Evaluation of Reasons that May Affect whether Academically Capable Females Choose to Major in STEM

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EVALUATION OF REASONS THAT MAY AFFECT WHETHER ACADEMICALLY CAPABLE FEMALES CHOOSE TO MAJOR IN STEM

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EVALUATION OF REASONS THAT MAY AFFECT WHETHER ACADEMICALLY CAPABLE FEMALES CHOOSE TO MAJOR IN STEM

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DEDICATION

I dedicate this to those that I love and cherish the most.

To my husband, Chris Adkins, who manned the house while I was away. To my children, who gave up so much of their mother while she pursued her dream. To the first boy who I really loved with all of my heart, Colby Alexander. To the one who shares my soul and kept me laughing throughout all of this stress, Zain Adkins. To the youngest of my boys who sacrificed the most with few complaints and inspired me to keep going, Kye Adkins. You three were the push behind me every step of the way.

To my parents, Don and Jeanette Alexander, I could not have completed this without you both. My whole life you have supported me in everything and believed in me when I did not even believe in myself. I hope that I have made you proud.
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The purpose of this research was to study the reasons why academically capable females choose to pursue majors in STEM (science, technology, engineering, and math) fields. A mixed-methods approach using focus groups and a survey were used. Data were gathered from the focus group sessions and used to develop the survey that was then validated and checked for reliability. After some edits, the survey was administered to female freshmen attending Western Kentucky University. Unfortunately, all female students who completed the survey except one indicated they were pursuing STEM majors.

The results from this study suggest that the reasons surrounding the decision to pursue a degree in STEM are complex and multi-faceted. The reasons found to be most important for respondents centered on the need to help others, salary, room for advancement, future salary, and job security. As a result of the research compiled during this study, a survey was designed that could be utilized to gather information concerning the reasons particular female students have chosen to pursue degrees in STEM fields. The collected data from the survey could then be used to provide female students in middle and high school with the necessary supports to increase the numbers of females pursuing STEM degrees in the future.
CHAPTER I: INTRODUCTION

The United States continues to lag behind other countries when it comes to STEM (science, technology, engineering, and math). In 2007, a committee was assembled that included the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. Its goal was to take a closer look at the state of math and science education, today’s workforce, the nation’s economy, and the global competitiveness of the US. The committee compiled all of its findings in a report titled Rising Above the Gathering Storm. It was reported, in Germany, that 36% of undergraduates receive their degree in science and engineering. In China and Japan, the figures are much higher at a reported 59% and 66%, respectively. In the US, the reported share is only 32%. In engineering degrees alone, the US only produces 5% of graduates, as compared to China’s 50% produced each year. Many of the suggestions given in the report to improve the number of students pursuing STEM centered around increasing the quality of math and science teachers found in the K-12 grades in an effort to increase self-efficacy in math and science.

Three years later in 2010, the committee reconvened to examine the progress that had been made regarding its suggestions published in Rising Above the Gathering Storm. As a result of its findings, a new publication titled Rising Above the Gathering Storm Revisited: Rapidly Approaching Category 5 arose. The new publication stressed that, despite the efforts geared toward improving science and math education found in K-12 schools, the 14,000 public schools studied had improved little to none. The committee found that 69% of students in grades 5 through 8 were taught mathematics by a teacher without a degree or certificate in math, and 93% of those students were taught physical
science by a teacher without a degree or certificate in the physical sciences, leading to lower levels of self-efficacy in the students.

The Business-Higher Education Forum (2005) announced that only 15.6% of the bachelor’s degrees awarded in the US were in STEM disciplines. Our largest industrial competitor, China, awarded 46.7% of their bachelor’s degrees in STEM disciplines. South Korea awarded the third highest percent of bachelor’s degrees in STEM disciplines at 37.8, and Germany followed awarding 28.1%. These statistics lead to the conclusion that the US has one of the lowest ratios of STEM to non-STEM bachelor’s degrees in the world. This should come as no surprise considering that K-12 students from the US typically perform poorly on international math and science tests and are, therefore, less likely to pursue STEM degrees (Fleischman, Hopstock, Pelczar, Shelley, & Xie, 2010; Gonzalez et al., 2008; Jolly, Campbell, & Perlman, 2004; Provasnik et al., 2012; Wood & Associates, 2008).

The U.S. Department of Labor and Statistics (2019) reports that STEM jobs will grow by 7.4% between 2016 and 2026. In order for colleges to fill these vacancies, it is crucial to understand more surrounding the factors that may promote student success in these fields in particular, specifically for females. Much of the research regarding females and their decision to pursue majors in disciplines outside STEM centers around self-efficacy (Bandura, 1997; Larose, Ratelle, Guay, Senécal, & Harvey 2006; Zeldin & Pajares, 2000; Zeldin, Britner, & Pajares, 2008). Less research has been focused on factors such as interest (Denissen, Zarrett, & Eccles, 2007; Jolly et al., 2004); role models (Ashworth & Evans, 2001; Bandura, 1997; Carell, Page, & West, 2010; Else-Quest, Hyde, & Linn, 2010; Rask & Bailey, 2002); and gender stereotypes (Bandura,
Barbaranelli, Caprara, & Pastorelli, 1996; Schmader, 2002; Spencer, Steele, & Quinn, 1999; Steele, 1997). Very little research has focused on other factors such as parental education, impact of extracurricular STEM involvement, perceived salary, perceived opportunities for advancement, etc. In order to fully examine ideas to promote higher female enrollments in STEM programs, I sought to investigate some of the factors that may play a role in a female student’s decision to pursue a STEM major.

**Statement of the Problem**

It is no secret that females and minorities are underrepresented in STEM fields, especially engineering and computer operations, in the US (U.S. Department of Labor and Statistics, 2019). These two occupations make up more than 80% of the employment that comprises STEM. The National Science Foundation ([NSF], 2010) found that women have earned 58% of the bachelor’s degrees in STEM since 2002. However, more than 50% of these degrees were awarded in biological science and not in other STEM fields. This could be attributed to females choosing STEM careers in education and nursing primarily (U.S. Department of Commerce, 2011).

This trend is perplexing when one considers the Brookings Institute Report (Rothwell, 2013) that found that 74% of middle school girls say that they are interested in STEM, while only 20% of those female students actually end up pursuing a STEM degree. Somewhere between middle school and high school graduation, we are losing females in these subjects. The million-dollar question is, Why are females choosing to pursue STEM degrees? In order to increase the number of females pursuing STEM degrees, the research needs to examine the reasons surrounding the lack of interest in pursuing STEM majors and the reasons that lead many females to pursue STEM majors.
Much of the research surrounding females and STEM fields has centered around self-efficacy (Mau, 2003) and aptitude (Mahoney, 2010; Maltese & Tai, 2011). Self-efficacy refers to a person’s belief in their ability to be successful at performing a particular task (Bandura, 1997). It is easy to understand how self-efficacy could influence an individual’s decision to persist or not persist in a particular subject. If an individual believes that they are not “good” in a particular subject, they will likely try to find another niche in which they are capable of being successful. However, many of the females who are choosing degrees outside of STEM are academically capable of succeeding in the program (U.S. Department of Education, 2007).

Recently, researchers have begun to examine other factors that may play a role in female students’ decision to pursue non-STEM majors. Factors such as interest, female STEM role models, and gender stereotypes have been addressed in the literature. Still yet, I felt that there may be other factors pushing female students away from STEM degrees, and I sought to identify these factors in this study.
Purpose of the Study

The purpose of this study was to examine the factors that may be contributing to the lack of females enrolled in STEM majors at WKU. The qualitative portion of the study was designed to gather data that would aid in developing a valid survey. The quantitative portion of the study sought to determine which factors are contributors and the degree to which they contributed in the decision-making process by administering the designed survey. These variables are important to research because they offer insight into the reasons surrounding the lack of females pursuing STEM degrees.

The definition for STEM can vary somewhat and, therefore, needs to be defined for this study. As mentioned earlier, STEM is an acronym for science, technology, engineering, and math. The National Center for Education Statistics (NCES) (Chen & Weko, 2009) uses the strict definition of “mathematics; natural sciences (including physical sciences and biological/agricultural sciences); engineering/engineering technologies; and computer/information sciences.” The NSF’s National Center for Science and Engineering Statistics (NCSES, 2015) uses a broader definition of STEM that includes the social and behavioral sciences. For this study, I chose to use the stricter interpretation defined by the NCES.

This study brings together the issues previously described. First, there is a lack of research reported on the reasons that fewer females pursue STEM degrees. Second, the research presented is not exhaustive regarding reasons other than self-efficacy and aptitude. Third, identifying the various reasons that cause young female students to choose majors other than STEM could allow educators to design and implement programs that could potentially increase interest.
Research Questions

The empirical research questions that I developed were based on a selective literature review revolving around the decisions that cause academically capable females to not pursue a degree in a STEM field. With the pressure from Obama’s 2011 State of the Union Address and the recent focus on the decrease in STEM graduates, particularly females and minorities, there continues to be a need to encourage more students to pursue and stick with STEM degrees. To assist in filling this gap, I sought to understand the reasons young female students are choosing not to major in STEM fields. Therefore, this study sought to answer the following questions.

1. How do the following factors influence female freshmen and their choice to major or not major in STEM?
   a. Personal interest in STEM
   b. Experiences in high school science and math classes
   c. Extracurricular clubs and activities revolved around STEM
   d. Exposure to female STEM role models
   e. Perception that STEM is a male-dominated world
   f. Self-efficacy surrounding STEM
   g. Projected salary and job security
   h. Opportunities for advancement

2. What other factors may be impacting the female student’s decision to pursue a non-STEM major?

3. What factors are most influential in their (who?) decision to pursue or not pursue non-STEM majors?
General Methodology

This study worked to develop a useful survey that could identify the reasons that female students may choose not to pursue majors in STEM at the college level, even though they are academically capable. I began by examining recorded transcripts obtained during focus group sessions retrieved from a small private school. These recorded transcripts contained the answers to questions given by junior and senior female girls during focus group sessions regarding their STEM self-efficacy, interests, STEM experiences, etc. Their answers were grouped according to likeness. Using their answers regarding various factors surrounding STEM, I synthesized a survey containing items that would assess the reasons that academically capable females choose not to major in STEM. After obtaining IRB approval to move ahead in the study, the survey was administered to female freshmen enrolled in an introductory chemistry course at WKU in the spring of 2019. It is my hope that this survey will be useful to high schools and colleges in the future by helping them to create programs that may encourage more female students to pursue STEM majors.

Thus, the central research question provides meaningful and rich information for educational professionals in both high schools and universities: Why do females who meet the ACT benchmarks in English, math, and science choose not to major in STEM fields?

Significance of the Study

Despite the increase in the number of females attending colleges in the last 20 years, females are still underrepresented in certain fields such as science, technology, engineering, and math (Sadker, Sadker, & Zittleman, 2009; Szelényi, Denson, & Inkelas, 2013). In 2009, the Obama administration initiated the “Education to Innovate”
campaign to foster the engagement of U.S. students in STEM. Shortly after in the 2011 State of the Union Address, President Obama called for colleges to graduate 100,000 new teachers over the next decade with majors in STEM to compensate for the gross deficit of teachers in these subjects. Obama’s hope was centered around building a solid educational foundation through which we can grow more STEM interest (Obama, 2011).

This research was designed to investigate the reasons female students are choosing not to pursue STEM majors in college and to create a survey that high schools and colleges can administer to obtain data regarding their specific student population. The data allowed me to develop a clearer picture of these factors and the degree to which they influence the female student’s decision-making process. Understanding the reasons females are not pursuing STEM degrees may help to implement more programs that will encourage STEM enrollment.

**Limitations**

This study examined the reasons why academically capable females choose not to pursue majors in STEM. Several limitations to the research follow. First, the study was limited to female freshmen enrolled in an introductory chemistry course. Only students pursuing certain types of majors would need to take an introductory chemistry course. This small pool may also have been more representative of students pursuing a STEM major or more academically capable than a broader pool. Second, the coded responses obtained for the purpose of designing a survey were obtained from a small private school. Therefore, the experiences of these particular junior and senior girls may be different than girls attending public school in a more populated area. Third, the survey designed and administered in this study was limited to one program at one public university in
southcentral Kentucky. The results found in this study may not be generalizable to other types of institutions or even other public institutions in other parts of the country.

Summary

This chapter introduced the study, provided some background and rationale for the importance of the study, and provided the research questions that guided the study. As the US continues to fall behind other countries in STEM areas, the need for more graduates in these areas will become critical. By identifying some of the barriers standing in the way of our female youths, it might be possible to help remove these barriers, or at least assist in overcoming these barriers so that we may progress as a nation in STEM fields.

Many studies have identified various reasons that cause academically capable females to choose not to pursue majors in STEM. Previous research points to issues such as stereotype, low self-efficacy, lack of female role models, and other deficits (Mau, 2003; Marx & Roman, 2002; Shanahan, 2006). Until the primary and secondary schools and the workplaces address the issues that are preventing women from persisting in STEM, the job market will continue to suffer.

