender. As she asserted, "I remember from a young age being able to ride 4 wheelers and

motorcycles with the guys." P1 stressed she was never told certain activities were off limits because of her gender.

The second major theme was that P1 did not encounter expectations to fulfill traditional domestic roles historically associated with females. She was not tasked with things like cooking and cleaning, specifically "because you are a female."

Ultimately, P1 highlighted the gender-neutral atmosphere she was raised in, free of the restrictions and judgments many females face based solely on their sex. As she stated, "I was just one of them. Like it was never like a stereotype, and I would almost say that I was never like said, "you're a female."

#### *Participants Two:*

Participant 2 highlighted that she "Never" experienced any gender stereotypes from her parents while growing up. Since phenomenology focuses on "lived experience", the researcher asked for specific examples of what led P2 to feel this way.

P2 explained that seeing her mother thrive as an engineer, a non-traditional profession for women, showed P2 she could also achieve anything regardless of gender. Additionally, P2 did not encounter differential treatment or limitations based on being female versus male in her household. Her parents placed no constraints on her interests, activities, or perceived abilities due to gender. As she stated, "I can do anything else that a man can do."

In addition to having belief in her potential in STEM majors, her parents encouraged P2's participation in sports teams, even taking on leadership roles in areas often socially aligned with masculinity. These examples showed the way she grew up was beyond restrictive gender norms.

*Participant Three:*

Like the other participants, Participant 3 did not experience any gender stereotyping from her parents, especially her father. P3 emphasized how her parents instilled the mindset of "you can do anything you want" in her and her siblings regardless of gender. She believed this parental influence was impactful since some careers or fields of study are still often considered more suitable for certain genders by society. However, P3 never encountered such limitations imposed by her own parents. They actively encouraged her to embrace the perspective that she was capable of any ambition or pursuit, irrespective of being female. As P3 distinctly stated about her parents' outlook:

Don't ever don't ever let being a woman or a girl, you know, make you think that you can't pursue this or that because, and I was very fortunate that they had that outlook and, because I don't think that I would.

This example underscores how parents' attitudes towards their daughters can profoundly shape confidence and self-efficacy. P3 acknowledged that without her parents instilling the belief she could achieve anything from a young age, she would not be where she is today. As she reflected, "I really honestly don't think I would be here right now if it weren't for them teaching me that at an early age." Parents' direct and indirect influence on their children can have a huge impact on their career choice and trajectory which in this case will be considered a STEM trajectory.

*Participant Four:*

Participant 4 (P4) shared she never witnessed gender stereotypes in her household while growing up. Most impactful was seeing her mother thrive as an engineer which is against societal norms about traditional female roles and capabilities.

When asked for examples of what conveyed this absence of stereotypes, P4 emphasized how both her parents held similar high-level positions and responsibilities in their respective companies, despite being different genders. As she stated, "I mean, I guess an example would be both of my parents were in similar roles in 2 different companies, but same basically level of work, same position, same salary and everything."

P4 described this as "cool to see" - two people succeeding in identical roles regardless of gender. Her mother's accomplishments illustrated that women could achieve the same status and success as men. This real-life role model and her parents' equal positioning countered limiting assumptions about gender-based differences in abilities or potential.

*Participant Five:*

Participant 5 (P5) discussed experiencing gender stereotypes and traditional attitudes from her parents while growing up. As she explained,

So, my parents are the more traditional type. So, things as simple as like chores like it's always my job to do the dishes my brother's job to cut the grass or take the trash out and I would like to be like, can we switch? I'm so tired of doing the same thing over and over. And they would say, that's a boys' job. You don't need to be doing that.

Therefore, a major theme emerging from P5's interview was parental expectations for her to fulfill traditional domestic roles historically associated with females.

P5 also shared experiencing restrictions based on traditional gender norms. While not directly related to STEM, these limitations shaped her experience. When asked how she overcame these challenges to pursue a STEM major typically aligned with males, P5 highlighted her determination, stating:

But for the most part, you know, just have my parents say well this is a boy job or like you don't need to be putting furniture together that's not for you like that's just too you should be doing that and so I'm like well I'm gonna do it I prove you wrong.

