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Females in STEM: Self-Efficacy Within Women Who Pursue STEM Majors

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FEMALES IN STEM:

SELF-EFFICACY WITHIN WOMEN WHO PURSUE STEM MAJORS

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By

Lori Grata

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Approved August 14, 2019

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ABSTRACT

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While many efforts have been made within the United States, women are still underrepresented within STEM. Research within this document shows that women and men score similarly on STEM-related standardized tests. The question remains, why are there still large quantities of men outnumbering women in college majors and career fields of STEM? Looking at female STEM self-efficacy and gender role in culture could provide insight to the problem at hand. A survey was given to investigate self-efficacy and students' STEM backgrounds of undergraduate female students who are currently in a 4-year STEM-related major within one university.

DEDICATION

I would like to dedicate this dissertation to my husband, my family, and my truest friends. To my husband, Walt Grata Jr., I love you so much. You have been my biggest fan and supporter for as long as we have been together. You have encouraged me to always be better, and you challenge me to be my best self. Grandma, Rose King, you always believed in my ability to work hard and my strength as a person. I dedicate this to my grandfather Dennis King. He was the funniest man I have ever had the opportunity to know. I love you and miss you every day. I know that you would be proud of what I completed here. Thank you to my wonderful in-laws, Walter Grata, Sharon Grata, and Kylee Grata who are like parents and a sister to me. Thank you for your encouragement and support.

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Chapter 1 Introduction

Background on STEM and Gender

Creating a strong knowledge base in the STEM fields is something that the United States government has prioritized for some time. Hall and Sandler point out that the passing of Title IX, which was a comprehensive federal law that prevents discrimination based on the biological sex of a person (1982), was a catalyst for funding education programs and activities for women (Hall & Sandler, 1982). Title IX opened the door for women to enter the field of STEM (Hall & Sandler, 1982). Since the 1970s, the United States government has been prioritizing female interest in the STEM fields, but many are still critical about the small number of women that are entering STEM careers (Hall & Sandler, 1982). Even in the current time, biology separates how men and women think (Hall & Sandler, 1982). As thinkers and researchers, there have been many advances to studying how men and women think. Is it the biology within that makes females and males different (like nature), or is it how males and females are raised that causes them to have different views and interests of the world? Yoder, Fischer, Kahn, and Groden (2007) point out that within early research there was a focus on gender and how males and females are compared to one another. Yoder et al. (2007) concluded that there was a presumption that men are normative and the studies on gender would undervalue women. A new concept arose in the study of gender which is the concept of androgyny (Yoder et al., 2007). Androgyny stemmed a new type of research that took the biological makeup out of the equation within gender research, allowing researchers to study more deeply the areas of social categorization and stereotyping (Yoder et al. 2007).

While this explains how the door was opened for gender studies, it does not explain whether or not a person's general biological makeup affects how one thinks or if it is the social roles that are placed upon both genders. Joel et al. (2015) discussed that "documented sex/gender differences in the brain are often taken as support of a sexually dimorphic view of human brains ("female brain" vs. "male brain"), and consequently, of a sexually dimorphic view of human behavior, cognition, personality, attitudes, and other gender characteristics." They point out that if biological gender (male or female) does have an effect on the brain, then it could be categorized into the concept of the degrees of "maleness-femaleness"; therefore, researchers could align brains on a "male-brain–female-brain" continuum. They studied 138 to 855 subjects within their data sets of both genders. Their test consisted of testing whether their subjects would fall consistently at one end of the "femaleness-maleness" scale. Their findings showed that the male and female brains do not vary, and there is overlap in areas in which the "male brain and female brain" were expected to be. Their finding supports the concept that gender difference may grow from the nurture element events and developmental stages experienced (Joel et al., 2015).

For over 100 years, many have attempted to explain why there were - and still are - different outcomes for women and men within STEM (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher (2007). STEM-related majors are considered any major in the field of science (i.e. nursing, pre-medicine, pharmacy, chemistry, biology, physics, etc.), any field of math (i.e. finance, statistics, cryptography, biotech, etc.), any field within engineering (i.e. mechanical, electrical, civil, aeronautic, etc.), and any fields within technology (i.e. computer science, information technology management, software engineering, database administration, video game programming, web development, etc.). Halpern et al. (2007) reference that some researchers have considered biological differences between men and women and their abilities to achieve. Biological differences between males and females and subsequent implications in STEM remains a questionable topic, given that there are few differences in cognitive ability between male and female infants and how they develop their cognitive skills. (Halpern et al., 2007). Even so, there are some in higher academia, like Lawrence Summer, who commented publicly on this discrepancy during a commencement speech in 2005 (Halpern et al., 2007; Summer, 2005). His comments were perceived as stating that men are developmentally more advanced than women in advanced mathematics (Halpern et al. 2007; Summer, 2005). The subject of biological differences between men and women is a hot issue. Xie, Fang, and Shauman (2015) identify that men and women are less biologically different than suspected in the past. However, there are outside influences that could explain gender differences within STEM (Xie, et al., 2015).

The United States has always valued creativity and innovation, but it is missing the large perspective of talented women who could add a voice to STEM careers and majors because compared to men in the STEM field, women make up less than 25% of the STEM workforce (Beede et al., 2011). Beede et al. (2011) point out that "according to the Census Bureau's 2009 American Community Survey (ACS), women comprise 48% of the U.S. workforce but just 24 percent of STEM workers." Noonan (2017) discussed that even though women and men are equally college educated, only 30% of women have a degree within STEM.

Men outnumber women on STEM career job boards, and women do have a different work experience when entering the field of STEM (Catalyst, 2016). According to Shenouda (2014), even though there are more female undergraduate students; overall, male undergraduates outnumber females in physics and engineering majors. Within physical science and engineering doctoral programs females only represent roughly 25% in physical science and 15% in engineering (Shenouda, 2014). This could have an impact on career longevity, as well as interest in the field itself. In the United States, 53% of women who start out in the STEM industry leave, and only 11% of women are engineers (Catalyst, 2016). According to Ehrlinger et al. (2018) women are largely underrepresented in the fields of computer science and engineering. Women only represent 24.7% of processionals working in the computer science field while only 15.1% of women represent professional women working in the engineering fields (Ehrlinger et al., 2018).

Even with all the changes throughout the years, STEM fields are lacking women. The United States government deliberately discussed and commented on building a strong female presence within STEM-related fields, especially technology-based majors; with former President Obama's challenge in 2011 in mind, The White House Council on Women and Girls (2012) declared, "… and that's why we're emphasizing math and science."

In 2018, the United States Congress passed a bill that should equalize entrepreneurship and economic empowerment for women, Bill HR 5480. HR 5480 is a bill that currently passed the House of Representatives and is now going on to the Senate floor for consideration (2018). It will be under consideration within the Senate in 2019.

This bill has not been passed yet. This bill is "to improve programs and activities relating to women's entrepreneurship and economic empowerment that are carried out by the United States Agency for International Development, and for other purposes." Bill HR. 5480 defines how "specific gender-constraints" hurt women both in the workplace and those trying to enter the workforce. This bill discusses discriminatory constraints against women that can be connected to barriers they must overcome. These barriers can include, but are not limited to, "land, machinery, production facilities, technology, and human resources (citation)". Even in 2018, there is still some concern about females within the workplace, and the financial insecurity they face might be caused by a lack of opportunities. One of the goals of this bill is to "increase the capability of women and girls to realize their rights, determine their life out-comes, assume leadership roles, and influence decision-making in households, communities, and societies" (HR 5480, 2018).

According to Beede et al. (2016), women within these fields can earn higher salaries and opportunities. In 2009, women in a STEM-related career could earn an average of $31.11 per hour compared to women in non-STEM-related careers who earn an average of $19.26 per hour (Beede et al., 2011). Grabmeier (2016) wrote a piece for The Ohio State University News stating that, "One year after graduation, women with Ph.D.'s in science and engineering fields earn 31 percent less than men do." Because of inflation and the rise of technology like *Facebook*, *Google*, *Uber*, etc. it can be assumed that career salaries in STEM-related fields have increased over time. The Glassdoor team (2014) looked at the major technology field when it came to salary. The report they created showed about a $6,000 difference between women and men who worked as software engineers in the field with the same amount of yearly experience (The

Glassdoor Team, 2014). According to Michelmore and Sassler (2016) even with a large educational drive for women to enter STEM-related fields, there still is evidence that shows that there is weak wage equality between men and women.

Beede et al. (2011) stress that there is also a smaller salary gap between men and women in a STEM-related field compared to a non-STEM-related field, with on average, a 14 percent gender wage gap compared to a 2 percent gender wage gap in non-STEM careers. They continue by pointing out, “for every dollar earned by a man in STEM, a woman earns 14 cents (or 14 percent) less, smaller than the 21 percent gender wage gap in non-STEM occupations, but a clear gender disparity nonetheless.” They point out that since there is a larger population of men within the STEM field it can be assumed that the earning gap between men and women would be small. While there is a noticeable shrinkage in the pay gap between men and women, researchers find that there is still a small gap (citation). When they look deeper into STEM careers and compare them directly, the wage gap shirks significantly. They give the example of a 7 percent average gap between male and female engineers (citation). Physical science shows an average of 8 percent gap, and computer and math fields showed a 12% average pay gap between male and females within the field (Beede et al, 2011).

Careers in STEM themselves can be lucrative for both men and women within the field. Careers in STEM-related fields can not only be lucrative but can also empower women. Women and men in STEM-related careers could average a base annual salary of $65,000, and software engineers and computer science engineers start higher at $72,600 (Jacobs, 2014). There is a noticeable pay gap in two particular STEM fields, engineering and computer science, and this could help explain why these two fields have a small representation of women within the field (Michelmore & Sassler, 2016). Building an interest and a community in STEM-related classes at an early age and in college majors can make women feel included in a male-dominated field where there is a demand for women.

Background Within Self-Efficacy with Females Within STEM

Bandura defines self-efficacy as a person's belief in their ability to be successful within specific situations or their ability to accomplish a task within a certain domain (1977). Bandura expanded on his definition of self-efficacy in his publication in 1993, defining it as, "People's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 118). He further expands on his definition in his book published in 1997 by stating, "Self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura). Bandura points out that there are different sources of experiences that builds a person's self-efficacy, and these levels are mastery experiences, vicarious experiences, verbal persuasions, and physiological reaction states (1997).

A reason presented by researchers to explain a lower percentage of women within STEM-related fields such as computer science and software engineering is a lack of self-efficacy. Albert Bandura is one of the influential psychologists within the study of self-efficacy. He spent a large part of his research identifying identities (?) and emotions and how they relate to action and motivation. Bandura is known for his dedication and research into self-efficacy. Self-efficacy can be defined as the perception that people have about their abilities; for example, whether they are able to complete a task with a positive or negative outcome (Bandura, 1995; Bandura, 1997). According to Bandura, self-belief is one of the most important aspects of how people motivate themselves (Bandura, 1986; Bandura, 1997; Zeldin, Britner, & Pajares, 2008).

There are four areas which Bandura has classified that have an influence on one's self through self-efficacy. These areas are as follows:

1. Mastery experience
2. Through vicarious experiences
3. Verbal persuasion
4. Physiological reaction states (Bandura, 1986).

Problem Statement

A stronger representation of women within STEM undergraduate programs and within STEM fields is needed in order to have multiple perspectives that would not be seen otherwise. A larger effort must be made in order to encourage the female population within STEM. The National Science Foundation (2014) shows STEM-related jobs on the rise and a need to fill them. On average, more women than men are graduating with bachelor's degrees from college, yet the number of women obtaining STEM degrees are less than men which is a contrast to the number of women graduating (Korn, 2017; Noonan, 2017). STEM fields, such as computer science and software engineering, are characterized by economic growth and job security, but less than one third of professional software engineers and technicians are women (McCarthy & Berger, 2008). Cheryan et al. point out that computer science can be a large area of recruitment for women with the field of STEM, but it struggles to gain and retain women (2009). Even more recent data shows that, “Women filled 47 percent of all U.S. jobs in 2015 but held only 24 percent of STEM jobs” (Noonan, 2017).

Female students appear to undergo a shift within their confidence level and interest level in the STEM-related subjects during middle school (SciGirls, 2012, p. 8). Personal self-efficacy is directly linked to the effort in which students of all genders will invest in an assignment, class, and/or action. Hill, Corbett, and St. Rose (2010) stress that K-12 can be a deciding factor of interest within STEM, and colleges and universities allow for those pursuing STEM careers to enter into the workforce; therefore, changes within education appear to be a way to promote STEM majors and resiliency. There is still a need for additional research when examining the area of female resiliency and confidence within STEM.

The study will add to the research and understanding of how self-efficacy and gender may correlate to whether female students select and stay in STEM-related majors in higher education. This study will also explore why females persevere within STEM majors.

Purpose Statement

The purpose of this research is threefold. The first research question that was investigated was what classes female students have taken during their high school experience, and how that compares to their male counterparts within STEM-related majors. The levels (foundations, academic honors, and/or advanced placement) of STEM courses that females have taken within their high school years will also be explored. The second item that was investigated was the level of female self-efficacy levels compared to their male counterparts within STEM-related majors. The last item that was investigated was exploring females only. The investigation consisted of Bandura's four areas of self-efficacy and seeing which area has the highest effect on females within STEM-related majors. This research explored the extent to which women in STEM-related majors view their capabilities based on gender and self-efficacy within STEM. Ridgeway (2009) defines gender stereotyping as "our belief about how 'most people' view the typical man or women" (p.148).