The next chapter provides a review of the literature surrounding the history of female students in STEM and the reasons that female students are believed to be choosing degrees outside of STEM.
CHAPTER II: REVIEW OF THE LITERATURE

Introduction

There continues to be a void in STEM careers in the US, especially concerning females and minorities. As of 2009, 52% of the workforce in the US was comprised of men, and 48% was comprised of women. At first glance, this statistic makes the workforce seem very balanced when examining gender. However, if one examines STEM jobs specifically, a very different picture emerges. Men hold 76% of all STEM jobs in the US, and women only hold 24% of all STEM jobs in the US (Szelenyi et al., 2013).

At a time when STEM knowledge is continuing to expand faster than any other discipline, our country needs all students, male and female, to pursue degrees in science, technology, engineering, and math in order to stay competitive with other progressing countries. In 2018, nearly 2.4 million STEM jobs went unfilled according to an email sent out by U.S. republican Martha Roby. The job market is wide open for engineers, computer techs, research scientists, math specialists, etc. If our country does not explore interventions to encourage high school students to pursue STEM degrees, specifically females and minorities, it will continue to see a shortage in the number of students pursuing STEM and will fall further behind other progressing countries.

A Historical Viewpoint

Women have come a long way since leaving their careers as homemakers to pursue careers outside the home during World War II. The movement into many professions has been substantial. Today, women dominate fields such as nursing and teaching. However, there are certain career fields that are still considered to be primarily
male dominated. According to the American Association of University Women (AAUW, 2010), women make up only 1% of the engineers and 27% of the biologists.

Early explanations of the underrepresentation of women in STEM fields centered around the inequalities that existed between men and women in academia and the workforce. Women were tasked with the responsibility of the household: raising children, cleaning, and cooking. Although some women were choosing to pursue careers outside the home, society was not very receptive to the idea. Many men resented the idea that their wives would not be at home waiting for them in the afternoon with dinner ready. Some men saw the movement of women into the workforce as competition for their jobs. Other men viewed women as being unable to keep up with the demands of a job and a household. Employers viewed women workers as a liability. They knew that if children were sick or schools were closed, they might lose their employee. Therefore, they often paid them less and withheld benefits they deserved.

These inequalities between men and women were not just bound to the workforce. They have long been present in school classrooms across the country. Sadker et al. (2009) described an experience in a 1960s high school chemistry class in one of his articles as being discriminatory:

Here’s how my 1960’s high school chemistry class was taught: Boys were seated by the male teacher on the side of the room with the teacher’s desk. Girls were seated on the far side of the room. Girls were told to be quiet and not cause trouble and they would not fail the class. When “dangerous” experiments were conducted, the boys went into the lab while the girls watched through the window. (p. 49)

The late 1900s continued to foster this idea that women were less intelligent, capable, creative, and had less scientific ability than males. Students who were male were deemed to have inherent qualities that made them more academically capable than
females. Males were especially believed to be more mathematically capable than females (Benbow & Stanley, 1980).

In 1995, a researcher by the name of Gerhard Sonnert used two models to explain the discrepancy in the ratio of males to females in science. The first model, the Deficit Model, explained that there were many structural barriers present giving women fewer opportunities to advance in the profession. These barriers were believed to be legal, political, and societal. Sonnert went on to explain that the costs incurred while pursuing a career in science would outweigh the benefits due to limited access and lower salaries for women in higher education and research. The second model that he proposed stated that the cause could be found in the different outlooks and goals that men and women made for themselves. Many women wanted to be able to work and help to support their families but still felt a great need to be present to raise children and care for the home. Therefore, they looked for careers that were more flexible and allowed more time at home, such as nursing and teaching.

More recent data from the U.S. Department of Commerce (2017) showed that although women filled 47% of all jobs in the US, they only made up 24% of the STEM jobs. This is surprising considering that nearly as many women now hold undergraduate degrees as men. However, only 30% of those degrees are in STEM fields. The wage gap is smaller in STEM fields also. Women in STEM jobs were found to earn 35% more than women in non-STEM jobs. So why is there still a deficiency?

This trend can be traced back from college all the way to the high school level (Gilligan, Goldberger, & Ward, 1991/1994). Their research found that 81% of girls liked math in elementary school. That number dropped to 68% in middle school and then 61%
in high school. However, 72% of boys were found to still like math in high school even though their grades may have been less than perfect. Many refer to this phenomenon as the “leaky pipeline.” This leaky pipeline for young females begins in elementary school and continues on to professional school (Sadker et al., 2009).

During these impressionable years from elementary to high school, girls encounter many influences that impact their decision to pursue a STEM career. Girls may receive less encouragement from home and in the classroom than their male counterparts, they encounter fewer female role models in STEM, there are societal gender role stereotypes, and they face a culture that presents males as more academically capable (Brown & Josephs, 1999; Price, 2010; Schmader, 2002; Steele, 1997). These factors and possibly others are steering girls away from STEM careers.

Franco (2012) examined students enrolled in several STEM schools in grades 8 through 12. Students were asked to complete an online survey that assessed their skill sets and career planning. She found that students enrolled in STEM schools expressed career intents in STEM at twice the national rate. Franco argued that earlier exposure (elementary and middle school) to STEM environments would increase the number of students that possess STEM skills. An increase in STEM skills would likely lead to an increase in self-efficacy, which could lead more female students to STEM careers. Franco also noted that STEM experiences have previously been geared toward high school students, which gives limited exposure. She suggested that schools need to provide more STEM experiences in lower grades.

Some girls persist in pursuing STEM into college. However, Lyons and Quinn (2010) found that many of the female students who initially entered college pursuing
STEM majors ended up switching into another discipline and abandoning the STEM field. Women who do earn a STEM undergraduate degree are less likely than their male counterparts to pursue graduate school in STEM or seek employment in a STEM field. The few females who pursue a STEM PhD are more likely to drop out; and if they obtain a PhD, are less likely to be hired for tenure-track positions. In 2010, the National Science Board (NSB) found that women represent less than a quarter of the total number of workers in STEM and often remain stuck in lower status and lower paying jobs. This bleak future could deter young women from entering into STEM fields.

Hill, Corbett, and Rose (2010) noted the importance of attracting more females to STEM disciplines. They stated that more females would enhance innovation, creativity, and competition and that the products created would better represent the entire population as a result. In order for the US to be able to begin to close the gap between males and females, educators and policymakers must understand the reasons that female students are not choosing STEM fields.

Past research has attributed the lack of females in STEM fields to a variety of reasons, some of which have been mentioned previously. In 1992, the AAUW produced research showing that the gender gap was widening, especially in STEM fields. Their research pointed to a lack of interest in pursuing STEM, a lack of support for girls in K-12 classrooms, a culture that promotes a male-dominated world, and the low self-efficacy of girls in subjects like math and science. A review of the current literature regarding each of these factors and their impact on the female student’s decision to pursue STEM can be found in the following section.
Lack of Interest

Interest must play a part in a student’s decision to major in STEM. People do not usually choose to pursue activities that do not interest them unless it is necessary. Jolly et al. (2004) found that student engagement increases when students possess an interest in the topic. Having an interest in a subject typically leads to more confidence because the student will work much harder to grasp the topics (Denison et al., 2007). Since confidence has been found to be a primary factor in promoting persistence in math and science courses, this absolutely has to be addressed (Jewett, 1996). Finally, despite all of the best efforts in the world to support female students, if they have no interest in STEM subjects, they are not going to pursue them.

Since females and males have different interests, STEM classroom teachers should make sure to include activities that foster a love for STEM in both genders. When technology classes and engineering classes include activities that are engaging and are easily relatable to real life, both males and females are interested (Mitts & Haynie, 2010). Unfortunately, we find that the activities that take place the most in classrooms focus on technical or mechanical concepts that will most likely not appeal to females (Bachman, Hebl, Martinez, & Rittmayer, 2009).

Weber (2012) performed a study to measure middle and high school student interest in becoming an engineer. The sample included 556 students enrolled in a contemporary technology and engineering program who completed a contemporary technology and engineering survey. The students were given the modified Technology and Engineering Survey. Two-way factorial ANOVA was performed in order to examine the following: (1) possible relationships between male and female middle school and high
school students’ level of interest in engaging in different types of technology- and engineering-related activities and work, (2) possible relationships between male and female middle school and high school students’ perceived personal capacity in technology- and engineering-related activities and work, and (3) possible relationships between male and female middle school and high school students in pursuing pathways created to stimulate interests in STEM fields.

The study found that males have a greater interest and desire than females to repair or fix things. Females indicated a greater interest in work that helped the community (Weber, 2012). Out of 388 males involved in the study, only 107 (28%) indicated that they wanted to become an engineer. When examining female responses, Weber (2012) found that out of 168 females, only 20 (11.9%) said they were interested in pursuing engineering. Female and male students who indicated an interest in pursuing engineering all responded on the survey with the belief that they possessed a high level of self-efficacy and a high interest in the activities presented.

It makes sense that having an interest in a subject increases the desire to learn the material and encourages the student to master related concepts. However, the research regarding interest and its relevance to females pursuing STEM is somewhat new and lacks depth. This study investigated the relationship between interest and the female student’s desire to major in a STEM field.

**Role Models in STEM**

Much research has been done to examine the influence that various role models (i.e., teachers, parents, etc.) can have on the female student’s pursuit of a STEM degree. Positive experiences with role models can help female students develop positive attitudes
toward careers in science and increase self-efficacy (Bandura, 1997). Negative experiences with role models may reinforce low self-efficacy, negative gender stereotypes, and decrease interest in pursuing STEM fields. A role model can also influence the student’s beliefs surrounding his or her own individual abilities. For example, a female student may believe that she is not good at math because she has been told that females are not typically good at math. She may revise her beliefs when she is presented with a female role model that is successful in math. In this way, female role models can serve to break down stereotypes regarding females and STEM.

**Female Role Models**

Due to the shortage of females choosing to major in many STEM disciplines, there remains a shortage of female role models in teaching positions available to students. According to the U.S. Department of Labor and Statistics (2019), women make up 48% of the workforce but only 24% of STEM workers. This statistic occurs despite the fact that women in STEM degrees earn 33% more than women who are working in non-STEM fields. Out of the total percentage of women who do end up in STEM, only 14% are in education. Many studies have suggested that having a female teacher in a STEM subject may encourage female students to pursue a STEM major (Ashworth & Evans, 2001; Carell et al., 2010; Rask & Bailey, 2002). Since young women, under the age of 18, spend the majority of their day in school, they have little access to female role models in STEM careers outside of teaching (Leggon, 2006).

The lack of STEM female role models in K-12 schools is particularly concerning since some studies suggest that having a female role model for STEM classes can increase the likelihood that female students will pursue a major in STEM. A study
performed by Else-Quest et al. (2010) found that female students were just as likely to succeed as their male counterparts if given positive female role models, encouragement, and the necessary educational tools. Having a female role model likely presents the idea to the female student that what she is trying to achieve is possible. Male students were just as likely to pursue STEM when they had a male role model as they were when they had a female role model.

However, some studies have shown that having a female teacher for a STEM class does not ensure that female students will persist in STEM, at least at the college level. Price (2010) examined data for all of the public universities within the state of Ohio to determine whether freshman female students were more likely to persist in STEM majors if they had a female instructor. The data included first-time freshmen enrolled in a four-year university during 1998 and 2002. There were over 157,000 freshman students examined, of which 22.4% were initially planning to major in a STEM field. Price used a fixed-effects model to examine the correlation between the number of STEM courses taught by female instructors and the outcome of persisting in a STEM field after the first semester. Results from the study found that there was a 2.1% decrease in the probability of a female student persisting in STEM when their STEM course was taught by a female instructor. Price pointed out that his study aligns with similar previous studies that show that, on average, having a female instructor does not have a significant effect on the persistence of female students in STEM fields. However, one of the limitations to the study was that it included all female students without considering their reasons for persisting in a STEM major or for changing majors.
Simply having a female teacher for a STEM class does not ensure success. If the teacher is incompetent or expresses a great amount of dislike or anxiety regarding STEM subjects, it could potentially have a negative impact on the female student. According to Beilock, Gunderson, Ramirez, and Levine (2010), early elementary teachers are almost exclusively female (> 90%) and those who major in elementary education have the highest levels of math anxiety of any major. This anxiety regarding math, along with an avoidance of math, could have a significant impact on elementary students and their perceptions surrounding math and their own abilities. Especially alarming is the idea that children are more likely to emulate the attitudes and behavior of their same-gender teachers. Therefore, elementary girls may be more likely to notice their female teacher’s anxiety and avoidance to math than elementary boys.

Beilock et al. (2010) hypothesized that the more anxiety regarding math that a female teacher had, the lower her students’ math achievement would be. They also hypothesized that this would particularly hold true for female students and that there would be no significant impact on male students. Last, they believed that any relationship that they did find between a girl’s math achievement and the teacher’s anxiety regarding math could be explained by pointing to the teacher’s beliefs regarding traditional academic stereotypes (i.e., boys are good at math and girls are good at reading).

Beilock et al. (2010) assessed 17 female first- and second-grade teachers from five public elementary schools. On average, the teachers had 13 years of experience teaching elementary school. Their math anxiety and math ability were assessed during the last two months of the school year. Math anxiety was assessed using a short version
of the Mathematics Anxiety Rating Scale (MARS). Math ability was assessed using the Elementary Number Concepts and Operations subtest of the Content Knowledge for Teaching Mathematics measure. Beilock et al. examined 117 elementary students’ math achievement and gender ability beliefs. Student math achievement was measured using the Applied Problems subtest of the Woodcock-Johnson III Tests of Achievement.