*Participant Six:*

Participant 6 (P6) mentioned experiencing some gender stereotyping from her mother but not her father while growing up. She explained that based on her mother's religious background and geographic she was growing up, she held some traditional views of gender roles, like expecting daughters to perform domestic chores historically considered "women's work."

However, P6 noted her mother had conflicting perspectives, saying: "She does kind of have a bit warped view at times, I think, of how much a woman should provide for a relationship...But there was still some more new age, I guess you could say thoughts." On one hand imposing old-fashioned expectations but on the other, encouraging women to pursue careers and financial independence.

Importantly, P6 emphasized that around schooling and education specifically, her parents were open-minded and supportive regarding her choice of any major, conveying confidence she could be successful. Therefore, while some gender-related divides existed in her household

responsibilities, P6's parents promoted equal educational opportunities and path flexibility regardless of gender.

### **Key Findings**

This study identified several key findings regarding the most common and impactful parental factors shaping participants' choice of a STEM major. To determine these themes, the researcher thoroughly and repeatedly analyzed the full interview transcripts to uncover shared experiences across participants.

Initially, the themes emerged from each participants' interview. These themes were then organized into categories summarizing the most common themes across all 6 participants shared experiences affecting female engineering students' STEM major choice with respect to their parents. The key findings are represented in Table 1 and are explained in the following section.

Table 1. Key findings

Parental factors/ Themes	P (1)	P (2)	P (3)	P (4)	P (5)	P (6)
High attitude toward STEM	✓	✓	×	×	×	×
Parents' support and involvement	✓	✓	✓	✓	×	✓
Early STEM exposure	✓	✓	✓	✓	✓	✓
Confidence in their daughters' ability	✓	×	✓	✓	×	✓
High academic expectation	✓	✓	✓	✓	✓	×
Parents' encouragement	✓	✓	✓	✓	✓	✓
Parents as role model	✓	✓	✓	✓	×	✓
Gender Stereotype	×	×	×	×	✓	N

Guidance to the table: Yes= ✓; No= ×; N = Neutral

### Parents' Support and Involvement

One major parental factor frequently emerging from participants' interview and analysis was a high level of support and involvement in their education. Five out of six participants emphasized how their parents made education a priority and provided full support of their academic efforts and achievement. This supportive environment was not limited to just STEM subjects, but rather fostered the participants' learning across all areas.



Many participants emphasized their parents' active involvement and support in their schooling. Participants 1, 4, and 6 specifically described their parents asking about schoolwork and being highly responsive if they were struggling. For instance, Participant 1 mentioned how her parents helped her work on non-STEM areas she found difficult. She stated that “they were in full support of me.” P6 also shared that “Yeah, they definitely supported me and continue to do so”.

### **Early STEM Exposure**

Another prominent theme across all six participants was early exposure to STEM domains starting in childhood, although the nature and intent of this exposure varied. Each participant described unique early experiences with STEM, but the common thread was introduction to STEM topics and activities before or during late childhood.

For instance, Participant 1 had formative STEM experiences through summer STEM camps in 7th grade and childhood play with STEM-related toys like Lego. These hands-on interventions sparked her early interest. Participant 4 similarly attended STEM camps and visited her mother's engineering workplace, granting crucial firsthand exposure to the STEM workforce.

Participant 6 began her STEM foundation with her elementary school's STEM-focused curricular concentration, allowing consistent reinforcement of STEM core subjects. This was supplemented by hands-on engineering design projects in middle school that imparted critical technical skills through experiential learning.

Participant 3 also gained hands-on, early STEM exposure by assembling machines and engineering-related projects involving mechanics while growing up. These tangible experiences gave her a perspective of engineering design. As an example, she mentioned that:

In our garage at home, he had a lot of tools. So whenever, like I was saying, whatever, if he was ever working on a car or something, then I, he would always invite me out into his space, you know, and to learn and see what he was doing.