The United States, much like the rest of the world, is growing through the use of technology. The internet has made technology a driving force within first world cultures. While technology keeps growing, there is a need for more people to enter the world of STEM. Software engineering and computer science is a rapidly growing field with a high demand for employment. Modi, Schoenburg, and Salmond reported in their report from the Girl Scout Institute that women make up only 20 percent of the bachelor's degrees in STEM-related fields (2010). With that there is a projection of 1.4 million jobs that will be available in 2020 in the field of software (Caralyst, 2016; Gilpin, 2014). According to Ellis, Fosdick, and Rasmussen (2016) there is a need for employees in STEM, and an increase of 10 percent would make a considerable difference with the STEM field. Efforts need to be made to help fill these job opportunities within this field, by changing the way these jobs and gender suitable roles are presented to the public (Ridgeway, 2009). Ridgeway stresses that women and men are not that different and changing the "Men are from Mars and women are from Venus" (2009) mindset is the first step (Ridgeway, 2009).

One possibility is to bring in groups that are not represented within the current field like women. Litzler, Samuelson, and Lorah found that the United States is lacking skilled workers with expertise in STEM-related areas (2014, p. 811). Women are still underrepresented within STEM-related fields; for example, computer programming and software engineering only account for 21 percent of women in that field (Caralyst, 2016; Gilpin, 2014). In order to address these needs, actions must be taken within STEM to build confidence in females in this field. Moakler and Kim (2014) compare self-confidence to self-efficacy by defining it as "students' attitudes, feeling, and perception concerning academic abilities, whereas self-efficacy is concerned with performance capability, not congruent ability" (p.130).

Litzler et al. (2014) point out that self-confidence and self-efficacy have an impact on how college students achieve at the university level and they stress in their research that in some cases gender differences can be seen in connection to self-confidence, self-efficacy, and persistence (p. 811-813). Betz and Voyten (1997) stress that "college student's beliefs about their educational and occupational capabilities were significantly related to the nature and range of the career options they considered" (p. 179). Litzler et al. (2014) state that many studies in the field of confidence and self-efficacy can drive how students perform academically, and there is research that shows gender differences possibly can be connected to self-confidence, self-efficacy, and persistence (p.811-813). Cech, Rubineau, Silbey, and Seron (2011) point out that gender segregation within careers and majors can affect one's belief systems with regard to ability, competency, role, and personal fit (p. 642). Moaker and Kim related that students who have high self-confidence in STEM-related classes, especially math and science, were able to achieve high grades in STEM-related majors and lasted longer within the majors themselves (2014, p. 131).

Research from Modi et al. (2012) has supported that girls are closing the gap in test scores within STEM-related subjects, showing that girls and boys are able to complete different levels of math class (2012). Girls and boys are academically (equal?) in math and science, but there is some reason why females do not pursue high-level maths, sciences, and STEM-related majors in college. Girls could lose an interest or confidence levels within STEM due to gender bias or lack of role models (word removed) at an early age. Modi et al. point out that females have been noted to lose interest in STEM-related fields during middle school whereas males do not (2012). Litzler et al. stress that the lack of female role models can influence females' self-confidence and self-efficacy, and the lack of role models can affect and/or impact the underrepresentation of women studying STEM-related majors (2014, p.814).

When females diverge from a conventional career path, their male counterparts and male faculty may perceive them as ill-equipped for a male-dominated profession, causing females to not have a sense of inclusion within their STEM-related major or career (Litzer, 2014, p. 813-814). According to SciGirls (2016), throughout the years, girls and boys are in educational settings together all over the world, but males still outnumber females in the career areas in STEM, especially engineering and math. Huziak-Clark, Sondergeld, Van Staaden, Knaggs, and Bullerjahn, (2015) point out that males within schools seem to have more confidence toward physics than their female counterparts (p. 227). SciGirls (2016) adds, while there has been a small increase in women in STEM based on school interventions and company diversity plans, there is still a growing demand for skilled women within the STEM-related fields. Huziak-Clark et al. (2015) also mention that when females do decide to major within college in STEM they are academically equal to their male counterparts, but their confidence level is much lower, and it is sometimes hard for them to reach success. Correll (2004) stresses that gender segregation within careers will not go away even within this modern culture.

Research Questions

RQ 1: What STEM courses did males and females take in high school that had an effect on their selection of a STEM-related major?

a. Sub question 1: What level of STEM courses did female students who major in STEM take in high school compared to their male counterparts?

RQ 2: What level of self-efficacy do undergraduate females within STEM have compared to their male counterparts within the same major?

RQ 3: What area of Bandura's self-efficacy scale (mastery experience, vicarious experiences, verbal persuasion, or physiological reaction) is the highest scored in females who choose majors in STEM?

Chapter 2 Literature Review

This literature review discussed the domains in which this study is drawn upon: the role of gender within STEM-related undergraduate majors and role of self-efficacy of female students in STEM-related undergraduate majors.

Gender and Self-Efficacy Within STEM

Gender Bias and the Cultural Message for Women in STEM

There have been many debates that have tried to uncover the reasons to explain why women are not pursuing computer science and software engineering. One theory is the aspect of popular gender roles and stereotypes established in the United States and the gender commonly associated with specific careers. Based on Bolliger's research (2008), the term "masculine" is often connected with strength, power, aggressiveness, competence, and success, while "femininity" is often connected with supportiveness, warmth, and nurturance. Gender roles and stereotypes can be influenced by teachers, parents, media and the society in which a person lives. Cromley et al. (2013) define the stereotype threat as how a person sees himself/herself through their personal performance compared to others. Bolliger adds that gender stereotypes can be inferred and that there are certain qualities that are attributed to men and women (2009). In parallel to Bolliger's research, Tellhed, Bäckström, and Björklund point out that even careers can be gendered, and gender-stereotyped (2017). Male gender jobs are typically associated with working with and on things whereas women-gendered jobs are associated with working with people. Careers themselves have a gender connection, for example: health care, elementary education and the domestic sphere are associated with the feminine whereas science, technology, engineering and mathematics are associated with the masculine (Tellhed et al., 2017).

The cultural message that the United States society sends to women is mixed. Even though the United States has made generous progress toward gender equality, there is still a gender divide within STEM (Xie et al. 2015). Children are being raised within a culture that highlights gender cultural norms and continues to contribute to the gender divide in the United States (Bolliger, 2008). Bolliger (2008) states that how we view and define gender can influence how people perceive themselves. Master, Cheryan, and Meltzoff (2016) state that girls are more affected by gender stereotypes and are less likely to go against the cultural norm. As part of the cultural norm, women and girls are constantly inundated with and influenced by media depicting the software engineer as a male-dominated field. Cromley et al. (2013) indicate that more men in the past 10 years have majored, earned the degree, and stayed in a STEM-related field than women, and gender stereotype is a possible explanation for the patterns being seen in STEM.

It is important not to overlook the biological research that has been debated over time as well. Good, Aronson, and Harder (2007) as mentioned earlier pointed out that some studies have debated that there is a biological reason why men think differently than women especially in STEM, or that there are biological reasons why women struggle with high level maths (p. 17). While studies like Summer (2005) contend that men may be developmentally more advanced than women in the areas of high level maths, research like Good et al., Bolliger (2008), Xie et al. (2015), etc. all show that there is more of an outside element that is affecting females within the STEM field. Within their study, Good et al. (2007), found that not just biological influences can affect high-level female math learners, and when exposed to stereotype threat, it effects their self-perception and grade (p. 25). Joel et al. (2015) discussed in their study of male and female brains that there was little to no difference within the gray matter of both genders.

Christensen, Knezek, and Overall (2005) point out that middle school-age girls can perceive computers differently than boys based on their parents' and teachers' perceptions of technology. Female computer programmers who do work in the field and whose gender identity is easily assessable by their names or profile pictures, received lower pull request acceptance rates at 58 percent compared to their male counterparts at 61 percent, whereas gender neutral female programmers had a 70 percent acceptance rate (Durham, 2017).

Xie et al. (2013), point out that females on standardized tests have outscored their male counterparts in math during elementary, middle, and high school, but even though this data is present, females are still not pursuing classes, majors, and careers within STEM. While Hausmann (2014) notes that in several meta-analyses performed over the years, the findings showed that men outperformed women in spatial awareness and mental retention, whereas women outperformed men in verbal abilities (p. 236). These differences could be connected to biology or be influenced by how male and female students are raised, e.g. male-dominate and female-dominated toys. Sheldon (2004) points out that children are exposed to stereotypical messages, books, media and toys from an early age. Huguet and Regner (2009) found that boys have an advantage when it pertains to visual special ability which plays a crucial part in developing STEM skills at an early age as well as continuing to develop over time (p. 1024).

Motivation is a large driving force in most people. Late elementary and middle school students have a strong need to fit in (Master & Meltzoff, 2016). Master and Meltzoff (2016) point out that elementary female school students may show a lower interest in STEM because they have fewer opportunities to ignite their excitement within the classroom primarily because girls spend less time than boys playing on the computer. According to Hilu (2016), over the years, computer companies have tried to build interest within girls using technology by devising games that fit the stereotypes of the female gender, however through this attempt the designers of the games have often had the opposite effect.

Nosek and Smyth (2011) feel that educators and parents may unintentionally behave differently toward females compared to males when studying STEM-related subjects, which may undermine the female sense of security within the STEM subject matter. Figure 1 (Master & Meltzoff, 2016) illustrates how early stereotypes form within young females and males. Once this early stereotype is internalized it can have an effect on female interest and motivation within STEM (Master & Meltzoff, 2016).

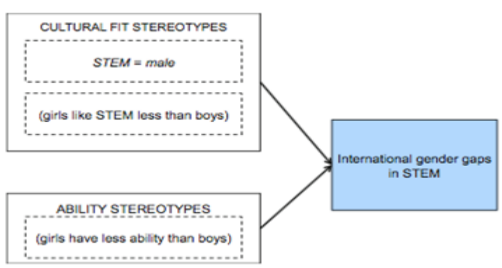

Figure 1. The cultural fits of two types of stereotypes, and the effect on gender gaps. From "Building bridges between psychological science and education: Cultural stereotypes, STEM, and equity," by A. Master and A. N. Meltzoff, 2016, *Prospects, 46*(2).

Male and female middle school students use computers in different ways. Male middle school students can be seen using computers to socialize or even play games

(Shanahan, 2006). Middle school females are not scared of computers, but they are more reserved when it comes to computers because they see computers as a tool (Christensen et al., 2005). Hilu (2016), points out that the gaming industry sees the untapped portion of female users and has been working to connect games with girls through the development of games like *Barbie Fashion Designer* and *The Sims,* but there is still a large market of girls that the industry is missing. Johnson (2016) indicated that even with the use of social media, there is a distinct difference between how girls and boys use technology, especially social media. For example, when studying how children of both genders between the ages 8 through 12 years use social media, he found that girls spent more time on television show sites and virtual worlds while boys explored sports and gaming websites (Johnson, 2016). This showed a difference in simple use of technology between female and male youth.

In contrast to the middle school female perspective, boys within the same age group look at computers as toys which makes it a fun learning experience (Christensen et al., 2005). According to Shanahan, in order to build female confidence in STEM especially within the technology field, girls need to feel like they are a part of the community, and they need to feel like they have the skills with technology that they are using in and out of the classroom (2006). As male and female middle schoolers continue to grow and move through fourth to eighth grade, there is a significant change in their perception that could lead to a relational finding within STEM (Christensen et al., 2005). At early ages, like fourth grade, boys and girls have similar and positive attitude toward technology, but as they grow, there is a clear divide that happens (Christensen et al., 2005). Leaper and Brown (2008) did research and discovered that over half of the middle school girls in their study were victims of STEM discouragement. Robnett (2016) found that the discouragement young girls get in school is mostly subtle like isolation, but a small amount have reported outright hostility in the study of STEM at some point in their adolescent studies. As both genders move toward 8th grade, male positive attitudes grow while female attitude toward computers decrease (Christensen et al., 2005).

While there is no cause and effect relationship that can be inferred at this time, there is a strong trend with middle age students of both genders. Shanahan points out that while females might score high in STEM-related subjects, the reactions received by parents and teachers vary based on the gender of who gets what score (2006). Shanahan points out for example, parents relate hard work to female success and for the male counterpart, talent and effort is related to their work (2006). Leaper and Brown (2008) found in their research that parents of young girls have high expectations for their daughters in the field of STEM and in athletics, and that these expectations follow female students into the classroom. In Leaper and Brown's research, they found that half of the adolescent females studied experienced hearing discouraging comments about their abilities in STEM (2008).

Young females can have a lower opinion of their abilities based on the feedback from their communities in the fields related to STEM because of verbiage connected to the subject matter and the gender (Shanahan, 2006). Leaper and Brown (2008) stress that female students who experience gender bias within STEM may not want to continue their pursuits. Hausmann (2014) points out that gender stereotyping in women can have multiple effects because it depends on the group identity that is associated with the gender or with STEM. For example, if the group or community that the female is associated with confirms negative stereotypes, female performance will decrease (Hausmann, 2014). If women and men are equally encouraged to pursue STEM, they are more likely to go against the gender stereotype that is created by society.

While looking at high school students, female students are considerably more likely to take higher level math and advanced biology classes but are still underrepresented with physics, which makes the gender gaps in secondary education even more confusing (Xie et al, 2013). Robnett (2016) points out that when, in fact, females do take higher level STEM classes in a high school setting, they excel, but there are signs and evidence that there is gender bias within the school setting. For example, female students have reported experiencing gender bias from male peers in a high school setting, and male peers are the most common connection (Robnett, 2016).

Female students are excelling in some STEM programs; for example, physical science classes and health-related classes within a high school setting (Xie et al, 2013). This may suggest that higher education is not properly promoting STEM retention and job career opportunities within its institutions to incoming students, nor positively supporting female populations within STEM majors (Xie et al, 2013). Robnett (2016) points out that both in high school and in higher education, females have reported gender bias from a variety of sources, such as other female peers that do not share the same interests, teachers or professors, and other adults.