Student math achievement was assessed during the first three months of school and again the last two months of school. Students’ gender ability beliefs were examined by reading two different stories: one story about a student who was good at math and another story about a student who was good at reading. The students were then asked to draw a picture of the student. They were scored based on whether they drew a boy or a girl for each story.

As was hypothesized, Beilock et al. (2010) found no significant relationship between teacher’s math anxiety and students’ math achievement. However, results showed that by the end of the year, the higher the teacher’s anxiety regarding math, the lower the girls’ math achievement. The impact was not seen in male students though. The study also found no relationship among the teacher’s math anxiety and gender ability beliefs at the beginning of the year. This held true for boys at the end of the year as well. However, the more anxiety regarding math that the female teacher possessed, the more girls’ ability beliefs were to fall into a traditional thinking pattern (i.e., boys are good at math and girls are good at reading).

As a result, it was suggested that all external influences be measured to account for the full range of social influence on math achievement (Beilock et al., 2010). Exploring other relationships, such as parents, peers, previous teachers, etc., would help
to give a broader picture. It was also suggested that math anxiety be reduced in elementary teachers through math education and training prior to earning teacher certification. Girls would likely not choose to major in a STEM field if their experiences with STEM were negative or they perceive that they cannot be successful.

Marx and Roman (2002) studied the effect of the presence of female role models and participants’ performance on math tests. They examined three specific aspects: (1) the effect of having a competent female experimenter administer the test, (2) the ability of the math competence of the female experimenter to shield female participants from their negative self-perceptions, and (3) the effect of knowing the female experimenter’s math ability on the female participants taking the math test.

In the first study, 22 women and 21 men participated. The participants were given 25 minutes to complete a test resembling the GRE math section that contained 25 problems. After testing, the students were asked to take a short self-esteem test that measured how confident they felt after the math test about performing well in future situations. The first study found that having a female test administrator helped to protect women’s math test performance allowing them to perform at the same level as men who have equal math abilities (Marx & Roman, 2002).

In the second study, the subjects included 24 women and 22 men. In this particular study, the female test administrator was presented as either having a high ability in math or a low ability in math. The administrator was presented as a senior in college so that the participants could view her as someone whose successes could be similar to that of their own. Students completed the same math test as mentioned in study one within the same timeframe. Data showed that having a female administrator with a
history of success in math boosted the female participants’ math scores (Marx & Roman, 2002).

The third study included 44 female participants who were asked to take the same test used for experiments one and two. The data suggested that women performed better when they believed the female administrator had a history of high achievement in math. The women who tested with the female administrator who had a recorded history of lower achievement in math scored lower. The data align with the research that suggests having more successful female mentors in STEM could promote more female involvement in STEM majors (Marx & Roman, 2002).

McIntyre, Paulson, and Lord (2003) performed a similar experiment to examine the effect of female role models on women’s math achievement. Their hypothesis suggested that women would perform better on math achievement tests if they were first told that they were going to perform a task at which women had the tendency to excel. The study involved 162 undergraduate women and men who were led to believe they were involved in a study that was going to help standardize GRE scores. Stereotype threat conditions were introduced by introducing the participants to the idea that women perform more poorly than men in math-related tasks. Participants were randomly assigned to two conditions: (1) participants were informed prior to testing that female participants tend to perform better as participants in psychological experiments, and (2) participants did not receive the message given to the first group. All participants completed 34 GRE questions of high difficulty. Immediately after testing, participants took another test that measured their perception of their performance.
The results showed that women who were not told of other women’s successes in psychological experiments performed more poorly than all of the other male and female participants. The researchers concluded that females perform at higher levels when they are reminded of other women’s successes. This finding coincides with the other research that suggests the importance of presenting female students with successful female role models.

Parents

Hall, Dickerson, Batts, Kauffman, & Bosse (2011) also attempted to pinpoint reasons surrounding the decline in STEM graduates by examining the motivation to major in a particular area of study. The researchers surveyed high school students; parents of high school students; high school personnel (teachers, coaches, counselors, etc.); and college students to find out why they chose their particular major. The high school students were between the ages of 12 and 18. Hall et al. surveyed 118 high school students, 184 parents of high school students, 13 high school personnel, and 83 college students majoring in engineering. The high school student survey contained two parts: the first part asked students to rate 10 specific influences (teachers, counselors, earning potential, friends, parents, etc.) on the impact they had on their career choice. The second part of the survey asked students to rate the importance of items (someone in their family who holds a similar degree, a teacher’s encouragement, a career counselor, etc.) on their career choice. Parents filled out a survey asking about their aspirations for their child. School personnel answered questions about their knowledge of careers particularly in STEM fields. College students majoring in engineering had surveys similar to high school student surveys with only one question added: When did you decide on engineering as your career choice? Interestingly, Hall et al. found that the second most
important factor in their choice of major was parental influence. Students who have one or more parents in STEM disciplines are more likely to major in a STEM field (Hall et al., 2011).

Parental influence has been found to be a significant contributor to career choice, especially when it comes to non-traditional career choices (Dryler, 1998). Outside of school, young girls spend the majority of their extracurricular time with their parents, giving them an enormous capacity to influence interests, confidence, and self-perception. Clewell and Anderson (1991) found that a lack of parental expectation in science could discourage their daughter’s interest in pursuing that field. They also found parental influence and family background play a critical role in female achievement in math, as well as being a contributor to their negative feelings regarding math.

To confirm this, Davis-Kean performed a longitudinal study at the University of Michigan’s (2007) Institute for Social Research in which a positive correlation was found between parental attitude toward their child’s interest in math and the child’s actual math achievement. The study also revealed that parents often provide a more supportive environment regarding math for their male children than for their female children. The study further revealed that as a father’s gender stereotype ideas increased, their daughter’s interest in math decreased. The son’s interest increased as the father’s gender stereotype ideas increased. Having a parent who has a career in a STEM field could positively influence female self-efficacy significantly (Leslie, McClure, & Oaxaca, 1998). Research has shown that it influences the female student’s perception that he or she can also achieve the same goal (AAUW, 2010; Burke & Mattis, 2007; Jeffers,
Safferman, & Safferman, 2004; Leslie et al., 1998). However, most young women do not have a parent working in a STEM field.

Although we cannot provide more young girls with parents who have careers in STEM, we can work to provide them with more role models. Providing competent, successful female role models to students in K-12 classrooms could likely encourage more female students to pursue STEM degrees. Young girls are very impressionable and can be easily influenced by stereotypes found in media, perpetuated by male classmates, and unknowingly transferred through inexperienced teachers. Female students need to have access to teachers who encourage and build up females in areas such as science and math and refrain from making comments that propagate fear and avoidance of STEM. They need role models who delicately balance work and home life successfully so that young girls can envision themselves being able to achieve the same success. Providing girls with more exposure to successful females in STEM can only encourage higher enrollments in these programs.

**Gender Stereotypes**

The demand for technology graduates continues to expand at unprecedented rates with the increase in use of technology gadgets such as iPhones, computers, Fit Bits, Apple watches, etc. In fact, the IT industry has grown a mind-blowing 83.27% over the last five years (Fidelity, 2015). However, in 1985 women were awarded only 37% of the computer science degrees, which fell to 18% in 2010 (Kasson, 2013). The number of females pursuing degrees in computer science or engineering continues to remain low and is extremely concerning.
This phenomenon may be partly explained by examining the stereotypes that are associated with the individuals who choose these kinds of careers. As previously mentioned, young girls are conditioned very early on to believe that they are not good at math. This stereotype can negatively impact their math achievement and cause them to underperform (Spencer et al., 1999). Steele (1997) identified this as “stereotype threat,” which refers to the anxiety that an individual can face as a member of a stigmatized social group. The fear that the individual will confirm the stereotype causes stress and anxiety to the point that it impacts the individual’s performance. According to Spencer et al. (1999), this negative stereotype surrounding girls and math can act as a catalyst to help young women overcome the “norm,” or it can work as a self-fulfilling prophecy that prevents them from being able to reach their full potential.

Steele (1997) went on to explain that this stereotype threat not only alters the performance of the individual but can also cause the individual to “disidentify” with stereotype-relevant domains. The individual disidentifies when they remove themselves from activities that are associated with the negative stereotype. This removal can be temporary, but with repeated exposure to the stereotype threat the individual can develop a very strong avoidance (Steele, 1997). Repeated disidentification is believed to be a coping mechanism created to deal with the fear of failure or confirming the negative stereotype.

In 1999, Brown and Josephs examined the impact of performance concerns regarding gender. The participants included 65 women and 61 men enrolled in introductory psychology. The experimenter told the participants that the math test that they would be taking was going to be used in the psychology department to track and
place incoming students. Half of the participants were told that the test was designed to identify students who were exceptionally strong in their math abilities. The other half of the participants were told that the test would indicate if they were especially weak in their math abilities. The results of the experiment showed that women performed poorly when they believed that the math test they were taking would determine if they were exceptionally weak at math. Men performed poorly when they believed that the test that they were taking would indicate if they were exceptionally strong in math or not. Both men’s and women’s performance decreased when they believed that their math-related stereotype was being assessed.

Schmader (2002) performed a similar experiment that examined gender stereotype threat and its effects on women’s math ability. There were 65 participants (33 white males and 32 white females). All had achieved an SAT score between 500 and 700. The participants arrived in groups of one to four and were led to separate cubicles to test. Instructions were given by tape recorder and explained that the researcher was interested in each individual’s performance on the test and that each of the participant’s scores would be compared to the other participants. The recording also stated that the researcher would be using the test as an indicator of their personal math ability.

For the individuals tested in the control group, the recording simply asked them to write their names on the cover sheets of the test. Gender was not mentioned in this group. For the group in which gender stereotype threat was examined, the recording announced that the researcher was interested in how women score on the math test relative to the men. Participants had to indicate on their test whether they were male or female, and individuals were made to feel personally invested in their performance. The
study found that men showed an increase in math performance when gender was relevant. As expected, females showed a decrease in math performance when gender was relevant. Interestingly, the change in performance was found to be correlated with the extent to which the individual felt that gender was an important source of their identity. Women who did not feel as if gender was an important part of their self-definition performed equally to men despite the manipulation.

In 2010, the NSF found that women obtain 59% of the undergraduate degrees in biology and nearly half of all of the undergraduate degrees in chemistry. However, they also found that women earn less than 20% of all undergraduate degrees earned in computer science and engineering. These statistics suggest gender stereotyping is deeply imbedded into our culture. It is portrayed in movies, songs, sitcoms, plays, etc. The ideas that are presented through these various media forms impact our perception regarding what is acceptable at an early age (Adya & Kaiser, 2005). These gender stereotypes can lower girls’ aspirations for STEM careers (Hill et al., 2010). Our culture pressures girls into gender stereotype careers such as nursing and education and tells females that they are not as capable as males in math and science (Bandura et al., 1996). This stereotype results in parents, teachers, and counselors holding lower expectations for girls, which discourages them from pursuing any field that could be considered mathematical, technical, or scientific (AAUW Educational Foundation, 1999; Bandura, 1997; Sadker & Sadker, 1995).

These gender stereotypes appear in popular movies, television shows, books, etc. No realm of media seems to be untouched or uninfluenced. Dumas (2011) found that the popular clothing company, Forever 21, produced a shirt for girls that read, “Allergic to
Algebra.” He also found that JC Penny had promoted a shirt that said, “I’m too pretty to do homework so my brother has to do it for me.” These two clothing items represent a very small portion of the stereotypes that young girls face.

The cultural stereotypes that have so long been a part of our culture in the US often push women away from STEM fields. Research has shown that female students who are highly skilled in two or more areas will choose the field that is more in line with cultural stereotypes despite being capable of pursuing either path successfully (Szalavtz, 2013). This is particularly true in information technology in which men and women are often labeled as “tech oriented, intelligent, and socially impaired” (Townsend, 2014). Television shows like The Office or Silicon Valley portray information technology specialists as “nerds.” As a result, young girls tend avoid this field for fear of being seen as “geeky” or not being accepted by mainstream culture.

The effort that researchers have made in the last several decades to change the institutional climate and its attitudes toward students and math and science success has been successful to some extent (Huang & Brainard, 2001). However, the gender bias that occurs in classrooms across the nation remains well documented. Girls receive less instructional time, less assistance, and are presented with fewer challenges because they are thought incapable. As a result, they have a lower engagement, self-confidence, and performance, which leads to less persistence in STEM (Burke & Mattis, 2007; Colbeck, Cabrera, & Terenzini, 2001; Sadker et al., 2009).

Sadker et al. (2009) were involved in providing professional development for a group of teachers. They videotaped the teacher instruction and then used the videos to point out gender bias in the classroom. The teachers being evaluated were shocked by
the results. Male students were often allowed to monopolize the classroom discussion, they asked and answered more questions, and received more praise and more help on challenging material. These subtle gender differences continue to send a message to young girls that they are to be spectators in the classroom.

A study by Pronin, Steele, and Ross (2004) examined gender stereotype and its propensity to cause some women to change certain characteristics about themselves in order to fit in male-dominated careers. Pronin et al. named this transition “identity bifurcation.” They found that individuals in careers that have certain gender characteristics associated with them will disassociate themselves with the negatively perceived gender aspects that they possess. For example, women who have a career in information technology may stop wearing makeup, stop acting flirtatious, and change their minds about wanting to raise a family. The study also found that women with more of a math background were much more likely to have experienced the identity bifurcation than women who were not exposed to an intense math background. This study proves that women in STEM fields often feel the need to change characteristics about themselves in order to be taken seriously, to receive promotions, and to fit in.