In contrast, Participant 5 did not have overt STEM promotion at home but gained exposure through museum visits intended for general enrichment. While not an intentional STEM intervention, these trips exposed her to relevant concepts.

### **Parents' Confidence in Daughters' Abilities**

A common theme across several participants was their parents expressing strong belief in their potential to succeed both academically and in pursuing their aspirations. Participants 1, 3, 4, and 6 emphasized receiving messages of confidence from parents that they could achieve anything they put their mind to. As Participant 1 noted, she was never discouraged from pursuing goals or interests due to her gender. Her parents conveyed their confidence in her capabilities regardless of limitations society may impose. For example, during the interview she shared that “they encouraged me to go on and do that if I wanted to do it like they knew I could do it.”

P4 and P6 also expressed similar experiences and mentioned how their parents have confidence in their ability to achieve whatever they want. As P6 mentioned that “And always told me that I was capable of a completion whenever I put my mind to, which is definitely good to keep in mind.”

## **High Academic Expectation**

When discussing their parents' academic expectations, 5 out of 6 participants described extremely high standards for performance and grades during their school years. Participants 1, 2, 4, and 5 specifically mentioned their parents demanded straight A's and prioritized education above all else. P 4 shared that her Middle Eastern cultural background contributed to very high academic expectations. However, this theme crossed racial and cultural lines, with multiple participants recalling their parents' laser focus on academic excellence. P1 also shared that "They expected me to get straight As. And high school and especially when I went to public school, my mom was like, you better get straight As."

P5 believed these ingrained high expectations guided her toward the rigor of engineering, instilling an "overachiever mentality" that persisted from childhood. As she stated that "They always had really high expectations from me and my siblings academically...I think since I'm in engineering that kind of translates into the like overachiever mentality."

In summary, for most participants, their parents' high academic expectation yet supportive standards created the foundation to take on highly demanding STEM disciplines.

## **Parents as Role Models**

Several participants emphasized the huge influence of seeing their parents being in STEM careers. Witnessing their mothers or fathers pursuing STEM paths firsthand provided impactful modeling that these fields were viable options for them as well.

For instance, Participant 4 shared how seeing her mother's success as an engineer encouraged her own engineering pursuits by showing women could excel in this traditionally male-dominated domain. For example, she shared "Growing up, I just see so many people around me and they're all, you know, doing what they like."

Participant 6 took this further by explaining that without her mother's STEM role modeling, she may not have found her way to a STEM career at all, or it would have taken much longer. As she quoted "I will say, I, if my mother wasn't an engineer. I don't know if I would be in engineering currently."

Participant 5 described how watching her accountant mother competently work with numbers daily helped her overcome societal math phobia and feel capable in mathematical fields. Participant 3 also pointed to her father's engineering career as an inspirational model guiding her to ultimately choose engineering.

### **Parents' Encouragement**

A prevalent theme across all six participants was their parents providing strong encouragement to pursue STEM fields like engineering. This encouragement manifested in diverse ways. For instance, Participant 1 described her parents motivating engagement in STEM extracurriculars like science clubs to spark her interests from a young age.

Similarly, Participant 2 shared how her parents recommended math and science courses and emphasized the value of focusing on STEM academics. Other participants like P3, P5, and P6 noted their parents highlighted the promising career prospects and financial stability potentially offered by STEM degrees. For instance, participant 3 explained that "So, yeah, but both of them definitely very much encouraged and supported me. All throughout all throughout."

Participant 5 also recalled her parents urging perseverance when STEM courses became challenging, keeping the goal of a secure future in mind. Participant 6 mentioned frequent childhood conversations with her parents about the excellent job security available in the STEM fields. P6 mentioned that "They consistently encouraged me to challenge myself, which was significant for me."

## Gender Stereotype

A notable finding was that most participants reported not experiencing any gender stereotypes from their parents. Participants 1, 2, 3, 4 explicitly stated they did not encounter stereotypes at home regarding gender roles or limitations.