Moss-Racusin, Molenda, and Cramer (2015) found that empirical evidence shows a presence of gender bias within the educational community, and that is evident in higher education where they found that professors of both sexes felt that male students had a higher ability in STEM than their female counterparts. They continue with discussing that gender bias within the classroom whether it is K-12 or higher education, puts constraints on females and takes away opportunities for possible careers. They point out that research shows that schools are more prone to hire and mentor male students while offering a $4,000 hire stipend. The perception is that female and male students are not looked at and evaluated equally, and male students are recommended into higher education positions based on their gender (Moss-Racusin et al., 2015).

Creating a sense of community within a social groups creates less division. Even looking at Eastern culture compared to Western culture can affect how women are perceived within STEM. Wang, in his research in Taiwan, wanted to understand the female experience in the field of technology (2012). He interviewed sixteen women in technology, including engineering and healthcare information majors. One of the female students he interviewed said that when she attends classes at the university, she felt like she had to become masculine by not wearing make-up and feminine clothing, so she would wear jeans and T-shirts. Many of the other women interviewed found that they were worried about being stereotyped as a strong woman. They also felt that there existed a stereotype that women were inferior to men in technology (Wang, 2012).

It is important to note that women in the Middle Eastern culture go to college and earn degrees in STEM-related fields. Charles and Bradley (2006) showed in their research that countries with a strong population of female depiction in the computer science field seem to have a strong push in curriculum that promotes learning within the math and science fields. Wang (2012) studied women in universities in Taiwan. Wang points out that females in some Eastern cultures are also dealing with gender inequality within a male-dominated society (2012). While females are showing signs of success within STEM-related fields, they still have to navigate the masculine field of technology (Wang, 2012).

Xie et al. (2013) report that cultural stereotypes within STEM fields structure inequality through implicit bias; for example, teachers and professors evaluate students' work, encouraging hostility or stereotypical behavior toward the people who are a part of the specific group targeted. Creating gender neutral technology environments early in the stages of education may give both males and females equal voices in the fields that they want to explore. Hausmann (2014) found that women in higher education can practice stress-reduction techniques and self-affirmation techniques to counter any negative stereotypes they may be feeling, but this makes fixing inequality the responsibility of the victim. Gender equality in higher education is a topic that continues to be explored; however, promoting interest in technology as well as disassociating gender stereotypes may start cultivating that environment.

While there are women excelling and moving forward in careers in STEM after higher education, these women face different challenges within the STEM community. According to the National Science Foundation, in 2009 only 30 percent of graduate students in STEM majors were women, and of them only 3 percent were computer engineers. Additionally, only 18 percent of full-time teaching professors in STEM departments at research universities were women. The National Science Foundation (2017) pointed out that although 30.8 percent of graduate students in computer science majors are women, a huge increase from 2009, the job market is increasing at a higher rate (2017). In 2014, only 18.8 percent of women were in the technology engineering field (National Science Foundation in 2017). In order to build a community and culture in STEM, there needs to be a steady growth of both men and women within STEM.

There has not been a significant growth in STEM careers for women since 2009 to 2012. While the U.S. census will release new data in 2020, Michelmore and Sassler point out that more gender gaps still currently exist within STEM fields (2016). Men still outnumber women in the field of STEM more than in any other field. Figure 2 (U.S. Department of Commerce Economics and Statistics Administration, Census Bureau, 2012), shows that STEM and STEM-related occupations still have a large gender divide within the United States, with a particularly large gap in the computer, mathematics, and statistics fields.

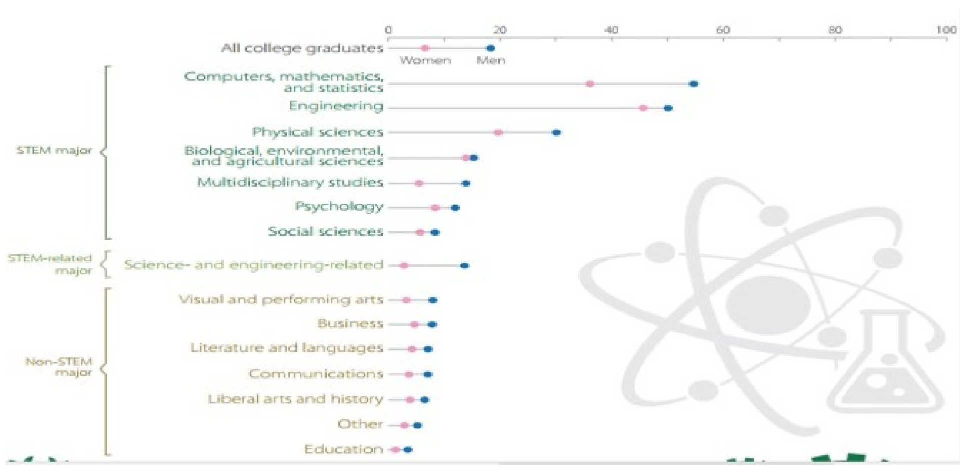

Figure 2. Community survey on men and women working in STEM careers. From "Men and Women Working in STEM," By U.S. Department of Commerce, Economics, and Statistics Administration, 2012.

Stereotyping within the field of STEM can be detrimental to both males and females. Implicit and explicit stereotypes can both have a large effect on why women are a minority within STEM, but explicit stereotype is easy to identify (Steffens & Jelenec, 2011). One large explicit stereotype of adults working in STEM-related careers is that the careers are strongly monopolized by white males (Shanahan, 2006). Steffens and Jelenec (2011) state that negative STEM stereotypes about females' abilities can have an influence on how women perform, their interests, and their goals within the field. Cheryan, Siy, Vichayapai, Drury, and Kim point out that stereotyping within STEM can be considered male-driven and unwelcoming toward women (2011). A negative stereotype can have an effect on a female's career choice as well (Steffens & Jelenec, 2011). To be even more specific, the "computer nerd" is an explicit stereotype that is largely connected with STEM-related fields, which is associated with social isolation and a singular focus on technology (Cheryan et al., 2011). Women may find this explicit stereotype counterproductive, because according to the female gender role women are considered to be socially skilled and more adept at helping others (Cheryan et al., 2011).

Implicit stereotyping occurs when the stereotype is not openly admitted and can be applied through association, and these stereotypes can influence student behavior without anyone's knowledge; an example of implicit stereotype is "language - women and male - math" (Steffens & Jelenec, 2011). Getting an early sense of both stereotypes, young girls may be discouraged in the field of STEM due to this stereotype (Cheryan et al., 2011). Shapiro and Williams (2012) show in their research that parents and teachers can add to gender-related stereotypes within early education and development which has a large influence on how females view math and themselves regarding STEM (p. 177).

Smeding (2012) points out that an implicit stereotype that women might face currently is the masculine connection to STEM. For example, one implicit stereotype is that STEM is connected to men (Smeding, 2012). Steffen and Jelenec (2011) then point out by the age of 13 through 15, the implicit stereotypes start becoming embedded in the psyche of boys and girls. These implicit stereotypes can influence both male and females' educational and career choices later in life (Steffens & Jelenec, 2011). Findings show gender implicit stereotype is more than just a theoretical issue in the United States, and that there is a negative connection between implicit gender stereotypes to STEM and achievement for women, whereas men have a positive or null relationship (Smedling, 2012). Smeding (2012) also states that implicit stereotyping within STEM could be connected to the Unified Theory.

The Unified Theory is defined as "a network of variable-strength associations among person concepts (including self and group) attributes" (Greenwald et al., 2002, p. 5). Using the Unified Theory to define what is happening within STEM, there needs to be a connection between two unlike things, such as within STEM and men and the connection that is adopted by the self; for example, for engineering men, their sense of self is directly associated with both their gender and their career in STEM, and STEM is associated with men as a masculine endeavor according the implicit stereotyping (Smeding, 2012).

Self-Efficacy and STEM

There are four areas in which Bandura (as mentioned in Chapter 1) has classified self-efficacy. They will be explored and defined are as follows:

1. Mastery experience
2. Through vicarious experiences
3. Verbal persuasion
4. Physiological Reaction (Bandura, 1986).

The four areas of self-efficacy can have an impact on not only how people view themselves, but how they view their place within the society around them. The following will explain how the areas of self-efficacy can have an impact on females within STEM, gender within the realm of self-efficacy and STEM, self-efficacy and K-12, and interventions with the literature.

Mastery Experience

According to Brown et al., (2016) research has debated whether or not mastery experience seems to have the strongest impact on a person's self-efficacy. Zeldin et al. (2008) backs up this idea by stating "according to the tenets of social cognitive theory people are more likely to perform a task if they believe they are capable of accomplishing it and less likely to engage in a task about which they feel less confident" (p. 136). Mastery experience helps the learner feel success in order to increase their self-efficacy and will influence the learner to move forward with similar tasks. When the person completing the task feels successful then they are more willing to move forward to complete tasks that are similar (Bandura, 1993; Bandura, 1995). Unfortunately, if a person has failed at a task in the past, they may be less likely to continue with that tasks or similar tasks.

Brown et al. (2016) also points out that research in the field of STEM shows that students' self-efficacy beliefs predict the students' intentions to persist in STEM, particularly in the engineering field. Within their study, they completed a quantitative study of middle school students in order to measure "their self-efficacy, beliefs about persistence, and attitudes toward group work before engaging in a STEM- related program." Within their study, there were 206 middle school students who participated in this study, with 91 male and 115 female participants. They were given a survey and pre- and post-tests in order to gain an understanding of their self-efficacy, attitudes and beliefs. The students were then given instruction and STEM-based curriculum was used to engage the students. The main findings show there were differences in students' STEM beliefs and attitudes before and after experiencing STEM curriculum. The most interesting and largest increase within their results from the pre- to the post-test showed an increase within the awareness of the benefit of STEM which was shown in the variance connected to the students' intentions and their persistence within the classwork (Brown et. al, 2016).

Yurt and Sünbül feel that vicarious experiences also have a large influence on developing self-efficacy in young adults (2014). The focus on an individual's ability to have mastery experiences in order to show accomplishments has a direct impact on a person's development of their self-efficacy skills (Brown et al., 2016; Bandura, 1997). Zeldin et al. (2008) point out that self-efficacy can also be an additional part of a person's belief in whether they can excel due to a connection with a person with previous accomplishments or the ability to complete a certain task. Lindely (2006) explains that within western psychology, self-efficacy personifies the masculine concept, in which those traits are viewed as "individualistic, agentic, and highly cognitive" (p. 144). Through Bandura's work, researchers have estimated that self-efficacy continues to be an important influence on human perspective because a person's self-belief system affects their indirect and direct ability for adaptation and achievement (Bandura 2001; Bandura & Lock, 2003; Schunk 2001). As both male and female students grow in age and learn, they develop their personal self-efficacy.

Charles B. Hodges agrees that self-efficacy can be applied to one's personal performance (2008). Self-efficacy is a very important influence in how both children and adults learn, and that influence plays a role in the interest that people then develop. According to Kaiser (2014), success is an important factor for a person to experience, because if they feel like they have mastered an experience they will more than likely increase the behavior that led to their success. If a person fails at a task, they are less likely to continue trying that experience (Kaiser, 2014). Bandura points out that if a person continues to have feelings of failure in their ability, then their positive experiences will decrease, and they are less likely to master the experience (1977). If a person, of either gender, further continues to experience failure, the person is less likely to continue a task (Bandura, 1977).

Exploring elementary, middle school, and high school students' development of self-efficacy could help explain why a lower representation of women in STEM-related fields exists. According to Falco and Summers (2017), data obtained through research studies indicates that male students, on average, have higher self-efficacy and outcome expectations in STEM-related classes compared to females of the same age. Falco and Summers (2017) also point out that female students placed in "gifted" or higher-level courses are still likely to disclose feelings of underconfidence in mathematics, which has a direct impact on their self-efficacy within STEM subjects. This gap can often originate during adolescence and grows over time. While middle school students may not show a correlation between gender, STEM, and self-efficacy, Chen and Zimmerman discovered that female students in middle school felt that they put forth more effort in math than their male counterparts (2007). Bandura (1997) explains that as students mature, an existing gender gap could grow, based on students' self-efficacy. High school students may be more influenced by their previous failures, and consequentially, these failures could directly influence decisions regarding future classes and college majors.

Creating equality in the classroom for all genders can be the first step in equally building students' self-efficacy within STEM and the classroom. Building self-efficacy in young children of all genders, especially females, can highlight their belief system while learning in STEM. Stout, Dasgupta, Hunsinger, and McManus (2011) point out that gender stereotypes may play into the development of female self-efficacy. Stout et al. (2011) observed that females are compared to their male counterparts in fields of STEM in every step of development.

Researchers are divided on the exact year that students start to show different levels of interest, values and motivations when it comes to technology. Even elementary computer and software may appear to hold more interest to the male gender. When Sheldon (2004), examined 44 pre-kindergarten and elementary educational animated software, the resulting data presented a significantly higher amount of male main characters than female characters. While there was a large-scale gap between female and male main characters, there was an equal display of visibility between genders of the secondary characters within the software. While this may seem insignificant, young girls are less likely to identify with male protagonists, and as a result, feel less connected to using the technology when compared to their male counterparts (Sheldon, 2004).

When students of both sexes enter middle school, they experience many physiological reaction changes. According to Leaper, Farkas & Brown, middle school is the time when individuals begin to develop their individual motivations and begin building their unique perceptions of gender roles within society (2012). Self-efficacy, which can influence motivation for both girls and boys can drive their ability to build self-efficacy skills, and it can affect how girls look at technology, in particular, computers.

MacPhee et al. (2013) also stress that a student's personal judgement about their capabilities in various domains is constructed from various experience in the social world. This includes verbal persuasion from individuals that they look up to, which can make a difference in the student's personal outlook and self-efficacy. Lee at al. (2014) also point out that goal setting can be an important aspect of connecting academic self-efficacy to a heightened sense of academic achievement. It is important to note that there are aspects of psychological functioning that can interfere with self-efficacy. For example, a student may have a high amount of self-efficacy and be willing to accept academic challenges, but their self-regulatory process, such as ability to cope with anxiety, may affect how a student views their academic achievement (Lee et al., 2014).