Schmader (2002) examined 33 Caucasian male and 32 Caucasian female undergraduates who had previously achieved an SAT score of between 500 and 700. Individual participants were placed in situations in which their gender identity was either linked to their performance on a math test or not. Participants were also asked to complete the Collective Self-Esteem Scale in order to assess the perceived importance of gender identity to self-definition. The study determined that an individual’s desire to maintain a positive sense of social identity can negatively affect their academic
performance. The desire is greater in those individuals who feel that their social identity is an important part of their self-definition. Therefore, those individuals who are highly identified with their social group experience the greatest degree of stereotype threat to their academic performance when the stereotype is portrayed as negative. When gender was relevant to academic testing, male subjects who felt that their social identity was an important component of their self-definition actually performed better. Whereas, female subjects who also felt that their social identity was an important component of their self-definition performed poorly.

Some young women feel threatened due to the stereotypes surrounding STEM or the perception that men dominate these fields of study. Hackett (1985) hypothesized that if a student had a high self-efficacy in math, the student could overcome the gender stereotypes surrounding it. The researcher tested her hypothesis by administering two math questionnaires to 262 students. One of the math questionnaires was the Mathematics Self-Efficacy Scale and the Fennema-Sherman Mathematics Attitude Scales. She also administered the Bem Sex Role Inventory measuring for traditional gender roles. She used the questionnaires and the inventory to determine why females are less likely to consider a major in STEM programs.

Hackett (1985) found that self-efficacy and math anxiety, the number of years of high school math completed, ACT math scores, and participation in math-related programs were highly correlated. In particular, she found a high degree of correlation between gender and years of high school math to be strong predictors of college major choice. She concluded by stating that self-efficacy in math, likelihood of enrolling in a math field, and math anxiety were all seemingly influenced by two factors: gender-
related stigmas and the level of preparation in math. She recommended that schools work through counselors and classroom instructors to break the gender stereotypes held by female students through encouragement, teaching, and presentation of career options to dissipate gender-related stigmas. She also recommended that students be encouraged to take more math and science courses in order to be more prepared and to increase their self-efficacy.

Fabert (2014) examined undeclared, first-year undergraduate students at Arizona State University. The study included 298 women and 191 men of various ethnicities and ages who were all enrolled in the same course. Participants completed a three-item measure, the “Index of Malleability,” in order to assess their beliefs about intelligence being malleable. Participants also completed a “Belief Scale” that examined their endorsement of gender stereotypes involving math ability. Finally, participants completed a Math/Science Course Self-Efficacy Scale designed to assess the student’s own confidence in their math and science ability. Other survey items were designed to gather demographics, intentions to pursue STEM as a career, etc.

Participants were randomly assigned to one of three groups: (1) treatment group, (2) comparison group, or the (3) control group. Participants assigned to the treatment group received a “growth mindset” tutorial and “mentor training” designed to develop a view that intelligence is fluid and changeable. Those participants in the comparison group received unrelated training before testing on “social influence strategies” and “persuasive writing skills.” Participants in the control group were tasked with a single outcome questionnaire and instructions for completing the assignment in order to gain credit for the course.
Aligning with other previous research, the data from the Fabert (2014) study showed that decreasing negative gender stereotypes by introducing an intervention can have a positive impact on women’s performance. However, the impact was not as significant as expected. The researcher suggested that unexpected results could be due to participants’ attitudes and beliefs regarding gender stereotypes being deeply rooted and difficult to change. She suggested that a longer and more in-depth intervention might need to take place to have any significant impact. It was also suggested that participants might not believe the typical ideas surrounding gender stereotypes and therefore showed no real significant difference from the comparison and control groups.

**Self-efficacy**

There is an extensive amount of supporting literature concerning the self-efficacy of female students when it comes to science and math. Self-efficacy refers to an individual’s belief about his or her capabilities on a specific task (Bandura, 1997). When it comes to STEM subjects, males typically have a higher level of perceived personal capacity than females (Weber, 2012). This does not mean that males are more capable of being successful in STEM though, but rather that they perceive themselves as being capable (Hill et al., 2010). Male self-efficacy in STEM revolves around the ability to master concepts, whereas girls seem to develop their self-efficacy ideas from experience and other’s perceptions of them (Zeldin & Pajares, 2000). According to Bandura and Locke (2003), self-efficacy is a strong predictor of both the level of motivation for a task and ultimately task performance. This is true especially when examining females. STEM self-efficacy seems to play a larger role in vocational choice for girls than boys (Larose et al., 2006). Many researchers have concluded that the primary factor for
females deciding to pursue and persist in a STEM major is that they feel they are good at math and science (Bandura, 1997). Therefore, females are likely to persist in STEM fields when their self-efficacy regarding those fields is high (Hackett, 1985; Zeldin et al., 2008).

According to Bandura (1997), there are four factors that make up student self-efficacy: past experience, vicarious experience, verbal persuasion, and psychological state. Past experiences could involve science or math classes taken; club involvement; or even extracurricular activities involving science, technology, engineering, or math. Positive experiences would help to increase the student’s self-efficacy. On the other hand, negative experiences would lower the student’s self-efficacy. Vicarious experiences refer to students comparing themselves to others by observing their successes or failures. If the student views another student’s ability to be similar to his or hers and they succeed at a particular task or assignment, the student’s self-efficacy will increase. The opposite happens when the student views the other student as having failed at a particular task or assignment (Bandura 1997). Verbal persuasion is limited in its effect but can have serious positive or negative consequences on a student’s self-efficacy. This aspect includes encouragement or discouragement from teachers, parents, other students, etc. Psychological states could impact self-efficacy negatively if the student experiences stress, anxiety, or negative changes in their mood or emotional level when performing tasks associated with STEM. Out of the four contributing factors to self-efficacy, past experience, was found to be the greatest contributing factor (Bandura, 1997).

Students begin to form ideas about their abilities regarding science and math as early as elementary school. Around seventh grade (pre-algebra, etc.), the level of
difficulty begins to increase, and students report that they receive less support from their parents, teachers, and peers (Jones & Howe, 2000). It is during this critical time that it seems like we lose most female students. In seventh grade, girls typically report having a lower ability in math and science despite their performance being level with boys in the same grade (Sadker & Sadker, 1995). As the gender gap in math and science self-efficacy widens, girls develop anxiety and avoidance for these subjects. Since each year brings more challenges and difficulties, their self-efficacy and confidence continue to drop (Beilock et al., 2010). Since confidence has been found to be a primary factor in promoting persistence in math and science courses, this absolutely has to be addressed (Jewett, 1996).

In school, confidence can be built up or destroyed by the teacher. We hope that teachers are building the confidence of their students and not placing limits on their abilities. However, many teachers still unintentionally send subliminal messages to their students about societal limits based on gender (Hall & Sandler, 1982). Their messages are likely subtle and oftentimes the teachers are unaware of the messages that they are sending to their students. Children are extremely impressionable, especially in the elementary grades, and they are intelligent enough to pick up on social cues and expectations that teachers present. For example, if a teacher uses an example of a doctor and nurse working together in leader/servant roles and the teacher chooses the doctor to be male and the nurse to be female, the teacher has subtly suggested a gender role. This would introduce or reinforce the idea that girls are not best suited for leadership roles.

Educators may also set limits for their students through questioning. According to Hall and Sandler (1982), gender bias may be very obvious in the classroom. For
example, a teacher may favor one gender over the other and only let those students comment or answer questions in class. A less obvious prejudice could be demonstrated when the teacher looks at male students to answer the questions before turning attention to female students. Some teachers may show prejudice in the types of questions that they ask males versus females. For instance, the teacher might ask male students questions that are higher order or require critical-thinking skills. The same teacher may direct memorization questions toward female students because they are lower level thinking questions. These subtle actions by teachers can leave female students feeling unimportant and incapable.

Males typically have more previous experience with activities that are mechanical or technical than females have. This can be seen in any toy aisle in any large retail store in America. Toys geared toward boys include building (Lego, Lincoln Logs, Kinects, etc.); motion (electronic race cars, video games, etc.); and problem solving (mad science kits, complex puzzles, etc.) Toys geared toward girls include dolls, cooking equipment, and beauty items. Boys tend to be given more tasks that exercise their spatial skills at a very young age (Hill et al., 2010). This leads to males being more capable of succeeding at these kinds of tasks in school initially, which leads to a higher self-efficacy (Shanahan, 2006). As a result, males are more likely to pursue technology and engineering classes, camps, etc.

A substantial amount of research has shown that the lack of self-confidence in one’s ability to do mathematics is detrimental to the continuation of math studies (AAUW, 1999; Burke & Mattis, 2007; Fenema, 2000). High school girls were found to score lower on perceived ability than high school boys despite their academic
achievements (DeBacker & Nelson, 2000). Denissen et al. (2007) also found that a student’s confidence and interest tend to feed one another. He suggested that most human beings do not want to continue to engage in activities that they perceive themselves to not be successful. When a student has great confidence in a subject, their interest also increases. Students tend to avoid subjects where they are not successful. DeBacker and Nelson (1999) found that perceived ability was the greatest predictor of semester grades for female high school Biology students, and girls have continued to experience low levels of confidence in math and science for decades (Burke & Mattis, 2007). Interest can fuel confidence as well. Students who are interested in a particular subject will spend more time trying to master concepts, which will in turn increase their confidence.

In search of answers regarding the expanding gender gap found in STEM programs, Gilligan et al. (1991/1994) explored results from a national self-esteem survey titled “Shortchanging Girls, Shortchanging America.” The survey conducted by the AAUW consisted of 3,000 boys and girls in grades 4 through 12. It contained 92 items grouped into three foci. The first focus examined the different perceptions of males and females regarding themselves and their future. The second focus centered on aspirations of both groups. The third focus collected data on participants’ attitudes about gender roles, classroom experiences, and school.

Gilligan et al. (1991/1994) reported that girls’ perceptions of math and science and their self-esteem continue to decrease as they grow older. The researchers reported that 81% of elementary school girls “like math.” As stated in their results, this number decreased to 68% in middle school and 61% in high school. However, when compared to
boys, the results showed a decrease but not nearly as drastic as seen with the girls. For boys, 84% were found to “like math” in elementary school, 68% in middle school, and 72% in high school. When they examined whether or not elementary boys and girls felt like they were “good at math,” half of the boys stated that they were good but only one-third of the girls said that they were good. The researchers reported that girls’ perceptions about their ability in math had a significant impact on their self-esteem. The researchers concluded that while girls’ perceptions regarding math decline, so do their goals and self-worth. Finally, it was determined that confidence in math is a significant contributor to female persistence in STEM majors.

As a result of their research findings, Gilligan et al. (1991/1994) suggested that family and school had the greatest impact on young girls’ self-esteem and, therefore, their persistence in STEM fields. The researchers suggested that school faculty converse with girls in and out of the classroom to make them feel more important. The schools also need to provide active learning opportunities and place the girls in situations that allow them to work independently with some assistance to increase their confidence. Consistent praise was recommended as the girls become successful so that they feel encouraged and want to continue to learn. Most importantly, schools need to promote STEM degrees as a viable option for girls.

Pajares and Miller (1994) also examined self-efficacy and gender in math. Their sample contained 350 students and was focused on confidence and its effect on problem-solving performance compared to math self-concept, anxiety, prior experience, perceived usefulness, and gender. The researchers used path analysis to statistically find cause and effect. The results of the experiment showed that there were gender differences between
girls and boys regarding self-efficacy perceptions. The power of self-efficacy was found to greatly impact the student’s performance on tests. Students who had lower judgments in their ability to perform the assignments consistently scored lower, specifically pertaining to females. Males typically performed tasks better and had lower reported levels of anxiety.

It makes sense that a student’s previous experiences with STEM will likely influence their self-efficacy regarding it. The more exposure a student has to science, technology, engineering, and math, the more comfortable and proficient the student will become. As this self-efficacy surrounding STEM fields increases, the student will be more likely to enroll and persist in a STEM major (Franco, 2012).

Espinosa (2011) studied the effects that certain pre-collegiate activities, institutional setting, and experiences in college would have on the persistence of females in STEM majors. The study showed that females who experienced an opportunity to engage with their peers and participate in STEM-related student organizations were more likely to enroll and persist in STEM majors. The study also found that females were more likely to pursue STEM if they were shown altruistic career opportunities. The findings stressed the importance of cohort STEM programs and organizations that provide female students with a sense of community; belonging; and demonstrate how a STEM career could influence environmental, social, and economic problems.

Fantz, Siller, and Demiranda (2013) examined students’ pre-collegiate experiences in engineering (i.e., outreach programs, field trips, summer camps, exposure to engineering colleges) and the students’ self-efficacy. The researchers hypothesized that exposure to a more rigorous pre-collegiate experience would result in the student
possessing a much higher self-efficacy in math and science. They believed that this would likely lead to that student being more likely to enroll in a STEM field and persist.