Participant 1 mentioned her parents provided the same toys as they did for her siblings of different sex. In addition, they did not impose pressure to fulfill historical domestic roles like cooking based on being female. As she shared, "I remember from a young age being able to ride 4 wheelers and motorcycles with the guys." She also explained that "We got everything like If we wanted to play with cars, we got to play with cars. My brother wanted to play with Barbie, so got to play with it."

Similarly, Participant 3 described her father inviting her to work on machines and engines alongside him, conveying technical fields as suitable for girls. "You can do anything you want."

Participant 4 powerfully recounted how seeing her mother and father in equivalent high-level STEM roles illustrated women could achieve at the same level. The equal footing of her parents, regardless of gender, shaped her beliefs around ability.

While most participants emphasized gender-equal upbringings, participants 5 and 6 encountered some traditional expectations around feminine domestic duties from their parents, particularly from their mothers. In essence, most participants stressed their parents treat them with no stereotype behavior and did not impose limitations based on gender.

## **CHAPTER FIVE: CONCLUSION**

### **Overview**

This study aimed to gain an understanding of how parents influence female undergraduate students' choice of engineering majors or STEM majors in general. A phenomenological approach was used, conducting semi-structured interviews with female engineering majors who indicated parental impact on their decision to pursue STEM as a career. Interview transcripts were analyzed following the procedures outlined in the prior chapters, revealing critical themes related to the research questions and the phenomena. The research questions were answered based on the findings of this study.

This discussion chapter presents interpretation and analysis of key findings that emerged from the participants' interviews. Connections to existing literature are drawn, including how outcomes confirm, diverge from, or expand on previous knowledge. Limitations of the current study are also acknowledged, along with suggestions for future research.

### **Conclusion and Discussion**

One critical finding that emerged from this study was the vital role of parental support and involvement in shaping participants' pursuit of STEM disciplines. Almost all participants shared how their parents provided supportive academic environments that enabled them to focus on their education and choose to be in a demanding major such as engineering. This finding shows the importance of parental involvement and support for daughters in choosing STEM pathways, aligning with existing literature (Salvatierra & Cabello, 2022; Puccia et al., 2021).

Supporting their daughters from childhood, parents cultivated confidence by conveying constant availability of support if needed. The findings of this study demonstrate that a mindset

of reliable support was invaluable preparation for undertaking demanding STEM majors. Female students who realized unconditional parental support felt empowered to pursue STEM, knowing assistance was accessible when facing challenges. Therefore, by providing a supportive environment at home, parents can help female students to overcome isolation when difficulties emerge. This underscores the importance of support from family consistent with the report by Douville (2020) on why women choose and stay in engineering.

Another major finding of this study is the encouragement female students received from their parents to get involved in STEM from their young age and pursue STEM majors. Even though the encouragement of parents may have different underlying reasons such as securing a job or parents holding high value and perception for STEM, the consistent encouragement was a common theme across all participants. These encouragements were represented in various ways such as conversation with their daughters about the promising future of STEM and subsequently the financial stability. For example, some participants acknowledged that their parents encouraged them through STEM based conversation while other participants dissuaded about how their parents encouraged them to focus on STEM subjects during school years or get involved in extracurricular activities. Therefore, this study highlights the importance of parents providing encouragement towards STEM in various forms during their females' formative years.

One of the most important and consistent findings across all participants was the early STEM exposure parents facilitated. Parents of females in engineering provided early STEM exposure through different activities. Early exposure to STEM helped participants to develop STEM identity and self-efficacy among students, which is consistent with the existing literature (Blotnicky et al., 2018; Simpkins et al., 2006; Puccia et al., 2021; Wan, Jiang & Zhan, 2021). However, this study added to the existing literature by focusing merely on female students since

gender differences are important when it comes to their different experiences that parents may provide for their children based on their gender.