Stout et al. (2010) state that "the skewed gender ratio of STEM experts in academic environments undermines female students' identification with, positive attitudes about, and self-efficacy in STEM and saps their motivation to pursue careers in science, engineering, or technology." Lee et al. (2014) state that when exploring self-efficacy and self-regulation with a school setting, there is a high chance that a researcher will come across gender differences in academic self-efficacy. For example, male students seem to show a larger academic self-efficacy in mathematics and science than their female counterparts. In elementary school, parents express lower expectations for their daughters' ability compared to their sons' ability in math and science (Stout et al., 2011). Sheldon (2004) states that on an elementary level, teachers and administrators have, whether intentionally or unintentionally, enforced negative female stereotypes in the schools. When in an academic setting, student interest has a direct impact on their personal self-efficacy, regardless of age.

Through his research, Robnett (2015) found that Leaper and Brown studied a sample of adolescent girls and reported more than half experienced a loss of confidence and self-efficacy within STEM. Rittmayer and Beier (2008) state that mastery experience seems to have an effect on males within STEM, whereas females are affected by experience and verbal persuasion within STEM. On the contrary, Huguet and Regner (2009) point out that setting a higher standard for young girls compared to their male counterparts can also have a positive effect on their achievement (p.1024). At an early age girls' and boys' self-efficacy start developing differently. Joo et al. (2000) point out that self-efficacy and self-regulation work together because they use strategies to help learners move forward and build their self-efficacy skills; for example, such strategies are "self-monitoring, goal setting and planning, self-consequence, and environmental restructuring." With that being said, the gender difference within STEM has a tendency to favor males and has increased male self-efficacy and could be a connection to why men are successful and higher populated in the field of STEM (Rittmayer and Beier, 2008).

According to Hodges (2008), there is more to building a student's self-efficacy than what is perceived; for example, an educator could affect a student's self-efficacy by focusing not only on a student's ability, but also a students' perception of their ability. It is important for educators to provide opportunities for students to succeed and build self-efficacy within the classroom from an early age. Kiran and Sung (2012) point out that a student's self-efficacy may not depend on their skills alone; student observations can directly impact their personal self-efficacy skills. For example, if some female student views others in her social group as struggling in a subject, this may impact her perception of her personal self-efficacy within that subject matter. What a student observes within the classroom, both successes and failures, can have a dramatic effect on their self-efficacy (Schunk, 2004, Kiran & Sungur, 2012).

There are numerous ways to boost female self-efficacy within STEM through interventions, but it is essential for an educator to take into account student ability, or the interventions may have the opposite effect than intended (Rittmayer & Beier, 2008). SciGirls (2012) points out that an ideal first step in increasing girls' self-efficacy is to increase their motivation within STEM by using STEM as a tool to research issues or topics in which they already show a strong interest. This is because if young females have the ability to process how STEM relates to their own lives, their motivation and their interest may increase. Another strategy that may increase self-efficacy for female students is to enable important figures, such as parents and teachers, to use verbal persuasion by giving positive feedback and encouragement to all students equally (Rittmayer & Beier, 2008).

As students move into the middle grades, signs that male and female students are developing their self-efficacy differently within their STEM-related classes are easy to observe. It has been documented that the gap between male and female students in math and science-related fields begins in middle school and then continues to widen as the students move into high school (Brown et al., 2016). While there is no difference in mathematical achievement between males and females, male students still had a higher sense of enjoyment in STEM-related classes, contributing to the divide with male and female self-efficacy (Catsambis, 1994). Brown et al. (2016) also found that when collaborative group work is being completed within a STEM-related subject, students were less engrossed in the activity by self-selecting their part in the group. This weaker engagement in the activity highlighted that students with lower self-efficacy were more likely to be passive members of the groups, indicating that self-selected roles cannot continue to promote negative self-efficacy (Brown et al., 2016).

The growing need for advancement in the fields of STEM in the United States exists because, in part, there has been a drop-in students entering the math and engineering fields by both genders (Brown et al., 2016) over the past 30 years. Nissen and Shemwell (2016) also discuss how gender differences can arise in STEM-related classes when women look back at their past instruction and recall levels of anxiety or a different style of instruction; it seems that this issue originates when a student focuses on the anxiety within previous STEM classes and cannot build positive self-efficacy as they move through developmental stages.

Vicarious Experiences

Vicarious experiences are the second area in Bandura's sources of self-efficacy. These are defined as how people view the world around them and how their perceptions impact them. While experiencing life events, the human brain forms positive or negative influences on those future events (Bandura, 1997). When students, both male and female, have higher self-efficacy and self-regulation, there is a stronger possibility that they will have a positive belief system in their competence and/or academic goals (Lee,

Lee, & Bong 2014). This is when a person of any age gains experiences by observing others performing a certain task (Bandura, 1997). This could be a way for students to develop mentors, or role models. Role models have an important impact on male and females alike, because they allow students to visualize themselves as being successful by observing someone they hold in high regard.

Role models and observations can have a direct effect on a females' self-efficacy within STEM. There is also an association with the low percentage of women in the fields of computer science and software engineering and a lack of same gender role models. Cheryan et al. (2011) point out that women need to see that they can be successful in the field of STEM, and for that to occur, women need to see other females in the field be successful and model their successful behavior.

According to Wang, when female students move beyond the high school classroom and pursue a STEM-related field like software engineering, they typically find themselves seeking male role models and identifying with male roles in higher education (2012). Wang conducted a qualitative study with sixteen female students who study technology learning in Twain. He reported that female students identified with role models that were male as they take on a more masculine style. The participants reported that they had feelings of anxiety because of the stigma branding of a "strong woman." Wang states that "If a woman makes it to the top of a corporate ladder, she is almost always seen as a shrew." Consequentially, Wang indicates that high-performing women within the field of technology can be seen maintaining their femininity, the opposite of what is expected by the general stereotype (Wang, 2012).

According to Bain and Rice, women who majored in STEM-related fields can be perceived as “path breakers” (2007). However, Leaper et al., point out that these females did not view themselves similar to other females (2011). STEM careers have the perception of being masculine pursuits and male dominated (Bernstein & Russo, 2008; Macphee et al., 2013). Under the Unified Theory, if there is a conflict between self and one’s self-knowledge, it can cause a disruption in how one views themselves. For example, if a woman majors in a STEM-related subject, a counter-stereotype is created, and she is perceived as masculine for pursuing a career in a masculine field (Smeding, 2012). McCarthy & Berger point out that females in technology education and STEM positions need role models in order to allow for emotional growth (2008). Emotional growth is defined as the emotional development that is developed by a child's experience, expression, and management of their emotions and their ability to establish positive and rewarding relationships with others (Cohen et al. 2005). Cheryan et al. (2011) stresses that if a female feels like her behaviors are similar to what is expected according to gender norms, she may feel alienated within the field of STEM. They point out that young women who encounter the stereotypical female STEM work may be discouraged and be less likely to go into that field (Cheryan et al., 2011).

Shapiro and Williams (2012) discuss in their research that stereotypes can have a negative effect on women entering the workforce and their career desires (p. 177). London, Downey, Romero-Canyas, Rattan, and Tyson point out that the negative stereotypes within the STEM field can also discourage women from pursuing STEM careers because women who fit the gender social norm may feel inadequate or at a disadvantage compared to others that fit that stereotype (2011).

Early imprinting on young girls' self-efficacy can be traced to elementary school, where parents and teachers place lower expectations on girls' ability in math and science. Academic self-efficacy can be defined as a person's ability to perform an academic task successfully with confidence (Schunk, 1991; Joo, Bong, Chio, 2000; Hodges, 2008; MacPhee, Farro & Cannetto, 2013). Lee et al. (2014) connect academic self-efficacy to academic performance because it can be used to predict the students' academic performance indexes. It is also closely linked to academic self-regulation, such that students with strong self-efficacy beliefs are also better self-regulated learners. For the male and female learner self-efficacy, grade goals, and achievement seem to connect to one another (Lee et al., 2014).

Ehrlinger et al. (2018) explain that past research has shown that people have a tendency to explore interests in activities if there is a prototypical person that they can relate to who is also engaging in the same activity. In her article for Fast Company, Kanenetz interviewed the CTO of Etsy, a shopping and crafting website, about the culture of women in programming. Kellan Elliott-McCrea, CEO of Etsy, stated that "great women engineers are not only NOT looking for work, but also, they're wary of being burned by the culture. If all they see are men, there's a decent chance, based on their experience, that your workplace is going to suck" (2013). Kanenetz (2013) also discusses how Etsy created a more gender diverse work environment by working with 37Signals and Yammer, and by paying $7,000 per student in grants to cover living expenses so women could attend a Hacker School boot camp session held at Etsy in 2012.

Leaper and Brown (2008) say that our society could suffer due to losing the female perspective in rapidly growing STEM fields. This could cost the United States future growth and perspective. Diversifying the work force within STEM could give multiple perspectives to a growing field and help the United States move toward the future by encouraging minds of all genders (Xie et al., 2013). Cheryan, Plaut, Davis, and Steele (2009) point out that having an all-male perspective can have a negative effect on a growing society, as proven by all-men design teams. Having teams that consist of all one gender can affect one's feeling of fitting into their environment (Cheryan et al, 2009). This can be considered or called ambient belonging (Cheryan et al, 2009). "Ambient belonging includes fit with the material (e.g., physical objects) and structural (e.g., layout) components of an environment along with a sense of fit with the people who are imagined occupying that environment" (Cheryan et al, 2009). Without a sense of belonging one is less likely to join a group, and it might influence them negatively (Cheryan et al, 2009).

Kanenetz was so delighted to observe more diversity within working environments like Etsy, as well as companies such as Dropbox and GitHub, which have joined Etsy in sponsorship (2013). The women that took part in Etsy's boot camp became a payout for Etsy, because it enabled Etsy to build a female community within their workplace (Kanenetz, 2013). Etsy then attracted more experienced female senior level engineers to apply to the company, which provided more experience and female influence (Kanenetz, 2013).

To summarize, many women lack role models and mentors within STEM workplaces, leading to an identity threat within the field (Xie et al, 2013). Young females in school can be discouraged from pursuing studies in technology and STEM due to lack of role modeling, negative cultural messages toward their gender, and lack of support from a middle or high school guidance counselor (McCarthy & Berger, 2008). According to Stout, Grunberg, and Ito, this lack of culture messaging is created by a lack of female role models and could be associated with a lack of community (2016). According to Stout et al. (2016), women tend to gravitate toward careers that they feel have a community base for them for a sense of acceptance, but men feel that they can adjust to both female and male career genders (2016). Females have made large strides to gain equality within the United States, and there are signs that role models and opportunities are becoming available to women, but despite these advancements, female students are still subject to gender inequality outside of the traditional gender roles (Leaper & Brown, 2008).

Verbal Persuasion

As far as external factors are concerned, verbal persuasion has the biggest impact on learners. Providing students with positive, genuine, appropriate, and realistic feedback is an essential task of authority figures in the classroom (SWE-AWE-CASEE ARP Resources, 2008). As stated before, parents and teachers can be a large factor in a student's learning.

Wang and Degol (2016) discuss the developmental stage could have an effect on children's cognitive ability which then has an influence on self-efficacy within STEM. They discuss the cognitive abilities can emerge at different ages for children, and there is little difference between males and females with reference to math in early childhood. They point out that gender gaps that are being noticed by researchers are emerging in early to late childhood and correspond to the beginning of schooling for children (Wang & Degol, 2016). Throughout childhood and adolescence, students' educational experiences may serve to reinforce these gender gaps in cognitive performance over time (Wang & Degol, 2016).

When adults refer to children as "impressionable," that is true because they are forming impressions through their observations that could shape their self-efficacy. For example, Kaiser (2016) points out that self-efficacy could be an influence in middle and high school girls when they are looking to study subjects in the STEM-related field. Young girls and boys tend to rely on self-efficacy when selecting certain tasks like sports, clubs, or subjects to excel in (Bandura, 1993). Teachers and parents can help build a student's self-efficacy within the area of verbal persuasion by promoting that females are just as equipped to enter STEM-related fields, and that there are not careers that are just female or male career choices. (SWE-AWE-CASEE ARP Resources, 2008)

Middle school students are particularly impressionable because they constantly observe important people in their lives such as their parents, teachers, siblings, crushes, and peers (Yurt & Sünbül, 2014). Many feminist researchers have asserted that placing children in early gender role stereotypes can limit young girls' potential, which can directly influence their self-efficacy (Sheldon, 2004). Brown et al. (2016) found in their study that middle school students of both genders are susceptible to positive self-efficacy growth within STEM by increasing their motivation, changing perception, and prompting a positive attitude. Females throughout their early education, as well as through stereotyping are being implicitly influenced to pursue fields that are more art-related (Shapiro & Williams, 2012, p. 177).

Self-efficacy can be a strong predictor of academic performance for learners even within higher education (Lee et al., 2014; Multon, Brown, & Lent, 1991; Schunk & Pajares, 2005). Brown et al. (2016) point out that teachers can assist with a student's self-efficacy in any level of education as long as teachers use an explicit approach when teaching STEM in the classroom and show STEMs usefulness while prompting student's self-efficacy skills. Teachers can aid building self-efficacy in the classroom by fostering student judgement and sending empowering messages to students equally (Kiran & Sungur, 2012). Having equal access to science and math encouragement, mastery experience, vicarious experience, and verbal persuasion, middle school girls will have shown signs of self-efficacy equal to their male counterparts (Kiran & Sungur, 2012). Brown et al. (2016) also point out that in order to meet the growing demand of the STEM workforce, it is important that as early as possible students build a positive self-efficacy attitude toward the STEM field.