Fantz et al. (2013) administered the MSLQ (Motivated Strategies for Learning Questionnaire) to 332 participants. MSLQ can be used to assess a student’s level of motivation to persist in a degree program and their likelihood of using different learning strategies for collegiate study. The questionnaire was administered to first-year undergraduate students who were enrolled in an engineering college. The sample was 81% male and 19% female. The questionnaire helped the researchers break down the students into two groups: those who did not experience pre-collegiate engineering experiences, and those who did experience pre-collegiate engineering activities. Fantz et al. further disseminated those two groups into four smaller subgroups. Under each broader heading, the sub-categories were titled formal and informal experiences. Formal experiences were defined as “middle school or high school courses, summer and out-of-school programs, and single-day field trips” (Fantz et al., 2013, p. 606). Informal pre-collegiate experiences included “work experience and personal experiences with toys and hobbies” (Fantz et al., 2013, p. 606).

As a result, the researchers found significant differences in the student’s self-efficacy based on the types of pre-collegiate experiences they had. Fantz et al. (2013) examined seven pre-collegiate activities: technology class, engineering class, programming as a hobby, electronics as a hobby, robotics as a hobby, model rockets as a hobby, and a production of video games as a hobby. Five of these were labeled as informal experiences: programming as a hobby, electronics as a hobby, robotics as a hobby, model rockets as a hobby, and a production of video games as a hobby. The
researchers found that the informal pre-collegiate experiences that were described as hobbies resulted in the student having a higher level of self-efficacy. The researchers theorized that this could be explained because the student had to be self-motivated, use problem-solving strategies, be interested in the subject, and gain immediate feedback on the success of the product. Fantz et al. also found that students who had formal pre-collegiate experiences had higher levels of self-efficacy than those students who did not share in the experiences. The researchers ended with suggesting that more resources be developed that place an emphasis on offering pre-collegiate STEM experiences to K-12 students. More exposure to these programs would result in a higher self-efficacy in math and science, which would lead to a higher enrollment in STEM majors in college.

Brainard and Carlin (1997) studied women attending four-year institutions pursuing a degree in engineering or science. Women began the program with a high level of confidence in their ability to succeed. However, for many female students it was eroded away during the first two years. The researchers found that the women’s confidence level increased with more time but never rose to the level that it was in the beginning. Interestingly, women who left the program had comparable grade point averages (GPAs) to those who stayed and completed their degrees successfully.

In 2011, Sawtelle examined the lack of representation of women in physics due to low self-efficacy. The American Institute of Physics (AIP) had previously reported that only 2% of all science, math, engineering, and natural science degrees were awarded in physics. Sawtelle used a mixed-methods approach, which involved taking a quantitative look at the influence of self-efficacy in male and female students and a qualitative approach that examined the development of self-efficacy in both males and females. The
sample consisted of 352 students enrolled in Physics with Calculus I at a primarily Hispanic-serving institution. Using sequential linear regression, she found self-efficacy to be a significant predictor in student success in physics. She then examined how self-efficacy developed in males versus how it developed in females. Her results showed that women develop self-efficacy ideas around different situations or scenarios than male students. Male self-efficacy has been reported as being strongly related to mastery experiences (Zeldin et al., 2008). On the other hand, women develop their self-efficacy from vicarious learning sources and social persuasion (Zeldin & Pajares, 2000).

Betz and Hackett (1981) studied the relationship between self-efficacy and the careers that men and women choose. They evaluated 200 college students and asked about the confidence they had in their ability to complete the educational requirements and job duties for 20 different careers. Careers such as dental hygienist and elementary school teacher were considered to be those that are mostly female dominated. Accounting and engineering were among those considered to be primarily male dominated. Their study found that women typically have a lower self-efficacy when it comes to careers that are viewed as primarily male dominated.

Cook (2013) examined the effect of self-efficacy and attitudes toward general chemistry of freshman students at WKU. She also looked at the intentions of the students to take future chemistry courses after their first experience in general chemistry at WKU. The sample consisted of 1,126 first-time, first-year students of various races, sex, declared major, etc. Self-efficacy of general chemistry was measured using the Self-Efficacy for General Chemistry (SEGC) scale containing 14 items using a 7-point Likert scale designed by the researchers. Attitude toward general chemistry was measured
using an Attitude Toward Chemistry Lessons Scale which contained 12 items and a 7-point Likert scale. Intentions to take future chemistry courses were measured using the General Chemistry Intentions (GCI) scale. This scale contained 6 items and a 7-point Likert scale. As a result of the previously listed surveys, the researchers were able to determine that the freshman population at WKU had poor attitudes toward chemistry and demonstrated a lack of confidence in their ability to be successful in the class. They also found attitude and self-efficacy to be accurate predictors of a student’s intentions to enroll in future chemistry courses.

Although it is evident that self-efficacy plays a vital role in a female’s decision to persist in STEM or to pursue another path, other factors need to be examined. Little research has examined these other factors in as much detail as self-efficacy. Along with increasing female student self-efficacy, we could identify and address these other issues to help close up the holes in the “leaky pipeline.”

Summary

The literature review revealed the female enrollment in STEM majors around the nation continues to remain low and has even decreased at times in the last years despite efforts to encourage enrollment. The challenges for female students underrepresented in STEM are real and point to the need for intervention programs. While many intervention programs have been put into place, including camps and after-school programs, female enrollment in STEM still remains low. Therefore, the reasons surrounding the question of why more females are not enrolling in STEM majors needs to be addressed.
CHAPTER III: METHODOLOGY

Overview

The current study was conducted to explore the demographics and characteristics of female freshman students enrolled at WKU, along with factors that impact their decision to enroll in STEM majors. The findings of this study can be used to promote enrollment in STEM majors by providing the needed resources and support that may be lacking for female students in high school and early college. This study offers evidence of the various factors that are contributing to the lack of growth for females in STEM majors. This chapter provides an in-depth examination of the research questions, the population and sample, the instrumentation, and the analysis of data.

Researchers have been searching for explanations to account for the widening gap between males and females in STEM fields for decades now. Bandura began studying the effects that self-efficacy in math and science had on females during the late 90s. As the gap continued to widen in early 2000, researchers (Bandura, 1997; Bandura et al., 1996; Bandura & Locke, 2003; Pajares, 2006; Pajares & Miller, 1994) continued to dig into self-efficacy and its effect on young girls. In the last decade the field of study has widened to include a variety of factors that are believed to impact the decision as to whether or not a young woman should pursue a STEM degree or not. Factors such as gender bias, interest, nature, and many others have been examined.

There is no lack of research surrounding the reasons that academically capable females are choosing not to pursue degrees in STEM areas, but rather a deficit in identifying which of these factors may be most important to a particular population of young females. The significance of this study is its contribution to a more detailed
understanding surrounding the reasons that female enrollment in STEM majors remains low. Most importantly, the study sought to develop a useful survey instrument that secondary schools and universities can use to help target potential females for their STEM programs. If the factors can be identified for a specific population, then the barriers can hopefully be removed, providing an easier path.

**Research Questions**

The following general research question was used to guide the study: What factors influence the academically capable female student’s decision to pursue or not pursue a STEM major?

1. How do the following factors influence their (female students) choice to major or not major in STEM?
   a. Personal interest in STEM
   b. Experiences in high school science and math classes
   c. Extracurricular clubs and activities revolved around STEM
   d. Exposure to female STEM role models
   e. Perception that STEM is a male-dominated world
   f. Self-efficacy surrounding STEM
   g. Projected salary
   h. Opportunities for advancement

2. What other factors may be impacting the female student’s decision to pursue a non-STEM major?

3. What factors are most influential in their (who?) decision to pursue or not pursue non-STEM majors?
Research Design

The purpose of this study was to uncover the reasons surrounding why academically capable females are choosing not to pursue college degrees in STEM fields. A large focus of this study was to design a survey that high schools and colleges could use to identify these “need” areas so that they might implement programs that encourage more women to major in STEM fields.

This study utilized a mixed-methods design to investigate the reasons that academically capable females choose not to pursue STEM degrees. A mixed-methods approach involves both qualitative and quantitative data. By combining the two approaches, I was able to provide a broader perspective and come to a better understanding of the problem (Creswell, 2013). Qualitative data might include interviews, focus groups, and questionnaires that provide more detailed information than quantitative data can provide. The researcher can then use the more detailed information to design a more useful survey. After the survey is administered and the quantitative data have been analyzed, it can then be used to implement a plan or solution to the problem presented (Sale, Lohfield, & Brazil, 2002).

Both quantitative and qualitative methods have shortcomings though. Quantitative data do not allow for the context or setting in which data are collected. Qualitative data can include the bias of the researcher and not present an accurate picture. Although a mixed-methods approach is more time consuming and requires more resources, combining the two methods eliminates the bias and allows for the setting and context to be incorporated into the message (Creswell, 2013). The combined approach also appeals to a wider audience.
Setting and Participants

Before any research was performed involving human subjects, an application was submitted to WKU’s internal review board (IRB), and approval was granted to administer the survey (see Appendix A).

In order to gather enough participants to get a good picture of female STEM experiences in K-12, I chose to invite female freshmen attending WKU. In the spring of 2018, all freshman female students within the Ogden College at WKU were invited to attend a focus group session. A $50 Amazon giftcard, as well as pizza and drinks, were offered. I received one response as a result.

A second attempt involved sending a mass email out to every 10th female freshman student enrolled at WKU living on campus. This totaled to 43 STEM majors and even more non-STEM majors. The same incentives were offered. This attempt resulted in zero responses.

A third attempt included sending the invitation out via email to 250 random freshman female students enrolled in a STEM major and 250 random freshman female students not enrolled in a STEM major either living on campus or off campus. The same incentives were offered. Two students responded. As a result of the low number of responses, it was decided that I needed to pursue another avenue.

After discussion with my committee chair, it was determined that I might be able to gather more participants for the focus group sessions at a community college located in my hometown of Somerset, KY. I applied for IRB approval through the Kentucky Community and Technical College System (KCTCS) and received it approximately one month later. I contacted nine professors at the college by email and asked if they would
be willing to help gather participants. One professor responded and agreed to get the information (time, day, etc.) to her students. One hundred fliers were also printed and posted on campus inviting participants to the focus group sessions. Two groups were scheduled: one for those pursuing a STEM degree and one for those not pursuing a STEM degree. The same incentives were offered as before. This resulted in one student response. Due to low response, the sessions were cancelled.

At this point, it was decided that I could use data that were being collected at the private school where I was currently teaching. The guidance counselor was collecting data regarding previous STEM experiences for senior girls. The two focus groups she held were made up of nine high school seniors. One focus group consisted of five female students who planned to pursue a degree in STEM. The other focus group consisted of four female students who planned to pursue a degree in a field of study other than STEM. The answers from the focus group were coded by me and were grouped according to likeness. After analyzing the results, common themes began to emerge. From these responses, I developed the survey.

The survey was given to four collegiate professionals for examination to determine its validity. After removing questions deemed invalid, a pilot test was performed. Twelve female students who were either attending a local high school or a local college in Kentucky were asked to take the survey, and the results were tabulated in order to determine its reliability.

After the survey had been edited based on the results from the reliability and validity tests, it was sent out to all freshman female students attending WKU via an email with an online link to the survey. This was attempted twice, and zero responses were
received both times. After two failed attempts using the mass email communication system at WKU, the survey was administered to female students who were enrolled in an entry-level chemistry course at WKU during the spring semester of the 2019 school year. WKU is considered to be somewhat rural with a student population of approximately 20,000 and is nestled in the small town of Bowling Green. WKU has a longstanding reputation as being a diverse and competitive academic college.

Female students were invited to participate in the survey when they attended class, and it was made clear that the survey was completely voluntary. They were allowed to take the survey home and return when completed within a two-week time frame. The surveys were submitted to the professor and then mailed to me, which allowed the participants to remain anonymous.

It is recommended that the sample range contain approximately 65 participants when using the power analysis formula in which the power criterion is set at 0.80 and the effect size is set at 0.50 (Creswell, 2012). Exactly 65 students returned their surveys, and these data were compiled and analyzed.

The IRB process dictated that all participants were treated ethically. All participants were provided with informed consent, which included a statement explaining their right to participate voluntarily and to withdraw from the research at any time. Participants were also notified of the right to obtain the results of this research.

**Instrument**

The data retrieved from the focus group sessions came from a local private school in Kentucky. The sessions were informal with guided questions, but participants were allowed and encouraged to discuss options freely.
After the student responses were coded from the focus groups, they were analyzed, and the items were grouped according to likeness. These answers were then used to design a survey that was then given to four college professionals with 15-30 plus years of collegiate experience. They were asked to rank the questions using a Likert scale. Questions deemed not valid were removed.

The survey was then administered in a pilot test to 12 upper-level high school students or lower-level college students to gauge the impact that these experiences had on their choice of major in college. Questions deemed to be unreliable were removed from the survey.

Finally, the modified survey was then administered to female freshman students enrolled in an entry-level chemistry course at WKU during the spring semester of 2019. Students completed a survey containing 35 items purposed to obtain demographic information, as well as assess their self-efficacy, experiences, and interest in STEM. Other items on the survey were also designed to gather information regarding the factors that may or may not have influenced the student’s decision regarding their choice of major.

**Procedures**

In order to aid in survey development, focus group sessions were originally scheduled to take place at WKU. After four attempts and receiving only four responses overall, I determined to use data that were being collected at a small private school in Kentucky. These data would still suffice in capturing young females’ past experiences in and around STEM. The only difference was that the data gathered consisted of nine young women in their senior year of high school, rather than freshman females in college.
The female students were split into two focus groups: one group intended to pursue a degree in STEM, and the other intended to pursue a non-STEM degree. The interviewer asked various questions regarding their previous experiences with STEM using semi-structured questions, as well as demographic questions. The information from the focus group sessions was tape-recorded. Using these tapes, I coded the questions and answers into written form and then grouped them according to likeness. From this, I constructed the survey.