The findings demonstrated that parents play a critical role in providing early STEM exposure through activities, toys, and choice of schools. As children's first and primary contacts, parents heavily influence the opportunities for STEM opportunities and exposure that girls can access during formative developmental phases. Even when parents do not encourage STEM directly, exposing girls to informal STEM learning opportunities positively will shape their STEM interests and self-efficacy by providing girls with STEM camps, hands-on engineering and design tasks, and visits to science museums were examples of different activities and explorations of STEM that parents of females in engineering provided for them. Therefore, by exposing females to STEM subjects, both through formal education and informal experiences, parents can help with building early interest in STEM and develop self-efficacy and confidence in this realm.

Another major finding was the influence of parents' perceptions of their daughters' abilities. Some participants described direct messaging from parents about their capability to overcome challenges and achieve aspirations. Parental confidence in daughters and its impact on females' self-efficacy in STEM aligns with research showing children realize parents' ability views, which shape their own self-efficacy (Eccles et al., 1993; Jacobs, 1991; Šimunović & Babarović, 2020). This study extended evidence to female STEM students with respect to engineering, demonstrating parental belief in potential directly impacted their own self-perceptions and confidence to pursue rigorous majors in STEM.

Parents of almost all female engineers in this study, not only avoiding gender stereotypes but directly conveying belief in daughters' capacity to succeed in STEM emerged as pivotal.



Participants described parents instilling the mindset they could accomplish anything regardless of gender, increasing their self-efficacy. This finding confirms existing research on parents' essential role in cultivating daughters' self-efficacy and overcoming limiting gender assumptions. The findings suggest that parents who express confidence in their daughters' STEM abilities and encourage their interests empower girls to pursue STEM careers. To increase women's representation in STEM fields, results indicate parents should avoid gender-stereotyped associations of STEM with masculinity and instead provide an environment in which their daughters can explore STEM and if interested choose to take STEM trajectory.

Another significant finding from this study shows the role of parents as influential role models. More than half of the participants in the study consistently highlighted the impact of witnessing both their parents, either their mother or father or both, thriving in STEM fields. This firsthand exposure not only presented STEM as viable career options but also worked to challenge prevailing stereotypes when female students see their mothers succeed in the STEM workforce.

Several participants whose parents possessed STEM careers or educational backgrounds emphasized how observing their parents in STEM motivated them to consider pursuing the same path. This finding underscores the crucial importance of having visible STEM role models within one's family. Parents engaged in STEM careers can serve as a source of inspiration, broadening young women's perceptions of STEM careers and helping them overcome the STEM anxiety. When family members are actively involved in STEM professions, their passion and competence serve as tangible examples for their daughters.

Furthermore, the research revealed how witnessing their mothers, in particular, engaging in mathematics or pursuing careers in the STEM workforce had a profound effect on girls'

perceptions about their own ability. It instilled in them the belief that they too could excel in STEM domains. This finding is aligned with the literature that female role models, especially within the family, play a pivotal role in encouraging young girls to pursue STEM fields with confidence and determination (Cheng, Kopotic, & Zamarro, 2017).

Alongside parental factors, this research underscores the significance of fostering a gender-neutral environment within which parents nurture their daughters. The majority of participants recounted their childhood experiences in environments free from the imposition of limiting gender stereotypes by their parents. Almost all the participants mentioned that they never encountered any gender stereotypes from their parents and were never subjected to messages about gender-appropriate norms.

Most participants emphasized that they never received messages like, 'That's not something girls do,' or 'You're a girl, so you can't do that.' There was one participant who did report facing some of the behaviors mentioned above. Furthermore, most participants in this study were not expected to perform chores traditionally associated with women, such as washing dishes. Parents consistently conveyed their belief in their daughters' potential to pursue any aspiration, regardless of gender. This finding highlights the significance of parents' general gender difference they might hold and convey to their daughters.

By limiting or eliminating general stereotypes related to historically gender-appropriate tasks and roles and by providing early access to STEM education and confidence-building in an environment promoting gender equality, parents can create a safe space for their daughters to explore their interests in STEM.