Physiological Reaction

A person's emotional and/or physical being can have an effect on how a person completes a task, and a physiological reaction can influence an emotional response based on performing a task (Bandura, 1997). For example, a student could feel calm when completing a reading task in class but could feel worried about completing a math problem on the board and fostering a building confidence within STEM can lead to higher self-efficacy (SWE-AWE-CASEE ARP Resources, 2008). Brown et al. (2016) also stress that a student's self-efficacy within the STEM classroom can largely predict if a student will persevere during STEM-related classes.

Liu, Lou, and Shih (2014) defined STEM self-efficacy as, "the self-evaluation of concepts, principle applications, and experimentation ability in science, technology, engineering, and mathematics required for the completion of STEM projects." Liu et al (2014) found in their research that project-based learning was a way to increase high school female interest while building their academic self-efficacy skills within the classroom. Liu et al. (2014) also found that when high school female students do demonstrate STEM self-efficacy, it could lead to a high chance of a female choosing an engineering major in college.

Villavicencio and Bernardo (2016) point out while positivity within the realm of self-efficacy can help promote positive outcomes within the STEM field, particularly math, negative emotion associated with a task within the subject matter can negatively affect a student's personal belief system. They also point out that emotionally stressful classes within STEM, specifically high level maths, can promote a negative reaction like anxiety which can then lead to the consequence in harming the student's personal self-efficacy. There needs to be a balance of emotional stress and higher-level learning. They stress that personal pride in one's work can connect itself to positive self-efficacy within challenging courses (Villavicencio & Bernardo, 2016).

Within early research as far back as the 1980's, studies have shown that females in their junior year of high school showed signs of lower levels of self-efficacy than their male counterparts. While considerable attempts have been made to strengthen female self-efficacy within STEM-related fields, females are still underrepresented within the fields of STEM (Lindly, 2006; Rice, Lopez , Richardson, & Stinson 2013). Kaiser stresses that if girls are perceived as having low self-efficacy in a STEM subject, then girls may not push themselves to excel learning STEM-related subjects (2016). Stout et al. (2010), also report that females can overachieve but believe they are lacking compared to others in the field of STEM. MacPhee et al. agrees that academic self-efficacy plays a very important role for women while in school (2013).

Furthermore, a female student's STEM test score may increase due to persistence in the classroom, but if female self-efficacy, attitude, and identity do not increase, they may not adjust their career outlook which means they will be less likely to move into a STEM-related field after graduation (Stout et. al). Stout et al. (2010) point out that the concept that STEM-related careers are only for men can have a lasting effect on females' self-efficacy, attitude and motivation within the field of STEM.

Joo et al. (2000) point out that self-efficacy has a strong influence on student motivation and achievement due to the research completed by Bandura over the years. Rice et al. (2013) found in their research that females being underrepresented within the STEM-related classroom can lead to stress factors that can strengthen their sensitivity to their abilities within the career field.

Exploring the concepts of academic and technological self-efficacy might show how the effect that it has on women within STEM and exploring gender stereotypes within the STEM community can aid in explaining why there is a lack of women within the field. No one in particular is to blame for the low representation of women in STEM fields. One needs to look deeper into how both of these issues work together to discourage women in pursuing the field, staying in STEM majors in college, and entering and staying in the workforce.

It can be argued that with the influx of men majoring in the field of STEM, fewer women are majoring within the field. Figure 4 (National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System, 2014) shows the percentage of women majoring within the field of STEM. Computer science from 1985 to 2010 shows a steady decline in female majors. Building a strong interest base for both men and women is a possible way for both genders to fill the need that is growing. Building a more gender diverse workforce will not only fill the jobs that are in demand within the STEM field, but it will give a voice to an unrepresented group within these careers. According to Brown, Concannon, Marx, Donaldson, and Black (2016) there seems to be an untapped market of highly intelligent females, but they are not pursuing the high paying and high demand jobs within STEM, especially in computer science.

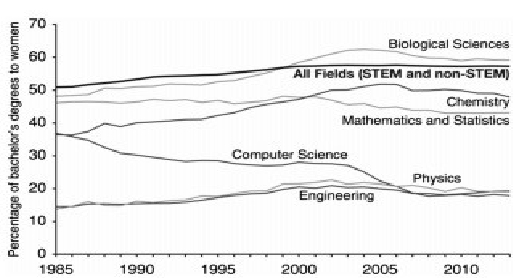

Figure 3. Percentage of bachelor's degrees awarded to women in STEM fields from 1985–2013. From "National Center for Science and Engineering Statistics: Integrated Science and Engineering Resources Data System," by National Science Foundation, 2014, retrieved from Webcaspar.nsf.gov.

Based on Figure 3 (National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System, 2014), it seems that there is a growing problem within some STEM-related majors when recruiting both men and women. According to the Department of Labor there are an estimated 1.4 million computer-related jobs that will be available by 2020, Figure 3 (National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System, 2014). This could be a large opportunity within the United States to employ a large part of the population.

Brown et al. (2016) state that there is a need for more qualified candidates in the field of STEM as the "Baby Boom" generation looks to retire, and for the past 30 years there has been a decline in both males and females entering the science and engineering field. This is a concern because in order to keep the STEM industry strong, there will be a need for qualified candidates to fill those roles within the United States (Brown et al, 2016). Therefore, encouraging students to pursue electives in computing will help build early interest in STEM, and in turn will help fulfill these estimated jobs (as cited in Israel et al., 2015).

The growth of STEM in a modern society is important for future innovation (Xie, Fang, & Shauman, 2015). Building and equalizing the numbers in STEM could be a way to problem-solve the lack of interest in ever-growing fields (Gilpin, 2014). The number of men and women majoring in computer science is on the decline according to Figure 3 (National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System, 2014). With the United States losing its lead in the world in science, there needs to be a more serious look at the population within STEM (Xie, et al., 2015). Within the population in STEM-related fields like computer science and engineering, there seems to be a lack a female representation, and taking a closer look at the explanation can help establish what is causing the problem (Cheryan et al., 2016). Robnett (2015) stresses that there is a large growth of women entering college and the workforce, but there still is an evident gap of women with careers that are related to STEM (p. 65).

The lack of females in STEM has been established in several studies (Cheryan et al., 2016). With the number of women who are moving toward seeking a bachelor's degree within STEM, it is important to promote this career and highlight its importance. For example, Figure 3 (National Science Foundation, National Center for Science and Engineering Statistics, Integrated Science and Engineering Resources Data System, 2014) points out there will not be enough computer scientists and engineers to keep up with the growing demand (Cheryan et al., 2016).

Discovering what is causing this large divide would help assist career growth within STEM-related fields. Three possible theories researched in this paper are: self-confidence with females in STEM, female self-efficacy within STEM, and gender roles/stereotypes that are associated with the majors or careers which create a cultural message for females pursuing STEM careers and majors.

Gender Roles and STEM Within Self-Efficacy

Lui et al. (2014) point out that gender role belief can have an impact on a female student's self-efficacy. They define female gender roles beliefs as "women's self-development and gender equality" (Liu et al., 2014). Figure 4 (Lei et al., 2014) found that a greater gender belief system within high school and beyond can provide commitment and dedication to the growing education field (Lei et al., 2014). Girl Scout Research Institute (2012) points out that 74% of high school girls have expressed an interest within STEM, but there is a perceived gender barrier that is still present that can hinder a female when pursuing a career. This may cause girls to not choose STEM fields. This could have an impact on their vicarious experiences because, as Bandura explains, it could influence the way people view the world around them and how their worldviews impact them (Bandura, 1997). By viewing STEM as a male-dominant force could have an impact on their self-efficacy.

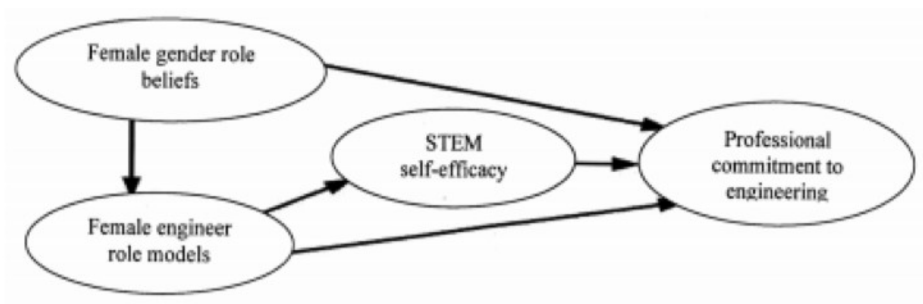

Figure 4. Female students' professional commitment to engineering theoretical model. From "The investigation of STEM Self-Efficacy and Professional Commitment to Engineering among female high school students," by Y. Liu, S. Lou, and R. Shih, 2014, *South African Journal of Education, 34, p. 3.*

Kaiser stresses that a person looks back at their past results when trying to make a decision about the future (2014). Kiran & Sungur (2012) point out that it is important to look at all the factors a student will take into account when building their self-efficacy skills. However, students' past experiences are not the only thing that plays a role in the development of their self-efficacy skills (Kiran & Sungur, 2012). Both male and female students combine their past experiences with environmental and emotional factors (Kiran

& Sungur, 2012). Kiran and Sungur (2012) studied 1932 8th grade students from 21 urban middle schools. They were studying the gender differences within self-efficacy within science (Kiran & Sungur, 2012). Their findings yielded no significant difference between the levels of self-efficacy due to similar experiences within science accomplishments while receiving similar feedback (Kiran & Sungur, 2012). Kiran and Sungur (2012) point out that mastery experience could be a possibility why there is not a significant difference. There was, however, a significant difference between boys and girls regarding emotional arousal which could be connected to the culture of girls in which they are raised to be more cooperative and inviting (Kiran & Sungur, 2012). This is taking into account that boys and girls are socially different (Kiran & Sungur, 2012). They also found that both boys and girls have similar access to self-efficacy which could lead girls into picking careers within the STEM field (Kiran & Sungur, 2012).

Lee at al. (2014) also studied the middle school population in Seoul, Korea. Through their research they set to measuring self-efficacy and grade goals amongst cognitive motivational constructs, individual interests, and the use of self-regulatory strategies, within students from grades 7th-9th grade. They had 132 7th grade students, 239 8th grade students and 129 9th grade students participate in the study. The middle schoolers were asked to complete two surveys, one every semester after completing the first two months of each semester. Results of T-tests suggested that girls had lower academic self-efficacy skills within the area of math, and they also found that girls have a much lower interest in math compared to their male counterparts. Within their results, they found that female students had lower self-regulation in math compared to the males. They also found that in Korea, female students outperform the male students on their achievement testing. They used an ANOVA test across all subjects which produced further results. In the areas of verbal subjects of Korean language and English as a foreign language, the female students showed higher academic self-efficacy. It is important to point out within their study that girls' academic self-efficacy within science was not largely higher than the 2 verbal areas, but it was much higher than the scores within math. Lee et al. (2014) stated the following:

> The pattern of between-subject differences for boys was less consistent than that for girls. Similar to girls, boys displayed significantly stronger academic self-efficacy in the verbal subjects than in science. However, despite their relatively lower self-efficacy in science, boys expressed significantly stronger interest in science as well as mathematics compared to their interest in the two verbal subjects.

Lui et al. (2014) used their research within self-efficacy to explore a slightly older population of students, high school level, in Taiwan. Lui et al. (2014) state that, "Stirling engine and cup speaker projects in STEM project-based learning, using social cognitive theory and SCCT as the foundation for developing a model through STEM verification." Their results showed that high school STEM female students' STEM self-efficacy was impacted when they were given role models of the same gender who were positively engaged with the area of engineering. The females who worked on the STEM projects for this study were able to learn and work with successful women within the field of engineering, giving them a strong sense of role modeling. This showed an improvement in the way female participants viewed their capability and competence in STEM.

Additional results indicated that “students can develop enthusiasm in studying engineering as a result of having female engineer role models” (Liu et al., 2014).

Falco and Summers (2017) discuss that “young people anticipate taking the coursework necessary for STEM careers as being closely connected to their self-efficacy beliefs in math and science.” They continued by pointing out that research has connected the contrast of self-efficacy and outcome expectations, specifically for careers where the opposite sex is the dominant sex. For their study, they recruited 88 high school freshman and sophomore high school students. The participants were split into two equal groups in one of two groups: treatment and no treatment. The participants for their study ranged from 14-16 years of age. With their study, they used “The Middle School Self-Efficacy Scale,” and this tool was created as a way to gauge how interventions within the maths and sciences benefit female and minority students. They applied nine interventions over the span of their study. Session 1 of their study was building the concept of STEM careers within the session. Session 2 of their study discussed different elements of a STEM career. Some examples would consist of salary, education, etc. Session 3 looked at barriers which they may face when pursuing a STEM career. Session 4 worked with the concept of growth-mind-set. In session 5, the participants were asked to discuss and create a timeline of success within STEM. Session 6 focused on how to deal with negative emotions. Session 7 focused on vicarious learning of Self-efficacy. Session 8 focused on verbal persuasion of self-efficacy. Session 9 was the final session, and the group worked with goal setting. Their results showed “a positive effect on the participants’ career decision self-efficacy and STEM self-efficacy” (Falco & Summers, 2017).

MacPhee et al. (2013) state that academic self-efficacy is critical within the United States, particularly with women who show curiosity and endurance within the STEM field. They completed a longitudinal study that explored one's self-perspective within the underrepresented groups within STEM. The participation for this study consisted of junior and senior undergraduates from Mountain West University in the McNair Scholars Program, consisting of a high population of groups of students that are not normally represented within STEM (i.e., females and minorities.) For instruments, they used "The Watson-Glaser Critical Thinking Appraisal" for measuring critical thinking. GRE scores and GPAs were also obtained. To measure academic self-efficacy, the "Harter's Scale" was used, and to measure self-efficacy "The What I am Like" scale was used because it covers the multiple areas of self-efficacy within the instrument. In their findings, they found that females perceive themselves lower academically than their male counterparts whose assessments suggest equivalent academic ability. After graduation though, on the contrary, they found that females and males have similar self-efficacy (MacPhee et al., 2013).