To ascertain the validity of the survey, the content of the survey was then examined by four individuals who hold various positions at Somerset Community College and have a combined experience of over 100 years with students in education. The first individual had 15 years of experience teaching math at the high school and college levels. The second individual had 40 years of experience as an RN and 25 years of experience as coordinator of the nursing program. The third individual had 30 plus years of experience in college advising. Finally, the fourth individual had 30 plus years teaching math at the college level.

Each of the individuals rated the 45 questions on the survey using a Likert-type scale from 1-4 (1- Not relevant, 2- Somewhat relevant, 3- Quite relevant, and 4- Highly relevant). After assembling the data, it was determined that six questions had poor Kappa scores. Cohen’s kappa coefficient (κ) can be used to measure inter-rater reliability for qualitative items. Cohen suggests that the Kappa results should be interpreted as follows: values ≤ 0 indicate no agreement and 0.01-0.20 as none to slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial, and 0.81-1.00 as almost perfect agreement.
Poor Kappa scores have been determined to be 0.200 or less. Seven questions were found to have poor scores and were removed from the survey.

To ascertain reliability, the revised survey was then administered to 12 students who were either seniors in high school or freshmen in college at various locations. The reliability test included a Likert-scale as well that ranged from 1-5, where 1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, and 5=Strongly Agree. When the data from the surveys were examined, one question was deemed unreliable. This question was found to have a Kappa score below 0.200 and, as a result, was removed from the survey.

After the survey was edited taking into account the results from the content validity and reliability studies, the final version was given to females taking an introductory chemistry course at WKU in the spring of 2019. A $100 giftcard was offered to female students at WKU who participated in and returned the questionnaire. Sixty-five freshman students returned the surveys and the data were compiled.

Data Management and Analysis

When performing a qualitative study, Slavin (2007) states it is essential for researchers to organize the data and search for themes that would allow the data to be categorized. This study began with the examination of opinions voiced during focus group sessions at a local private school regarding female experiences in STEM. These data were examined and grouped into categories in order to determine key themes that seemed present in all participants’ thoughts and feelings.

The gathered opinions were used to form a survey consisting of 29 questions surrounding the reasons why academically capable females are choosing not to major in
STEM fields. This survey was then administered to 65 female freshmen enrolled in an introductory chemistry course at WKU. These data were collected, and the frequencies were examined.

**Role of Researcher**

The role of the researcher in a mixed-methods study is to combine quantitative statistics and qualitative observations in such a way as to better understand that which is being studied. In the qualitative portion of the study, the researcher acts similar to a spectator. Patton (2002) refers to the researcher as “the instrument.” Through this method the researcher is able to observe more than numerical data. He or she can see, hear, and feel the whole setting and gain a better understanding of the larger picture. Once the data are organized, categorized, and analyzed the researcher must be able to communicate the results in a way that others can understand (Creswell, 2012).

Sometimes the researcher may choose to use the qualitative data collected in order to develop a psychometric instrument that can then be administered to a population. In this case, I used the qualitative information to develop a survey that was then administered to a set population. The data were analyzed and categorized to develop themes among the population.

**Trustworthiness**

Trustworthiness is essential to any research study. I ensured that all participants were aware that their participation was completely voluntary, and they were free to share their thoughts and ideas openly without any negative implications. The surveys were distributed and collected by someone other than me, making it impossible to identify participants.
Limitations

With any study performed, there will be limitations and it is important to mention these. This study was limited to one program at one public university in southcentral Kentucky. The results found in this study may not be generalizable to other types of institutions or even other public institutions in other parts of the country.

This study also relied on the participant’s honesty in reporting their high school GPA and ACT scores. Although participants would receive no compensation based on higher or lower reported scores, individuals may have been somewhat embarrassed by low scores and reported higher inflated scores. It is also possible that students unintentionally reported false scores because they did not remember.

A third limitation for this study was that, despite my efforts, I was only able to collect data from students who were pursuing a degree in STEM. Only one participant indicated that they planned to pursue a non-STEM field. Therefore, the data are not representative of the entire female population.

Summary

This chapter provided an overview of the methodology used, the rationale behind the practices implemented, and attempted to explain the sample selection. The purpose of the study was to examine potential factors involved in academically capable females choosing to pursue or not pursue majors in STEM. Previous research has proposed several areas of concern, and those areas remained the theme of this research. However, open-ended questions allowed for new factors to be discovered. The research procedure included the qualitative data that were obtained from the high school focus group sessions and the survey administered to the females enrolled in an introductory chemistry
course at WKU. The description of the process utilized to collect the data and the procedures involved in analyzing the data were described, along with the ethical concerns pertaining to this study.
CHAPTER IV: RESULTS

Introduction

In 2006, the U.S. government released data that showed an increase in postsecondary enrollment. However, the number of female students pursuing a degree in STEM has continued to decline. Since the release of data by the U.S. government, numerous initiatives have been implemented in the past in order to promote more female representation in STEM fields. Programs such as Project Lead The Way (PLTW), Girls Incorporated-Eureka, and other local summer camps and after-school programs have made only a small dent in the continually decreasing numbers. An increased awareness of the issues that many young women face, such as self-efficacy in math and science, male dominance, a lack of female presence, and others, have also been addressed to some extent, but more is needed. Interventions at the primary and secondary levels designed to promote confidence and interest in STEM fields for young females also remain crucial to addressing this wide gender gap that continues to expand.

The purpose of this study was to examine the factors affecting young, academically capable females in their decision to pursue a degree in a STEM field. According to the U.S. Department of Labor Statistics (2019), the educational system has failed to produce enough qualified individuals to keep up with the growing demand in the STEM industries. STEM jobs are predicted to grow by over 8% in the future, which will create a substantial void if action is not taken to increase the number of individuals, particularly women, in STEM. Many of the young women who need to be targeted are high-performing and could add real value to the workplace (Lowell, Salzman, Bernstein, & Henderson, 2009). Innovation is only achieved by combining skills, experience, and
knowledge from a diverse group of employees (Quintana-Garca & Benavides-Velasco, 2008). Companies cannot achieve this level of diversity without including female employees. Therefore, it is necessary to identify and address the obstacles and challenges presented to young, academically capable females.

The remainder of this chapter details the results found in this mixed-methods study. The chapter concludes with a summary.

**Descriptive Statistics**

This was a mixed-methods study that involved gathering data from a local private school in which two focus groups that included high school senior girls (some pursuing a STEM major and some not pursuing a STEM major) were composed. Each of the nine participant’s responses to each question were carefully examined for the purpose of finding commonalities and patterns. The information gathered from those focus group sessions was used to design a survey meant for the purpose of examining the reasons that academically capable females are choosing not to pursue majors in STEM.

The survey underwent tests to determine its validity and reliability, and questions were edited or removed according to the data collected from these tests. After obtaining IRB approval (see Appendix A), the survey was then administered to female freshmen taking an introductory chemistry course at WKU. The survey not only gathered information regarding the student’s previous experiences with STEM, but it also included demographic information found to be important based on previous research.

Table 4.1 provides the high school GPA for all freshman females who participated in the survey. As shown, the majority of students who participated had a GPA between 3.76 and 4.0. Seven of the participating students received over a 4.0 GPA.
by taking AP or dual-credit classes. Only nine participants had a GPA equal to or lower than a 3.5, which would be considered an A- or a B. No one reported having a GPA of less than a 3.0, or the equivalent of a B. One participant chose not to provide her GPA.

Table 4.1

*High School GPA of Participants*

<table>
<thead>
<tr>
<th>GPA</th>
<th>3.0-3.25</th>
<th>3.26-3.50</th>
<th>3.51-3.75</th>
<th>3.76-4.0</th>
<th>4.01-4.25</th>
<th>4.26-4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>43</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 4.2 represents the ACT composite score for 62 participants. Three students chose not to respond to the question. The data show a fairly even distribution among the participants and their ACT composite score. Less than a quarter of those who answered the question scored above a 32 on the ACT. Approximately one quarter of the participants scored below or near the threshold for college academic readiness according to the benchmarks set forth by the state of Kentucky, despite their impressive GPAs found in Table 4.1.

Table 4.2

*ACT Composite Score of Participants*

<table>
<thead>
<tr>
<th>ACT Score</th>
<th>20-23</th>
<th>24-27</th>
<th>28-31</th>
<th>32-35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>15</td>
<td>18</td>
<td>21</td>
<td>8</td>
</tr>
</tbody>
</table>

Only 37 participants out of 65 chose to indicate their current major. All but one of the majors listed falls under the category of STEM. It would be impossible to know what the other 28 participants have decided to major in or whether or not any of these individuals may change their major in the future. Table 4.3 shows the breakdown of those participants who did choose to respond. The only participant not pursuing a degree
in STEM listed that she was pursuing a degree in paralegal studies. The largest group of participants were pursuing degrees in biology, with a few pursuing double majors (a STEM and a non-STEM degree). The data show the trend mentioned in the literature review regarding certain STEM degrees. Biology and its branches held the most participants, while engineering and technology held the fewest.

Table 4.3

*Declared Major of Participants*

<table>
<thead>
<tr>
<th>Chosen Major</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Animal Science</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Biology</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Bioengineering</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Dance with Bioanthropology</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Engineering</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Exercise Science</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Gatton Academy</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Geology</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Health Science</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Medical Science</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Molecular Biotechnology</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Paralegal Studies</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pre-pharmacy</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pre-med</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Due to the type of class that the participants were enrolled, all 37 participants who answered the question concerning their major of study (minus one individual) indicated that they were pursuing a major in STEM, except for one. As a result of the inability to collect data from female freshmen pursuing non-STEM degrees, I had to adjust my original research question from, What factors influence the academically capable female student’s decision to pursue or not pursue a STEM major? to What factors influence the academically capable female student’s decision to pursue a STEM major?

**Findings for Revised Research Question 1**

RQ1: How do the following factors influence their (female students) choice to major in STEM?

The research questions in this study were designed to examine the various factors believed to play a role in a young woman’s choice to pursue a STEM major or not.

**Personal Interest in STEM**

The survey contained six questions (Question 8, parts 1-6) regarding students’ personal interests concerning STEM. These questions were Likert-type questions with answers ranging from strongly disagree to strongly agree. The results can be found in Table 4.3.

According to the survey, 60% of students reported that they enjoyed math, and a little over 92% reported that they enjoyed science. Interestingly, 55% stated that they enjoyed technology, while less than 25% said that they enjoyed engineering.
Table 4.4

**Personal Interest in STEM**

<table>
<thead>
<tr>
<th></th>
<th>Strongly</th>
<th>Disagree</th>
<th>Neither</th>
<th>Agree</th>
<th>Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>I enjoy science</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>I enjoy technology</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>I enjoy engineering</td>
<td>3</td>
<td>5</td>
<td>16</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>I enjoy math</td>
<td>5</td>
<td>8</td>
<td>13</td>
<td>20</td>
<td>9</td>
</tr>
</tbody>
</table>

**Experiences in High School Science and Math Classes**

These questions were Likert-type questions that assessed a student’s experiences in previous science and math classes. Table 4.4 shows the results for these two questions.

Close to 72% of participants indicated that science class had not been difficult for them in the past. A little over 63% of the respondents said that math had not been difficult for them.

Table 4.5

**Previous Experiences in Math and Science**

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Life science classes have always been difficult for me</td>
<td>16</td>
<td>25</td>
<td>31</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>Math classes have always been difficult for me</td>
<td>18</td>
<td>28</td>
<td>23</td>
<td>35</td>
<td>7</td>
</tr>
</tbody>
</table>

Question number 9, part 2 on the survey, asked respondents to indicate how much of an influence math and science teachers in high school had on their choice of major.
Almost 71% of participants stated that middle and high school teachers had an impact on their choice of major. This question did not specify whether or not these teachers were STEM teachers, nor did it specify whether the impact was positive or negative.

Question number 9, part 3 on the survey, asked participants to rate the impact the difficulty of their high school coursework in their major had on their decision to pursue STEM. Over 86% indicated the difficulty of the coursework had an impact on their choice of major. This again suggests that students who have been successful in STEM classes in the past may be more likely to pursue a degree in these areas in the future.

Table 4.6

*Percent Impacting Factors on the Decision to Pursue a STEM degree*

<table>
<thead>
<tr>
<th></th>
<th>Significant Impact</th>
<th>Some Impact</th>
<th>Little Impact</th>
<th>No Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Parents and Family</td>
<td>24</td>
<td>37</td>
<td>22</td>
<td>34</td>
</tr>
<tr>
<td>Middle and High School Teachers</td>
<td>23</td>
<td>35</td>
<td>23</td>
<td>35</td>
</tr>
</tbody>
</table>

**Extracurricular Clubs and Activities Revolved around STEM**

The question pertaining to students’ experiences with STEM were open ended and included activities such as camps, clubs, classes, etc.

Question number 3 on the survey involving clubs the student participated in was, If you were a part of 1 or more STEM clubs in middle or high school (e.g., GEMS, PRIDE), how do you think your STEM club experiences influenced your choice of major in college?