This discovery highlights the importance of family dynamics during a girl's formative years and how both direct and indirect messages from parents regarding gender differences can

impact females' career trajectory. Šimunović and Babarovi (2020) noted that the majority of cultures possess varying perspectives on the roles and tasks deemed appropriate for males and females and culture plays a role in how different gender views their roles and tasks.

In conclusion, this study underscores the urgency of breaking the intergenerational transmission of gender stereotypes that restrict girls' engagement in STEM fields. Fostering early interest in STEM necessitates creating environments free from limiting assumptions and stereotyped behaviors. Parents should critically examine their own unconscious biases related to gender to empower and instill confidence in their daughters. By instilling gender-neutral messages, parents can play pivotal roles in expanding girls' perceptions of what is possible across all career paths, especially in STEM. This study affirms the strong impacts of childhood environments where female students grow up and view themselves as someone in STEM or traditional roles.

### **Limitations**

There are several limitations associated with this study as will be discussed.

First, the sample lacked diversity, as most participants were White, while African-American students were notably underrepresented. The institute where researchers recruited had predominantly white enrollment, making it difficult to recruit African-American participants. Future research should aim for greater representation by sampling from more racially and ethnically diverse institutions.

Another limitation of this study is the lack of demographic diversity among the participants. All participants were recruited from a single university in the southeastern United States, constraining the geographic scope. A more demographic diversity can help to understand the "lived experience" of different populations.

Finally, the participants came from middle income families. A wider social economic status that includes students from various socioeconomic backgrounds may reveal additional parental factors impacting STEM trajectories that this limited sample could not capture.

In general, broadening the diversity of the participant pool could elucidate more generalizable trends and a more varied range of student perspectives and lived experiences as all the factors mentioned above may play a role in females' students lived experience and STEM major choice.

### **Recommendations for the future research**

This study presented several parental factors influencing female students' STEM major and career choices, reinforcing parents' critical role. However, further research should explore how parents' own experiences shape their behaviors and expectations. This study captured engineering students' "lived experiences", but additional insights could emerge from understanding parents' "lived experiences "influencing their STEM perceptions.

Future work should also examine cultural forces and having large-scale comparative studies across diverse cultural backgrounds can illuminate variances in how parents view gender norms, academic expectations, appropriate roles, and STEM or engineering viability for their daughters. This research shows three different cultures and family backgrounds. However, larger samples from varying cultures can find relationships between family context and attitudes toward daughters' STEM success.

Additionally, family socioeconomic status may impact parents' ability to provide early STEM exposures, suggesting another critical area for investigation. While this study focused on middle income families' experiences, new research should contrast cases of low versus high

income families. Comparing across socioeconomic status can reveal differences in factors shaping daughters' STEM journeys based on available resources.

Examining how different financial status can impact the types of STEM encouragement, exposure opportunities, and motivations emphasized by parents can reveal new findings. For instance, lower income parents may highlight STEM career prospects to a greater degree, while financially secure parents may focus on intrinsic passions. The goal would be gaining a fuller picture of how parental socioeconomic status influences the nature and intent of STEM messaging and experiences cultivated for daughters or in general for different gender respectively.

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## **APPENDIX**

## Appendix 1

### Interview Questions:

1. According to your experience, what was your parents' attitude toward STEM majors? For instance, what opinions did they express about STEM professions and STEM professionals?
2. Did you experience any stereotype about female and male roles in your household? Were there any distinct observations about the capabilities and responsibilities of male and female students?
3. Can you recall any specific events or situations involving your parents that influenced your decision to choose a particular major? For example, did your home financial situation, a significant event, or a role model influence your decision?
4. Did your parents encourage or support you in your decision to study a field in (STEM)? Can you provide examples of their support?
5. Do either of your parents have a background or education in STEM fields? If so, how did this impact your decision to pursue a degree in STEM?
6. Can you share your experiences in relation to your parents' expectations for your academic performance during your school years? For instance, did they have high or low expectations for your grades and achievements?
7. Is there any additional information you can provide that would assist the researcher in understanding the role that parental factors played in your decision to study a field in science, technology, engineering, and mathematics (STEM)?