Nissen and Shemwell (2016) point out that physics is being explored as well for the gender gap in self-efficacy, and they have noted that there are noticeable gender differences that can cause negative shifts in attitudes which then can negatively affect self-efficacy for females within physics related classes of STEM. Tellhed et al. (2017) then point out another area in STEM that is a cause for concern and that is software engineering. Tellhed et al. (2017) call attention to the fact that women tend to have lower self-efficacy than men in STEM occupations, such as software engineering, and suggest that low self-efficacy could possibly be a factor in why there are less women in the field (2017).

Within Bandura's domains, self-efficacy for both men and women are directly affected by their learning experiences in their learning environments (Bandura, 1977). Forming their personal self-efficacy based on their educational background, men and women could feel that they can only handle jobs within gender-dominated career areas, so they rarely deviate from those paths (Tellhed et al, 2017). It could be argued that men would have lower self-efficacy within fields that are associated with women, like careers that are language-based and community driven (Tellhed et al, 2017). Liu et al. (2014) stress that some of the factors that affect gender role beliefs within STEM can be related to socialization with a role model which would affect self-efficacy, personal gender role belief systems, and role modeling; all of these factors would affect a female's professional commitment to STEM and, more specifically, to engineering.

Self-efficacy can also affect a work environment. According to Lindly (2006) the difference in which males and females in a diverse population can experience positive and negative experiences can have a different type of effect on their self-efficacy within the workplace. Occupational self-efficacy theory is defined as the belief that a person can perform a behavior which will produce a desired outcome (Bandura, 1978; Blais, 2015). In simpler terms, occupational self-efficacy can be defined as a broader type of self-efficacy measurement that is abundant enough to address different sorts of necessary job outcomes while being a largely specific indicator for assessing a work place (Rigotti, Schyns & Mohr, 2008; Blais, 2015).

MacPhee et al. (2013) feel that exploring both academic self-efficacy and occupational self-efficacy can help them understand why minorities and females are so grossly underrepresented within the field of STEM. MacPhee et al. (2013) found in their longitudinal study that females viewed themselves academically weaker than their male counterparts even though they had comparable test scores on the assessment given. Within the early stages of research in the 1980's, which explored self-efficacy and gender within the workforce, women showed lower levels of self-efficacy within male-dominated fields, and when research went into the 1990's the trend continued (Lindly, 2006). Despite 20 years of research, researchers are stilled divided on what can increase female self-efficacy within STEM.

Self-Efficacy Within K-12

Exploring elementary, middle school, and high school students' development of self-efficacy could help explain why there is a lower representation of women in STEM-related fields (Falco & Summers, 2017). Their research has data that supports the concept that male students on average have higher self-efficacy and outcome expectations in STEM-related classes compared to females of the same age. Females placed in "gifted" or higher-level class are still likely to disclose feelings of under confidence in mathematics which has a direct impact on their self-efficacy within STEM subjects, and this gap can appear in adolescence and grow over time (Falco & Summers, 2017).

While middle school students may not show a correlation between gender, STEM, and self-efficacy, Chen and Zimmerman discovered that female students in middle school felt that they put forth more effort in math than their male counterparts (2007). Bandura can explain this way of thinking through experiences (1997). As students grow and move into high school the gap between male and females' interest in STEM could grow, based on their self-efficacy. High school students might be more influenced by their past failures and due to that fact, the failures could have a direct influence on which future classes and college majors get chosen.

Creating an equal classroom for both male and female students with common encouragement for both genders can be the first step in equally building students' self-efficacy within STEM and the classroom. Building self-efficacy in children of both genders at a young age, especially girls, can highlight their belief system while learning in STEM. Stout et al. (Stout, Dasgupta, Hunsinger, & McManus, 2011) show how gender stereotypes can play into the development of female self-efficacy. Stout et al. (2011) observed that it has been seen that girls are compared to their male counterparts in fields of STEM in every step of development.

Researchers are divided on the exact year that students start to show different levels of interest, values and motivations when it comes to technology. Even elementary computer and software use can be seen gravitating more toward the male gender. Sheldon (2004) examined 44 pre-kindergarten and elementary educational animated software programs, and the data presented a significantly greater amount of male main characters than female characters. While there was a large-scale gap between female and male main characters, there was an equal display of visibility between genders of the secondary characters within the software programs. While this may seem insignificant, young girls are less likely to identify with protagonists with the software, and as a result there is a chance that they will feel less connected to using the technology compared to their male counterparts (Sheldon, 2004).

When students of both sexes enter middle school, they experience a lot of changes to their body, self-awareness, and education. According to Leaper, Farkas & Brown, middle school is when individuals start to develop their individual motivation and begin building their perceptions of the gender role within society (2012). Self-efficacy, which can influence motivation for both girls and boys can drive their ability to build self-efficacy skills, and it can affect how girls look at technology and, in particular, computers.

MacPhee et al. (2013) also stress that a student's personal judgement about themselves, such as the ability to complete work in various domains, encompasses learning from various experience in the social world and verbal persuasion from people that they look up to can make a difference in the student's personal outlook and self-efficacy. Lee at al. (2014) also point out that setting goals can be an important aspect that connects academic self-efficacy to a heightened sense of academic self-regulation and achievements. It is important to point out that there are aspects of students that can interfere with their self-efficacy. A student could have a high amount of self-efficacy and be willing to accept academic challenges, but their self-regulatory process, like anxiety, may affect how a student then views himself or herself and the material in the class (Lee et al., 2014).

Stout et al. (2010) state that they feel that "the skewed gender ratio of STEM experts in academic environments undermines female students' identification with, positive attitudes about, and self-efficacy in STEM and saps their motivation to pursue careers in science, engineering, or technology." Lee et al. (2014) state that while exploring self-efficacy and self-regulation with school, there is a high chance that a researcher will come across gender differences in academic self-efficacy. For example, male students seem to show a larger academic self-efficacy in mathematics and science than their female counterparts. In elementary school, parents express lower expectations for their daughters' ability compared to their sons' ability in math and science (Stout et al., 2011). Sheldon (2004) states that on an elementary level, teachers and administrators have, whether intentionally or unintentionally, enforced negative female stereotypes in the schools. When students are in an academic setting no matter the age, their interest has an impact on their personal self-efficacy. Robnett (2015), through his research, found that Leaper and Brown studied a sample of adolescent girls and reported more than half have experienced a loss of confidence and self-efficacy within STEM.

Interventions Within Self-Efficacy

There are ways to boost female self-efficacy within STEM through numerous interventions, but an educator needs to take into account the students' ability or the interventions may have the opposite effect than expected (Rittmayer & Beier, 2008). SciGirls (2012) points out that a good first step in increasing girls' self-efficacy is increasing their motivation within STEM by using STEM as a tool to research issues or topics that they show a strong interest in. If young females have the ability to process how STEM relates to their own lives, their motivation and their interest may increase (SciGirls, 2012).

As students move into a middle school setting, there are signs that male and female students are developing their self-efficacy differently within their STEM-related classes. It has been documented that the gap between male and female students in math and science-related fields begins in middle school and then continues to widen as the students move into high school (Brown et al., 2016). While there is no difference in mathematical achievement between males and females, male students still had a higher sense of enjoyment in STEM-related classes which can add to the divide with male and female self-efficacy (Catsambis, 1994). Brown et al. (2016) also found through their study that when group work is being completed within a STEM-related subject, students were less engrossed in the activity by self-selecting their part in the group. This poses the question: could teacher-selected groups in STEM-related classes be a strong first step intervention within classes? This weaker engagement in the activity highlighted the students with lower self-efficacy because students with lower self-efficacy were more likely to be the passive members of the groups; continuing with self-selected roles may not only continue to promote negative self-efficacy, but it may stop a student from moving in the positive direction (Brown et al., 2016).

There is a growing need for advancement in the fields of STEM in the United States because in the past 30 years there has been a drop-in students entering the math and engineering fields by both genders (Brown et al., 2016). Nissen and Shemwell (2016) also discuss how gender differences can arise in STEM-related classes when women look back at their past instruction and recall levels of anxiety or a different style of instruction; it seems that the problem arises when a student focuses on the anxiety within previous STEM classes and cannot build positive self-efficacy moving forward.

Chapter 3 Methodology

Building an interest within students for STEM could impact the United States and how they are viewed by the world. While there is a large push in the United States to interest women in STEM majors, a clear divide exists between men and women entering the STEM field. As displayed in Figure 5 (Beede et al. 2011), the gender percentages within a STEM career in 2009 shows a large domination of men in the field, whereas the data representing all careers shows that there is a 2 percent difference between men and women entering the workforce. While 48% of the women are entering the workforce, only 24% of the total are entering the STEM field as reported in 2011. The study will explore undergraduate female students who entered the university who are in a STEM major (Beede et al., 2011).

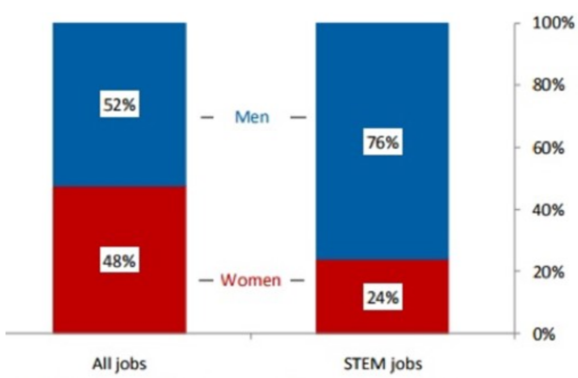

Figure 5. Gender share of all jobs and STEM jobs. From “Women in STEM: A gender gap to innovation”. by D. Beede, T. Julian, D. Langdon, G. McKittrick, B. Khan, and M. Doms, 2011. Retrieved from US Department of Commerce, Economic and Statistic Administration.

In his paper, Watkins (2018) states that Noonan's (2017) republication of the report by Beede et al. (2011) demonstrated that data has not changed over time. Watkins (2018) showed that Noonan in 2017 republished Beede's report to the US Department of Commerce in showing that the data has not changed over time. Watkins stressed, "It is meant to put into perspective just how large the gap is between the two in STEM careers" (2018). This demonstrates that there is a continuous problem that needs to be explored.

Participants

This study involved undergraduate students enrolled at Duquesne University, a private university in western Pennsylvania. Participants ranged from freshman (1st year student) to senior (4th year student). The selection of the participants was a process driven by the research questions and focused on the STEM-related major participation. Information about the participants was collected on a very limited scale because all the participants that participated were from the same university. Participants were identified by gender, major, and university year. Very little interaction to no interaction took place between the researcher and participants. The tool, described below, was administered through email.

Research Design

This study, examined gender and self-efficacy in undergraduates, utilized a quantitative case study research design method, using descriptive statistics, to analyze the data collected. According to Creswell and Creswell (2018), a quantitative research approach "focuses on carefully measuring (or experimentally manipulating) a parsimonious set of variables to theory-guided research questions and hypotheses" (p. 147). Experts have traditionally used numerical data to in order to make a strong case for their research and to remove conjecture. This was the primary rationale for selecting a quantitative study. The direct examination of self-efficacy in females and males within STEM-related majors determines the need to conduct a survey analysis using the self-efficacy scale. The study was guided by the research questions, and the gathered data that was collected through online surveys distributed online to students who are involved in current undergraduate degrees within STEM.

Prior to the decision to use a quantitative research model, other types of research designs were considered. While other types of studies, a mixed study or a qualitative study for example, could be insightful, a quantitative study gave the benefit of being able to examine data without interacting directly with the participants in the study. Using a quantitative research method also aided in analyzing a large amount of data in a systematic and organized matter.

Sampling

A convenience sample was used to select the subjects for the study. The subjects selected were from STEM majors only and were attending Duquesne University. The procedure for recruiting participants consisted of these steps:

Step 1: Reach out to the chairs of the STEM departments (biology, chemistry, computer science, engineering, nursing, physics, etc.).

Step 2: Get study consent form signed by the department chair.

Step 3: Retrieve email addresses of undergraduate students within the STEM-related majors (both male and female).

Step 4: Within each survey, an individual consent form will be attached (See Appendix A). Since the researcher was not in direct contact with the participants, they filled-out the consent forms online through the survey entry page. Interaction with the participants was not needed at this time because the statistical differences was what will be explored within this study. A mixed study in the future could be used to expand on the statistical differences as a follow-up study with these statistics. If they did not agree to the terms of the survey, the survey closed and collect no information from the participant. If they choose to proceed, the participants could close the survey at any time and no data was sent to the researcher.

After the participants were identified, a stratified sampling was used to select the participant by gender. All STEM students were asked to participate in the study, which included but was not limited to: Binary Engineering (Physics/Engineering), Biochemistry, Biology, Biomedical Engineering, Chemistry, Computer Science, Environmental Science, Environmental Chemistry, Mathematics, Nursing, Pharmacy, Pre-medical, etc. Stratified sampling was used because the research within this study would be sampling male and female students who are undergraduates within STEM-related majors, making it possible to draw a conclusion about the female STEM group specifically by the comparison to their male counterparts.

Survey Instrument

The survey designed for this study was created in order to collect objective, unbiased data from participants in STEM-related undergraduate programs. The survey had a 4-point Likert Scale that is given in multiple choice format. A demographics section was placed at the beginning of the survey in order to isolate a variety of independent variables (gender, major, courses taken, etc.).

Objective and opinion-based questions were placed within the survey in the order matching the flow of the research questions. Survey questions based on research question 1 were objective and are formatted as multiple choice with a write-in option. Research questions 2 and 3 were opinion-based and based on the self-efficacy scale that was adapted from the Self-Efficacy Questionnaire created by the Research Collaboration Group (Gaumer Erickson, Soukup, Noonan, & McGurn, 2016). The Research Collaboration Group of Kansas University gave permission for the researcher to use and modify their survey to fit the needs of the study (Please refer to Appendix C) (Gaumer et al., 2016). A Likert scale was created ranging from 1 ("Strongly disagree"), 2 ("Disagree"), 3 ("Agree"), and 4 ("Strongly Agree"). A four-point Likert scale with no option for a neutral response was selected in order to ensure that participants select a clear answer to each question. The opinion questions used positive wording. The survey instrument is attached as Appendix B. Self-efficacy was the repeated measure within the study being conducted.