Only 26 students chose to respond to the question. Out of those 26 responses, 16 students indicated that the club(s) they were a member of had an influence on their choice
of major. The other respondents indicated that participating in a STEM club had little to no impact on their choice of major.

The next question (Question number 5 on the survey) concerning students’ experiences with STEM was, If you were a part of 1 or more STEM summer camps (e.g., 4-H, Robotics camp, etc.), how do you think your STEM camp experiences influenced your choice of major in college? Close to 60% of the respondents indicated that they had never participated in any STEM camps. This is surprising considering the large number of STEM camps made available to young people today. Of those who had participated in at least one STEM camp (26 participants), only 13 indicated that the camp had any real impact on their choice of major. The remaining 13 participants reported it having no effect on their choice to pursue STEM.

The last question (Question number 7 on the survey) pertaining to students’ experiences in STEM was, If you were a part of 1 or more STEM after-school events (e.g., GEMS, PRIDE, etc.), how do you think your experiences influenced your choice of major in college? Only 39 respondents reported being involved in any kind of after-school STEM activities. Only 12 of those indicated that they felt like the after-school activities had any impact on their desire to pursue a major in STEM.

**Exposure to Female STEM Role Models**

Only one Likert-type question listed on the survey (Question 9, part 11) assessed the impact that having female instructors had on the student’s decision to pursue a degree in STEM. Out of all of the freshmen who participated in the survey, approximately 50% reported that a presence of other women in STEM had a significant impact or some impact on their decision to pursue a degree in STEM.
Perception that STEM is a Male-Dominated Field

Question 9, part 5 on the survey, was a Likert-type question that asked students to rate how their perception of STEM being a male-dominated field had impacted their choice to major in STEM.

Only 14% of the participants indicated that this had a significant impact on their choice of major. Almost 60% of the respondents said that it had little or no impact on their choice.

Self-efficacy surrounding STEM

The survey contained four Likert-type questions (Question 1, parts 3-6) regarding students’ self-efficacy in STEM. Fifty-five percent of the participants stated that they were confident in their math abilities. Approximately 63% of the participants disagreed when the question was stated as, “I was never successful in STEM classes.” Almost 83% reported that they were just as capable as their peers in math. Nearly 80% reported that they were just as capable in science as their peers. Previous findings have suggested that students with a low self-efficacy choose not to pursue STEM but, rather, choose to pursue something that they feel like they are more likely to succeed in.

Projected Salary and Opportunities for Advancement

When students were asked if salary had an impact on their decision to pursue a STEM degree, over 50% reported this as being a significant factor. Fifty to fifty-five percent said that job growth and job security also had an impact on their decision to pursue STEM.
Findings for Revised Research Question 2

Research Question 2: What other factors may be impacting the female student’s decision to pursue a STEM major?

The final question on the survey allowed students to report any other factors that they felt had an impact on their decision to pursue a degree in STEM. Thirty-seven responses were left blank. Out of the remaining 28 participants, many of the factors already mentioned were repeated again. Students expressed that parents, mentors, interests, and previous experiences in STEM had prompted them to pursue a degree in one of the four STEM areas. Several responses centered around being able to help others, which also supports previous research.

In the demographic section of the survey, participants were asked to provide the highest level of education completed by their father and mother. Table 4.6 shows that over 50% of the participants had parents that possessed a bachelor’s degree or higher. Exposure to educated parents could have played a role in self-efficacy for the participants.

Table 4.7

Parent’s Educational Background

<table>
<thead>
<tr>
<th></th>
<th>High School</th>
<th>Associate’s Degree</th>
<th>Bachelor’s Degree</th>
<th>Master’s Degree</th>
<th>Doctorate Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Father</td>
<td>20</td>
<td>32</td>
<td>9</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Mother</td>
<td>16</td>
<td>26</td>
<td>13</td>
<td>21</td>
<td>16</td>
</tr>
</tbody>
</table>
Findings for Revised Research Question 3

What factors are most influential in their decision to pursue STEM majors?

Participants were asked to rate various factors that impacted their decision to pursue a degree in STEM using a Likert-type scale. The information is compiled in Table 4.8.

Table 4.8

Percent Impact of Various Factors on the Decision to Pursue a Degree in STEM

<table>
<thead>
<tr>
<th>Factor</th>
<th>Significant Impact</th>
<th>Some Impact</th>
<th>Little Impact</th>
<th>No Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents and Family</td>
<td>24</td>
<td>22</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Middle and High School Teachers</td>
<td>23</td>
<td>23</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Difficult High School Work</td>
<td>17</td>
<td>20</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Presence of Other Women</td>
<td>14</td>
<td>18</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>Seeing Successful Women</td>
<td>20</td>
<td>21</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Perception of Females</td>
<td>9</td>
<td>17</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Chance to Help Others</td>
<td>46</td>
<td>15</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Projected Job Growth</td>
<td>24</td>
<td>30</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Job Security</td>
<td>29</td>
<td>21</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Future Salary</td>
<td>34</td>
<td>20</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Room for Advancement</td>
<td>32</td>
<td>20</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

According to the data, the opportunity to help others and the projected job growth in certain fields had the greatest impact on the female students’ decision to pursue a degree in STEM. Nearly 94% indicated that this was a significant impact. The desire to help others was noted as a major contributor to the student’s decision.

Job growth and job security were also found to be important factors. A little over 83% of participants noted job growth as a factor that impacted their decision. Nearly
77% indicated that knowing they would be able to keep working once they graduated was a large contributor in their decision process.

The impact that family members and previous teachers had on their decision cannot be ignored either. Over 70% of the participants reported that a family member or teacher had played a big role in their decision to pursue a STEM degree. These factors were also noted in the final question of the survey. In this question, students were asked to list any other factors that they felt really influenced their decision to pursue STEM. Four different participants mentioned someone in their life who had inspired them to choose STEM as a major even though the survey had previously asked similar questions.

**Summary**

The data analysis served to determine what factors impacted female freshmen’s decision to pursue or not pursue a degree in a STEM field. However, 36 out of the 37 participants who recorded their major were found to be pursuing a degree in STEM. Therefore, the research questions were modified to focus on the factors that may affect the female student’s decision to pursue a degree in STEM.

The study also set out to identify which factors had the greatest impact. Percentages were compiled for the 65 individuals who completed the survey. Questions were grouped into like categories such as interest, self-efficacy, previous experiences, demographics, etc. Some percentages were combined to find the overall effect, such as agree and strongly agree or disagree and strongly disagree.

For research Question 1, the data suggest that personal interest in math and science play an important role and could explain the gender discrepancy found in many STEM careers. Female participants reported a high interest in math and science but an
average or low interest in technology and engineering. Female participants noted positive, successful experiences in previous math and science courses, giving them high levels of self-efficacy to continue along that particular path. Clubs and extracurricular STEM events were found to not have any real impact on the female students’ decision to pursue a degree in STEM. Having access to female role models was not particularly important and they were not deterred by male dominance. Potential salary and opportunity for advancement were found to be important contributors in their decision-making process.

For Research Question 2, many students simply reiterated what had already been stated in some of the Likert-type questions. The desire to help others, salary, opportunities for advancement, and personal interest led them to pursue a degree in STEM.

For Question 3, the largest contributor in the female students’ decision to pursue a degree in STEM was their desire to help others. The data also suggest that personal interest in math and science play an important role. Students also listed projected salary and opportunities for advancement as large contributors in their decision-making process. Parents and previous math and science teachers were mentioned in the open-ended questions and listed as slightly significant contributors as well. Interestingly, male dominance, self-efficacy, and previous experiences in STEM did not play a huge role in their decision to pursue a major in STEM.
CHAPTER V: DISCUSSION

The gender gap continues to widen in STEM fields across the nation despite the rise in college graduates over the last two decades. Government, industrial, and educational institutions have been searching for the reason or reasons behind this discrepancy in the hopes of filling future vacancies. In 2019, the U.S. Census Bureau reported that women made up 47% of the workforce in the US but only 25% of the STEM workforce. According to Gilligan et al. (1991/1994), 81% of girls report liking math in elementary school. That number falls to 68% in middle school and continues to drop into high school. Lyons and Quinn (2010) referred to this as “the leaky pipeline.” This “leak” continues on into college where those pursuing engineering or science begin with a high level of confidence that is eroded away in the first two years of school. Although their confidence can rebound, it never reaches the same height as before (Brainard & Carlin, 1997). In order to remedy this tragedy and place women in jobs where they can contribute to innovation and creation, we must figure out why they become disinterested and what barriers we might be able to remove in order to make the path slightly easier.

Many programs have been put in place to try to encourage more young women to pursue a degree in STEM. Project Lead The Way (PLTW) has been fairly successful in creating more interest in engineering and technology. They boast that individuals who participate are 5 to 10 times more likely to pursue one of these areas in college. Girls, Incorporated is a four-week summer camp that includes hands-on STEM activities and has been somewhat successful in encouraging girls to pursue STEM degrees. Numerous
local clubs and extracurricular activities have been geared toward the same goal, yet the numbers continue to drop.

The purpose of this study was to explore the various factors believed to play a role in academically capable females deciding whether to pursue a degree in STEM or not. This study attempted to design a survey that would be useful in identifying which of these perceived factors play the largest role so that those factors can be addressed and the proper support implemented. This study was conducted primarily at a rural college in southcentral Kentucky. This chapter discusses the findings relative to the research questions and their parts, along with the literature reviewed.

Specifically, this study sought to answer the central research questions:

1. How do the following factors influence their (female students) choice to major in STEM?
   a. Personal interest in STEM
   b. Experiences in high school science and math classes
   c. Extracurricular clubs and activities revolved around STEM
   d. Exposure to female STEM role models
   e. Perception that STEM is a male-dominated world
   f. Self-efficacy surrounding STEM
   g. Projected salary
   h. Opportunities for advancement

2. What other factors may be impacting the female student’s decision to pursue a STEM major?

3. What factors are most influential in their decision to pursue STEM majors?
Discussion of Findings for Revised Research Question 1

How do the following factors influence their (female students) choice to major in STEM?

a. Personal interest in STEM
b. Experiences in high school science and math classes
c. Extracurricular clubs and activities revolved around STEM
d. Exposure to female STEM role models
e. Perception that STEM is a male dominated world
f. Self-efficacy surrounding STEM
g. Projected salary
h. Opportunities for advancement

Personal Interest in STEM

The findings for the survey suggest that interest does play a large role in the female student’s decision to pursue a degree in STEM. It seems to be the most obvious factor considered when determining a career path. Parents tell their children to pursue something that they are passionate about. Therefore, it should come as no surprise that this should also be considered when trying to determine the factors that may influence the female student’s decision to pursue a degree in STEM or to pursue a degree in another area. The previous research has supported this as well. Jolly et al. (2004) found that student engagement increases when students possess an interest in the topic. Even if the most talented and entertaining teachers in this country are teaching STEM subjects, the female student must possess some interest.

It was also found that the student will try harder to succeed and persist in something that they are interested in (Jewett, 1996). This idea helps to explain the “leaky
pipeline” that exists from middle school into college. As students progress through required math and science courses, the work becomes more difficult. Unless female students take a particular interest in one of the STEM fields, they are likely to pursue something in an area that is easier in which they have more interest. Despite all of the best efforts in the world to support female students, if they have no interest in STEM subjects, they are not going to pursue them.

Since females and males have different interests and are driven by different factors, STEM classroom teachers should make sure to include activities that foster a love for STEM in both genders. Jolly et al. (2004) found that males have a greater interest and desire than females to repair or fix things. Females primarily choose careers that allow them to help others. Therefore, it would be more productive for technology and engineering classes to include activities that focus on how they can be used to help others, that the activities that take place the most in high school classrooms focus on technical or mechanical concepts that will most likely not appeal to females (Bachman et al., 2009).

**Experiences in High School Science and Math Classes**

The findings suggest that self-efficacy was not a problem for these particular participants. They reported having experienced successes in STEM subjects, which likely led to their decision to major in a STEM area. Denissen et al. (2007) stated that students become more interested in subjects in which they experience success. If a student experiences difficulty early on in a subject, their confidence is lowered and they tend to avoid that subject as much as possible. Even when the students make an attempt
to try to succeed in the subject later, their confidence never rises to what it was before they failed (Brainard & Carlin, 1997).

The more confidence that a student possesses through successes in a subject, the more interest and persistence that they will have to continue pursuing it (Zeldin et al., 2008). Therefore, it is important that educators and mentors set up females for success so that confidence can be built. They can achieve this by assessing where the female student is at currently and designing challenges that meet the student there. As the student experiences successes, the level of challenge can be increased.

Franco (2012) compared students in two STEM schools to national data in order to determine whether the students exposed to more STEM experiences were more likely to pursue careers in STEM. She found that exposure to more STEM experiences during elementary, middle, and high school led to an increase in the percentage of students intending to pursue STEM degree in college. More than half of the STEM school students indicated that they had intents to pursue STEM in college. This is double the national percentage of regular high school graduates. This would suggest programs, such as STEM schools, that encourage more exposure to STEM lead to increases in the number of students pursuing STEM degrees in college.

**Extracurricular Clubs and Activities Revolved around STEM**

The findings suggest that clubs and extracurricular activities have little influence on the female student’s decision to pursue a degree in STEM. Less than half of the students reported being involved in some kind of STEM club or extracurricular STEM activity. Out of those who were involved in at least one activity during middle school or high school, less than half of those indicated that it had influenced their decision to pursue a STEM degree. This contradicts previous research by various organizations that
target young girls in middle and high school. Previous data suggest that girls involved in extra STEM activities are more likely to make the connections they need in order to desire a career in STEM. While this particular study did not support this idea, I do see the benefit in these programs. They allow for more exposure to STEM and can boost self-efficacy for female participants.

**Exposure to Female STEM Role Models**

The findings suggest that exposure to female role models has little impact on the participant’s decision to pursue a STEM degree. Several students indicated in the open response at the end of the survey that someone in their life had a major impact on their career choice. Some indicated that this was a woman. Others lacked gender information, but the impact of role models was clearly seen.

The previous research has suggested that having access to female role models is important but not necessary. Carrell et al. (2010) emphasized the importance of students having access to instructors with the same race and gender as themselves. He noted that female students were able to achieve higher grades when the class was taught by a female instructor. He went on to note that previous studies had indicated that simply having a female instructor neither ensured success in future STEM classes nor encouraged a pursuit of STEM degrees. However, when combining the correlation between confidence and interest, it would be reasonable to assume that there would be some increase in those choosing to pursue STEM degrees if they experienced academic success. This could be a daunting task though, considering the continual decrease in females pursuing STEM degrees and the predicted decline of teachers in Kentucky in the coming years.
Perception that STEM is a Male-Dominated Field

The findings suggest that the perception of STEM careers being male dominated did not deter female students from pursuing those degrees. Only 26 out of 65 participants indicated that this perception impacted their choice of major. While this may not be a significant contributor, previous research has suggested that it does play a role.

When examining the four segments of STEM, technology and engineering are the two that research has suggested hold the strongest stigma for females. This coincides with the data published by the NSF in 2012. In their report, they state that females make up only 20% of computer science and engineering degrees. Much of the research has suggested that this centers around the idea that girls are not as successful in some subjects as boys.

Spencer et al. (1999) identified this inferiority to males as “stereotype threat.” They suggested that girls are taught very early on that boys are better at math and science than female students and, as a result, the female underperforms. According to Spencer et al., this negative stereotype surrounding girls and math can either act as a catalyst to help young women overcome the “norm” or it can work as a self-fulfilling prophecy that prevents them from being able to reach their full potential in this particular subject.

If the desire is to draw more women into technology and engineering, there needs to be support built for them at the elementary and middle school levels. Research has shown that teachers’ attitudes toward math and science, specifically female teachers, leave lasting impressions on their female students. If the teacher has an aversion to a specific subject or expresses anxiety over certain topics, her female students also buy into the idea that if she cannot be successful, they will not be either. Therefore, it is necessary
to ensure that our female teachers are well equipped to teach all math and science in these early grades in order to boost self-efficacy.

**Self-efficacy surrounding STEM**

According to the data collected, self-efficacy was not a factor for this particular group of female participants. However, this study only examined students who had chosen to pursue a degree in a STEM field. The data may look different if it included individuals who may have chosen not to pursue a degree in STEM because they did not feel adequate enough or capable enough.

Bandura et al. (1996) and Bandura (1997) first published their ideas surrounding self-efficacy and the challenges that it presented for young female students. Since self-efficacy was one of the first ideas to be presented as a challenge for females wishing to pursue STEM, the data could also mean that society has adjusted for this fallacy and has been able to convince young female students that they are just as capable as their male counterparts.

**Projected Salary and Opportunities for Advancement**

The data suggest that projected salary was one of the most important factors for these female students to consider when choosing a degree in STEM. This is not surprising with the increasing cost of education and prosperity of the US. Most young people are looking to maintain their current lifestyle or possibly expand their lifestyle after graduation. Many want to be able to purchase a home, drive a nice car, and travel. Salary is understandably an important factor in choosing a college degree. However, this factor is hardly mentioned in any previous research.

According to the results, knowing that there may be room for advancement in a particular career has a significant impact on the young female student’s decision to
pursue a particular degree in STEM. It is reasonable to assume that this factor and salary are closely related. Advancements usually also mean pay raises for employees, so it is not surprising that this would be something that a young person would want to factor into their decision-making process. However, this factor also has not been emphasized in previous research.

**Discussion of Findings for Revised Research Question 2**

What other factors may be impacting the female student’s decision to pursue a STEM major?

Three other factors were listed on the survey outside of those previously mentioned. They were as follows: projected job growth, a chance to help others, and projected job security. All three were found to be important factors in pursuing a degree in STEM.

Projected job growth and projected job security were found to be important factors in the female student’s decision-making process. However, pursuing a degree that provides females with a chance to help others was found to be the most significant contributor overall in their decision-making process. This supports previous research that has encouraged educators to help students to understand how certain careers in various STEM fields can help others (Weber, 2012). It is encouraging to know that many young people today still want to contribute to society in positive ways. Therefore, the burden lies with society to help young female students connect various careers in STEM with their desire to help others.
**Discussion of Findings for Revised Research Question 3**

What factors are most influential in their decision to pursue STEM majors?

I used 70% as the cut-off margin when considering whether or not a variable was a significant contributor. If 70% or more of the individuals having taken the survey indicated that the variable had a significant impact or some impact on their decision to pursue STEM as a degree, it was deemed influential. Using this value, there were seven factors found to have a significant impact. They were as follows: parents and family, middle and high school teachers, projected job growth, a chance to help others, projected job security, future salary, and room for advancement.

The most important contributor that I found was the desire to care for others. Previous research has suggested that females pursue careers as teachers and nurses mainly to fulfill their internal drive to care for others (Turner & Bowen, 1999). Therefore, it is not surprising that they tend to seek out careers that allow them to fulfill this desire.

**Limitations**

Unfortunately, despite my best efforts, I was also unable to conduct a comparison between those female freshmen pursuing degrees in STEM and those who had chosen another field of study. After emailing out the survey via an online link to all female freshmen on WKU’s campus twice, I received zero responses. As a result, I was left with only a group of students taking an introductory chemistry course who indicated on the survey that they were pursuing a degree in STEM, with the exception of one participant (as shown by Table 4.3).
**Recommendations**

The survey developed could be used in the future to identify the variables that may be preventing female students to pursue a degree in a STEM field. In order to promote females in STEM areas, teachers in math and science and school systems need to show female students how they can help others in areas such as technology and engineering. Female students are making that connection in fields such as nursing and teaching but seem unaware of how they can help others in some areas of STEM. For example, they may not be making the connection between technology and the ability to use it to help others. Engineers can be responsible for designing life-saving devices such as 3-D hearts and insulin pumps. They can also make life easier by inventing various prosthetics and other aids. Teachers in math and science need to be strong advocates for females, encouraging them to pursue these areas to make a difference.

Programs that give students insight into jobs and their potential salaries and opportunities in STEM areas may also help to encourage more females to pursue various aspects in college. Some of the most influential factors found in the survey centered around these areas.

**Implications for Further Study**

This study has the potential to be replicated in several different ways. This could be performed by (a) comparing responses from students who are currently pursuing a degree in STEM with those who are not pursuing a degree in STEM; (b) distributing the survey to individuals in larger universities, other states, or even other countries; and (c) teachers within their own school identifying variables that may be impacting their female student population and their decision to pursue STEM degrees or not pursue STEM
degrees in order to address these barriers.

After administering the survey and reflecting on the results, I also determined that it would have been beneficial to have heard more from the participants about their negative and positive experiences with STEM in the past. Just knowing that they had a parent or teacher who had a significant impact on their decision gives little insight into the actual interaction. Knowing what instances prompted them to think negatively or positively about STEM might help us to be able to provide middle school and high school students with what they need in order to pursue STEM.

The survey had several personal interest questions that only highlighted how the individual felt toward certain subjects at that moment in time. It did not dig any deeper. It may have been helpful to have asked deeper questions with time frames. For instance, the student may enjoy math now, but was there a time in their life previously when they did not necessarily enjoy math? If so, when and why did it change? If the student did not enjoy math previously, what led to them enjoying it now? These are questions that could be added to the survey to provide a better picture of the student’s overall experiences during their school years as opposed to just providing a snapshot.

**Conclusion**

The purpose of this study was to design a survey that could identify possible factors affecting the female student’s decision to pursue or not pursue a degree in a STEM field. The student responses from this study provided evidence to support the survey. The results from the survey made it apparent that the various factors that influence the female student’s decision are complex. No one factor seems to discourage female students, but rather, multiple factors are intertwined and occur throughout the
individual’s life.

Most of the research concerning females and STEM in the late 1990s has centered around self-efficacy (Bandura, 1997; Bandura et al., 1996; Brown & Josephs, 1999; Gilligan et al., 1991/1994). Since that time, it seems female students have mostly overcome the idea that they are not capable of performing the same as their male counterparts. However, there still remains many other factors to be examined and addressed in the decision-making process.

Interest was confirmed as being one of the major factors in the process. If the student has no interest in the subjects of math and science, they will not pursue a degree relating to those areas. It is also important for young females to be able to see other successful women who have broken through these barriers so that they are inspired to do the same. Finally, more thought needs to be given as to how to provide information about STEM careers to female students concerning salary, job growth, room for advancement, and security.
REFERENCES


INSTITUTIONAL REVIEW BOARD OFFICE OF RESEARCH INTEGRITY

DATE: November 14, 2017

TO: Kerri Adkins

FRO University (WKU) IRB

PROJECT TITLE: [1156138-1] EVALUATION OF THE REASONS SURROUNDING WHY ACADEMICALLY CAPABLE FEMALES ARE CHOOSING NOT TO MAJOR IN STEM

REFERENCE #: IRB 18-179

SUBMISSION TYPE: New Project

ACTION: APPROVED

APPROVAL DATE: November 14, 2017

EXPIRATION DATE: September 1, 2018

REVIEW TYPE: Expedited Review

Thank you for your submission of New Project materials for this project. The Western Kentucky University (WKU) IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. Please use the appropriate...
reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of September 1, 2018.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact Paul Mooney at (270) 745-2129 or irb@wku.edu. Please include your project title and reference number in all correspondence with this committee.

- 1 - Generated on IRBNet

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Western Kentucky University (WKU) IRB’s records.

- 2 - Generated on IRBNet
APPENDIX B: SURVEY

Q1 Please choose how much you agree with each of the statements below.
<table>
<thead>
<tr>
<th>Life science classes have always been difficult for me (1)</th>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neither Agree nor Disagree (3)</th>
<th>Agree (4)</th>
<th>Strongly Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math classes have always been difficult for me (2)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I have always been confident in my abilities in math (3)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I was never very successful when it came to STEM classes (4)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I have always been just as capable in math as my male peers (5)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>I have always been just as capable in science as my male peers (6)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Q2 Please indicate below any STEM clubs of which you were a member in middle or high school.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Q3 If you were a part of 1 or more STEM clubs in middle or high school (e.g., GEMS, PRIDE) how do you think your STEM club experiences influenced your choice of major in college?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Q4 Please indicate below how many STEM summer camps that you attended during your K-12 education.

○ 1
○ 2
○ 3
○ 4 or more

Q5 If you were a part of 1 or more STEM summer camps (e.g., 4-H, Robotics camp, etc.), how do you think your STEM summer camp experiences influenced your choice of major in college?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Q6 Please indicate below how many STEM after-school events you were involved in during your K-12 years.

- 1 (1)
- 2 (2)
- 3 (3)
- 4 or more (4)

Q7 If you were a part of 1 or more STEM after school events (e.g., GEMS, PRIDE, etc.), how do you think your experiences influenced your choice of major in college?

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________
Q8 Please choose the response below that best fits your particular interest regarding STEM subjects.

<table>
<thead>
<tr>
<th>I enjoy math (1)</th>
<th>Strongly Disagree (1)</th>
<th>Disagree (2)</th>
<th>Neither Agree nor Disagree (3)</th>
<th>Agree (4)</th>
<th>Strongly Agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy science (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy technology (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I enjoy engineering (4)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I have a desire to pursue a STEM degree (5)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>I previously had a desire to pursue a STEM degree (6)</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Q9 Choose the best response that accurately reflects the amount of impact each item had on your choice of major in college.
<table>
<thead>
<tr>
<th></th>
<th>Had a significant impact on my decision (1)</th>
<th>Had some impact on my decision (2)</th>
<th>Had very little impact on my decision (3)</th>
<th>Had no impact on my decision (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents/Family (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle/High school teachers (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty of high school coursework in your major (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of other women pursuing the same major (4)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Perception that females should pursue your major (5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Projected job growth (6)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>My major provides a chance to help others (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projected job security (8)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfortable future salary (9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room for advancement in my future career (10)</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Q10 Was there another factor, not mentioned, that played a significant role in your choice of major that was not listed above? If so, what was it?

________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

Q11 What is your declared major?

________________________________________________________________________

Q12 What was your final high school GPA?

________________________________________________________________________

Q13 What was your composite ACT score?

________________________________________________________________________
Q14 What is the highest level of education completed by your father?

- High school (1)
- Associate degree (2)
- Bachelor's degree (3)
- Master's degree (4)
- Doctorate degree (5)

Q15 What is the highest level of education completed by your mother?

- High school (1)
- Associate degree (2)
- Bachelor's degree (3)
- Master's degree (4)
- Doctorate degree (5)

End of Block