Three Goals, Hypothesis, and Variables of the Research Questions

Specified below are the goals for the study, the hypothesis created for each research question, and the independent and dependent variables.

Research Question 1

Research Question 1: What courses did males and females take in high school that had an effect on their selection of a STEM-related major?

Goal 1: The purpose of this survey is to analyze and compare undergraduate females to their male counterparts enrolled in STEM-related majors. This will provide data that will compare differences between the male and female experiences that built initial interest in STEM fields. Comparison will be made using a T-test. There can be a comparison made about the high school course(s) that females and males studied before entering college.

Hypothesis 1: When comparing females to males' high school coursework, females will have taken a larger quantity of STEM classes than their male counterparts.

Null Hypothesis 1: When comparing females to males' high school coursework, there will be no difference between the amount of and quality of STEM-related coursework; for example, higher level math and science classes as well as early or advanced technology classes.

Alternative Hypothesis 1: When comparing females to males' high school coursework, the male students will have taken a larger quantity of STEM classes and achieve a higher quality of classwork compared to their female counterparts.

The two genders represent the independent variable for this research question. STEM-related classes consisted of any math, science, engineering, or technology classes offered in a traditional high school course curriculum based on common core standards set by the United States and the ISTE (International Society for Technology Education). The dependent variable explored in this research question is the number of STEM-related classes taken during high school. Again, STEM-related majors are considered any major in the field of science (i.e. nursing, pre-medicine, pharmacy, chemistry, biology, physics, etc.), any field of math (i.e. finance, statistics, cryptography, biotech, etc.), any field within engineering (i.e. mechanical, electrical, civil, aeronautic, etc.), and any fields within technology (i.e. computer science, information technology management, software engineering, database administration, video game Programming, web development, etc.).

Research Question 2

Research Question 2: What level of self-efficacy do undergraduate females within STEM have compared to their male counterpart within the same major?

Goal 2: This study compares the level of self-efficacy that female students who are pursuing a STEM-related major view themselves as having when compared to their male counterparts. Parts of the referenced survey were created by Research Collaboration (Gaumer et al., 2016). The survey will consist of an even value system like mentioned above with values ranging from 1(strongly disagree) to 4 (strongly agree). There will be no neutral option within this survey. The Research Collaboration Group gave permission to the researcher to use the survey, as well to make changes to the questions, in order to be more applicable to the research questions (Gaumer et al., 2016). Alterations were made by the researcher in order to measure STEM and STEM self-efficacy directly. STEM itself is the field in which one works or studies, but STEM self-efficacy is one's belief system in their ability to enter in or complete STEM work. In Appendix A, a copy of the permission email and the original survey are listed. This modified survey will collect data that may determine if there is a difference between male and female students' self-efficacy in relation to STEM-related majors.

Hypothesis 2: When comparing females to males' self-efficacy scores by the data provided by the survey results, females will have a higher level of self-efficacy within their STEM-related classes when compared to their male counterparts.

Null Hypothesis 2: When comparing females to males' self-efficacy scores by the data provided by the survey results, females and males will have an equal level of self-efficacy within their STEM-related classes.

Alternative Hypothesis 2: When comparing females to males' self-efficacy scores by the data provided by the survey results, males will have a higher level of self-efficacy within their STEM-related classes when compared to their female counterparts.

Gender was the independent variable for this research question because gender does not depend on any other variable. The dependent variable that was measured is the level of self-efficacy scores by method of self-assessment.

Research Question 3

Research Question 3: What area of Bandura's self-efficacy scale (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction) is the highest scored in females who choose to major in STEM?

Goal 3: This study will analyze and compare the four areas of self-efficacy in order to find the highest area self-efficacy scores within female students pursuing a STEM-related major. Mastery experience is defined as "opportunities to learn and practice the rules and strategies necessary to perform a task effectively" (Rittmayer & Beier, 2008). Vicarious experiences are defined as "learning through observing others perform tasks" (Rittmayer & Beier, 2008). Verbal persuasion is defined as "others' judgments, feedback, and support" (Rittmayer & Beier, 2008). Physiological reactions are defined as "how one interprets his or her emotional and physical states to determine his or her self-efficacy beliefs" (Rittmayer & Beier, 2008). A T-test will be used to analyze and compare the four areas of self-efficacy within females question 3. This will be a repeated measures test. This will be a direct look at females within the STEM majors and their levels of self-efficacy and if there is an area that is more prominent within these participants. The T-test will then determine if there is an area of Bandura's four areas of self-efficacy (mastery experiences, vicarious experiences verbal persuasion, and physiological reaction) in which females score the highest.

Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction), there will be one area that gives the largest statistical difference on the self-efficacy scale for females within STEM-related majors.

Null Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction), no area will show a significant statistical difference.

Alternative Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction), data pertaining to there will be two or more areas that gives the largest statistical difference on the self-efficacy scale for females within STEM-related majors.

The independent variable for research question 3 was gender, and the dependent variable was the levels of self-efficacy (mastery experiences, vicarious experiences verbal persuasion, and physiological reaction).

Procedure and Data Collection

IRB approval was the first step to collecting required documentation for this research study. IRB approval was secured. An online survey was distributed digitally to the participants' email addresses. The chair advisors were contacted in order to obtain the participant's email address. The email to the chairs (see Appendix D) stated that they do not need to comply with this email, in order for the chairs to not feel obligated to comply. Every undergraduate student within a STEM-related major was contacted. In order to protect the confidentiality of the participants, no code system or email collection was used. All email addresses of participants was destroyed immediately after surveys are electronically distributed.

The direct procedure for this study is as follows:

Step 1: Reach out to the chairs of the STEM departments (biology, chemistry, computer science, engineering, nursing, physics, etc.).

Step 2: Get study consent form signed by the department chair.

Step 3: Retrieve email addresses of undergraduate students within the STEM-related majors (both male and female).

Step 4: Within each survey, an individual consent form will be attached (See Appendix A). Since the researcher will not be in direct contact with the participants, they will fill out the consent forms online through the survey entry page. If they do not agree to the terms of the survey, the survey will close and collect no information on the participant. If they choose to proceed, the participants may close the survey at any time and no data will be sent to the researcher.

Step 5: All data will be stored on the researcher's home research computer. The researcher purchased a computer for the collection of this data. The computer will be password-protected. This computer will be locked in the researcher's personal home safe where the researcher has the only combination for the safe.

Step 6: Once data is collected; the researcher will then analyze the data.

Step 7: The analyzed data was then was placed the dissertation in Chapter 4. The data itself is currently being kept on file within the locked computer for 3 years.

All information that resulting from completed surveys was on the researcher's personal computer that was purchased for exclusive use during this research study. This computer (laptop) is being kept in a secured lockbox within the researcher's home. No one has access to the computer due to the researcher being the only one with a key. Participant names and information were not collected. The only identifying information collected was what STEM major the participants are currently majoring in, GPA, and the participants' genders. The online survey was emailed to the participants during the 2019 spring semester (January 2019 – May 2019). The email addresses were obtained and were stored on the secure computer until the study was complete. The surveys emailed out to the participants. The first question of the survey was the consent form (see Appendix A). If they chose to accept, they did within the survey. If they do not, the survey shut down, collecting no data.

Data was collected and analyzed using statistical instruments in or SPSS. t-test comparisons distinguished between the female and male responses. The t-test indicated if there is a difference between the female and male groups within STEM as well as show a comparison between the four areas of self-efficacy. Because a t-test will be used to analyze the data, a p-value of .05 was used to validate the data being analyzed. Additionally, a Chi-square test was used to test whether the samples size within the study were statistically different. The Chi-square test determined whether male and females are different within the data. This helped determine whether the variable was explained by noise or an actual variable. Statistical noise is defined as, "the random irregularity we find in any real-life data" (Statistical noise: Simple definition, examples and significance, 2018). This test indicated if the variables and the participant selection were random.

Survey Limitations and Validity

Research participants were selected from one university in Western Pennsylvania. This may mean that there is a higher likelihood of sample bias and that the survey results may prove challenging to reproduce in a consistent manner. Additionally, the participants who chose to not participate in the survey will not be represented within the numerical data.

The surveys were only distributed to the domain of undergraduate students studying STEM-related majors, which limits the number of participants in the study. This may influence the interpretation of results. This may also likely detract from generalizability. There could also be other factors unknown to the researcher that may influence the participants to select certain answers in the survey. Background information like poverty level, socioeconomic background, and race are not currently being considered within this study, which can be considered a limitation. Within this study one constant measurement used was the Likert scale which assists with the reliability within the study.

Within the Likert scale, the neutral option was removed, in order to receive answers that are positive or negative, possibly having an effect on the internal validity of the study. Since the participants were asked to complete an online survey, there will be no collection of any of their personal information. They had the ability to leave the study while in the midst of completing the survey but not after in order to prevent participants from dropping out of the study. With multiple STEM majors that were surveyed, it was not only important to protect their identity and confidentiality, but the likelihood of participants dropping out was high with more than one group.

The GPAs of all participants who agree to complete the study were collected in order to represent all types of students such as low achievers or high achievers. Grades in particular STEM classes or grades in STEM classes when they were in high school was not be considered for this study. If the participants did not know their GPA, they could type into the written response, “I do not know.” In order to prevent the Hawthorne Effect, the drafting of questions was done with particular care in order to remove as much leading bias as possible.

Checking for reliability within this study assisted in achieving robust results. If the test produces a small p-value (usually less than .05 or 5 percent), it suggests the results are not due to chance. With producing a p-value of .05 the results should be able to be replicated by different researchers in different experiments, including later post-doctorate work.

Chapter 4 Results

Survey Results

An online survey through Survey Monkey was administered to 69 female and male STEM university students ranging from freshmen to seniors. The survey was given during the spring term of the 2019 college semester. The survey asked participants to answer questions about their academic background, major, and self-efficacy within Bandura's four areas.

A total of 69 participants completed responses to the survey. All 69 participants completed the survey in its entirety to give a 100% completion rate. There were four open responses in the survey. Those questions consisted of entering their GPA, college major, technology classes that were not listed, and science classes that were not listed. The demographic questions pertaining to high school STEM classes and year of study were located at the beginning of the survey and were answered by all participants. The analysis is with the responses of the overall sample population. All 69 of participants responses were complete and included within the analysis. The analyses of the survey results are organized through each of the three research questions. The data in Table 1, shows the breakdown of gender and grade level of the participants.

2019 Spring Gender and Percent of Survey Participants.

Gender	Freshmen	Freshmen Percent	Sophomore	Sophomore Percents	Juniors	Junior Percents	Senior	Senior Percent
Female	12	17%	10	14%	16	23%	14	20%
Male	3	6%	7	10%	2	3%	5	7%

Table 1.

Research Question 1: Analysis of Data

Research question 1: What courses did males and females take in high school that had an effect on their selection of a STEM-related major?

a. What level of STEM courses did female students who major in STEM take in high school compared to their male counterparts?

An independent t-test was run on a sample of 69 university STEM students to determine whether there was a statistically significant difference between the STEM classes they took in high school compared to their gender. The independent variable is gender and the dependent variable is the number of STEM-related classes taken during high school. The Research Collaboration Group of Kansas University gave permission to use and modify their survey to fit the needs of this study (Appendix C) (Gaumer et al., 2016). The Duquesne IRB granted permission to analyze students' high school classes and compare efficacy in STEM subject areas. This section begins by looking at the gender differences between males and females within their high school classes. Tables 2, A3, and B3 below summarize analysis of the multiple STEM classes that were offered in a high school setting and compared to classes that each gender took in high school.

Descriptive statistics were used to analyze these results. A Chi-square test was used to analyze high school STEM classes in order to compare males and females' classes within high school. A chi- square test was used because its analysis explored how well the observed distribution of data fits with the distribution that is expected if the variables are independent. With a chi-square test the study observed the experimental group and the expected value. The test was used to see if the sample was drawn from a normal population. The data in Table 2 displays the p-values indicating that no significant difference exists when comparing STEM classes that females and males have taken in a high school setting. In the chi-square test in Table 2, 29 of the cells have an expected count less than 5 equaling 85%. The assumption has been violated. The statistics in the Likelihood Ration shows a value of 10.506 with a *df*=11 and the level of significance with a value of .486. The level of significance is much higher than .05 which allows the acceptance of the Null Hypothesis 1, being that there is no significant difference between gender and STEM high school classes.

Birth Gender Compared to STEM Classes Taken in High School

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.693[a]	11	.558
Likelihood Ratio	10.506	11	.486
Linear-by-Linear Association	.036	1	.850
N of Valid Cases	69		

29 cells (85.3%) have expected count less than 5.
The minimum expected count is .25.[a]

Table 2.

An independent t-test was also completed on the high school classes and gender to support the chi-square test. The female group (*n*=52) was associated with the high school STEM classes which is associated to the listed mean within Table 3 by the 31 STEM high school classes. By comparison, the male group (*n*=17) is associated with the listed mean within Table A3 and B3 by the 31 STEM high school classes. To test the hypothesis that when comparing females to males' high school coursework, females will have taken a larger quantity of STEM classes than their male counterparts, an independent t-test was performed.

Gender Descriptive Statistics for High School STEM Class Selection

Group Statistics

	What is your birth gender?	N	Mean	Std. Deviation	Std. Error Mean
Application Development: Desktop	Female	52	.0962	.29768	.04128
	Male	17	.1765	.39295	.09531
Computer Programming: Python	Female	52	.0000	.00000	.00000
	Male	17	.0588	.24254	.05882
Web Design: HTML	Female	52	.0192	.13868	.01923
	Male	17	.0588	.24254	.05882
Design Thinking	Female	52	.0192	.13868	.01923
	Male	17	.0000	.00000	.00000
Robotics	Female	52	.0000	.00000	.00000
	Male	17	.1176	.33211	.08055
Principles of Technology	Female	52	.0385	.19418	.02693
	Male	17	.0588	.24254	.05882
CAD: Computer Aided Design	Female	52	.0962	.29768	.04128
	Male	17	.0588	.24254	.05882
Civil Engineering and Design	Female	52	.0192	.13868	.01923
	Male	17	.0000	.00000	.00000
Computer Science I	Female	52	.1346	.34464	.04779
	Male	17	.1765	.39295	.09531
Computer Science II	Female	52	.0385	.19418	.02693
	Male	17	.1176	.33211	.08055
Computer Science A	Female	52	.0000	.00000	.00000
	Male	17	.0588	.24254	.05882
Computer Science Principles	Female	52	.0769	.26907	.03731
	Male	17	.0588	.24254	.05882
Other	Female	52	.2115	.41238	.05719
	Male	17	.4118	.50730	.12304
Life Science	Female	52	.3654	.48624	.06743
	Male	17	.3529	.49259	.11947
Geology	Female	52	.0577	.23544	.03265
	Male	17	.0588	.24254	.05882
Introduction to Science	Female	52	.1538	.36432	.05052
	Male	17	.1176	.33211	.08055
Biology I	Female	52	.9423	.23544	.03265
	Male	17	.8235	.39295	.09531
Biology II	Female	52	.2692	.44789	.06211

Table A3.

Gender Descriptive Statistics for High School STEM Class Selection Continued

Biology II	Female	52	.2692	.44789	.06211
	Male	17	.1765	.39295	.09531
AP Biology	Female	52	.4231	.49887	.06918
	Male	17	.4706	.51450	.12478
Environmental Science	Female	52	.1154	.32260	.04474
	Male	17	.2353	.43724	.10605
Chemistry I	Female	52	.8846	.32260	.04474
	Male	17	.8235	.39295	.09531
Chemistry II	Female	52	.2308	.42544	.05900
	Male	17	.1765	.39295	.09531
AP Chemistry	Female	52	.3654	.48624	.06743
	Male	17	.4118	.50730	.12304
Physics I	Female	52	.6346	.48624	.06743
	Male	17	.7059	.46967	.11391
Physics II	Female	52	.2308	.42544	.05900
	Male	17	.1176	.33211	.08055
AP Physics	Female	52	.1346	.34464	.04779
	Male	17	.2353	.43724	.10605
AP Physics - Mechanics	Female	52	.0385	.19418	.02693
	Male	17	.0000	.00000	.00000
AP Physics - Electromagnetism	Female	52	.0385	.19418	.02693
	Male	17	.0000	.00000	.00000
Astronomy	Female	52	.0577	.23544	.03265
	Male	17	.0588	.24254	.05882
Anatomy & Physiology	Female	52	.2885	.45747	.06344
	Male	17	.1765	.39295	.09531
Other: Science/Math	Female	52	.1538	.36432	.05052
	Male	17	.0588	.24254	.05882

Table B3.

Table A3 and B3 show the lower and upper confidence level of the difference. Analyzing the confidence level of the differences, all of the upper and lower values for both males and females cross over zero. This shows no significant differences within male and female high school class course-load in STEM. Throughout the data in Table 4, all classes show that there is no significant difference between gender. Figure 6 illustrates the comparison between males and females within their STEM high school classes. It shows how closely related males and females are when they were selecting STEM classes in high school. A common class for both males and females to call attention to is the significance that both a large quantity of males and females took Biology I. The quantitative methods summarize the overall results, review the meaning of the data, identify the study's limitations, and provide suggestions for future research.

Hypothesis 1: When comparing females to males' high school coursework, females will have taken a larger quantity of STEM classes than their male counterparts.

Rejected: Hypothesis 1 has been rejected due to no significant difference between males and females taking high school STEM classes. There is no significant difference in the number of STEM classes taken within each of the two genders.

Null Hypothesis 1: When comparing females' to males' high school coursework, there will be no difference between the amount of and quality of STEM-related coursework; for example, higher level math and science classes as well as early or advanced technology classes will exhibit no differences.

Failed to reject: The data collected failed to reject Null Hypothesis 1 due to no significant difference between males' and females' high school STEM classes.

Alternative Hypothesis 1: When comparing females to males' high school coursework, the male students will have taken a larger quantity of STEM classes and achieved a higher quality of classwork compared to their female counterparts.

Rejected: Alternative Hypothesis 1 has been rejected due to no significant difference between males and females high school STEM classes. There is no statistical difference between high school leveled STEM classes and gender.

Summary of Findings for Hypothesis 1

Hypotheses 1 and the alternative hypothesis 1 have been shown to be statistically insignificant. Thus, hypotheses 1 and the alternative hypothesis 1 are both rejected. Failing to reject null hypothesis 1 means the data could not detect differences between male and female and high school STEM classes.

Independent t-test for gender and STEM High School Classes

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Application Development: Desktop	Equal variances assumed	2.942	.091	-.890	67	.377	-.08032	.09024	-.26043	.09980
	Equal variances not assumed			-.773	22.320	.447	-.08032	.10386	-.29553	.13490
Computer Programming: Python	Equal variances assumed	14.362	.000	-1.776	67	.080	-.05882	.03311	-.12492	.00727
	Equal variances not assumed			-1.000	16.000	.332	-.05882	.05882	-.18352	.06588
Web Design: HTML	Equal variances assumed	2.790	.099	-.837	67	.406	-.03959	.04732	-.13404	.05486
	Equal variances not assumed			-.640	19.533	.530	-.03959	.06189	-.16889	.08970
Design Thinking	Equal variances assumed	1.347	.250	.569	67	.571	.01923	.03380	-.04824	.08670
	Equal variances not assumed			1.000	51.000	.322	.01923	.01923	-.01938	.05784
Robotics	Equal variances assumed	35.853	.000	-2.595	67	.012	-.11765	.04534	-.20815	-.02714
	Equal variances not assumed			-1.461	16.000	.163	-.11765	.08055	-.28840	.05311
Principles of Technology	Equal variances assumed	.489	.487	-.352	67	.726	-.02036	.05777	-.13566	.09494
	Equal variances not assumed			-.315	23.091	.756	-.02036	.06469	-.15416	.11344
CAD: Computer Aided Design	Equal variances assumed	.928	.339	.468	67	.641	.03733	.07976	-.12187	.19653
	Equal variances not assumed			.519	33.120	.607	.03733	.07186	-.10886	.18352
Civil Engineering	Equal variances assumed	1.347	.250	.569	67	.571	.01923	.03380	-.04824	.08670

Table 4.

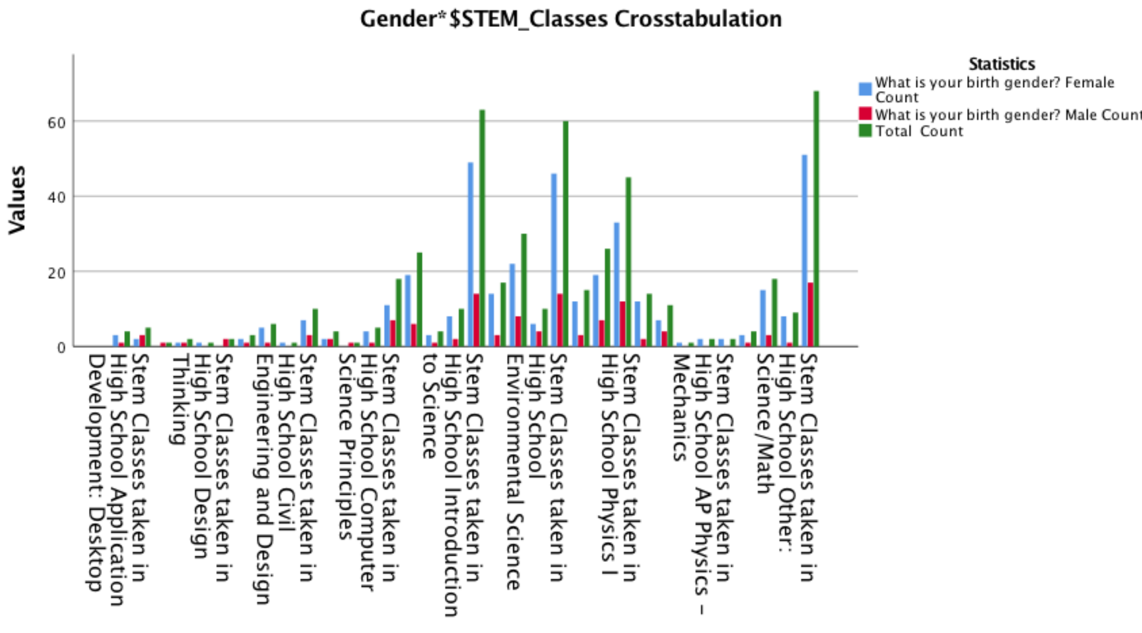

Figure 6. Comparing gender to STEM high school classes

Research Question 2: Analysis of Data

Research Question 2: What level of self-efficacy do undergraduate females within STEM have compared to their male counterparts within the same major?

A quantitative method was used to answer the second research question. A descriptive statistic test was conducted in order to determine if an independent t-test could explain the findings. The group descriptive statistic was broken down into the four areas of self-efficacy. Each area was coded with the initials of Bandura's four areas (i.e. ME=mastery experience, VE= vicarious experiences, VP= verbal persuasion, PR= physiological reaction). A one-way ANOVA test was also conducted to examine the F value in order to examine any statistical differences and assumptions for research question 2.

ANOVA Test for Self-Efficacy and Gender

			ANOVA			
		Sum of Squares	df	Mean Square	F	Sig.
Mean of ME	Between Groups	2.389	1	2.389	13.399	0
	Within Groups	11.947	67	0.178		
	Total	14.336	68			
Mean of Vicarious Experience	Between Groups	0.608	1	0.608	3.176	0.079
	Within Groups	12.828	67	0.191		
	Total	13.437	68			
Mean of VP	Between Groups	0.139	1	0.139	0.733	0.395
	Within Groups	12.731	67	0.19		
	Total	12.871	68			
Mean of PR	Between Groups	0.268	1	0.268	1.088	0.301
	Within Groups	16.487	67	0.246		
	Total	16.755	68			

Table 5.

The analysis consisted of *n*=52 females in each category and *n*=17 males in each of the four categories. In Table 5, each of Bandura's areas of self-efficacy is given a mean based on the answers in the scoring survey. A Likert Scale was used to survey the 69 participants. Scoring was as follows: 1=Strongly disagree, 2=Disagree, 3=Agree, 4=Strongly agree. The means varied between males and females within each category showing differences within their personal self-efficacy levels. For mastery experience, *n*=52 females with a *M*=3.0740 (*Sd*=0.44319) compared to *n*=17 males with a $\bar{x}$=3.5059 (*Sd*=0.34726). This shows that the average master experience self-efficacy questions males have a higher average in that category. Table 5 shows that there is a significant difference in means for mastery experience with a value less than .001 considering that α=.05 shows significance and a p value lower shows a high significance for this area of self-efficacy. There is a statistical difference between males and females within mastery experience.

With a *m*=3.0740 for females and *m*= 3.5059. Using the same *n*=52 females and *n*=17 males through the following three categories, there is one area of note. Vicarious experience shows female's self-efficacy $\bar{x}$=3.0885 (*Sd*=0.42364) whereas the male self-efficacy $\bar{x}$=2.8707 (*Sd*=0.47928). This shows a higher mean for females within that area of self-efficacy. The p value for vicarious experience shows little significance at a α= 0.0.79.

The last two areas (verbal persuasion and physiological of self-efficacy show males with a higher mean in both areas. The last two areas of Bandura's self-efficacy show no significant difference due to the p value being significantly larger than 0.05. Table 5 shows verbal persuasion having a α=0.395 a physiological reaction at a α=.301

Descriptive Statistics for Self-Efficacy Comparing Males and Females

Group Statistics

	What is your birth gender?	N	Mean	Std. Deviation	Std. Error Mean
Mean of ME	Female	52	3.0740	.44319	.06146
	Male	17	3.5059	.34726	.08422
Mean of VE	Female	52	3.0885	.42364	.05875
	Male	17	2.8706	.47928	.11624
Mean of VP	Female	52	3.3192	.43971	.06098
	Male	17	3.4235	.42357	.10273
Mean of PR	Female	52	3.1731	.49946	.06926
	Male	17	3.3176	.48507	.11765

Table 6.

Further analysis was conducted using an independent t-test, which was run on a sample of 69 university STEM students to determine whether there was a statistically significant mean difference between male and female self-efficacy. This shows that mastery experience and vicarious experience has a significant difference ($p < 0.05$), whereas in verbal persuasion and physiological reaction are not significant.

Independent Sample T-test Comparing Female to Male Self-Efficacy Areas

		Levene's Test for Equality of Variances		t-test for Equality of Means		t-test for Equality of Means			t-test for Equality of Means	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Mean of ME	Equal variances assumed	0.698	0.406	-3.66	67	0	-0.43184	0.11797	-0.66732	-0.19637
	Equal variances not assumed			-4.142	34.508	0	-0.43184	0.10426	-0.64362	-0.22007
Mean of VE	Equal variances assumed	0.3	0.586	1.782	67	0.079	0.21787	0.12225	-0.02614	0.46188
	Equal variances not assumed			1.673	24.712	0.107	0.21787	0.13024	-0.05053	0.48627
Mean of VP	Equal variances assumed	0	0.986	-0.856	67	0.395	-0.1043	0.12179	-0.34739	0.13879
	Equal variances not assumed			-0.873	28.163	0.39	-0.1043	0.11946	-0.34895	0.14035
Mean of PR	Equal variances assumed	0.139	0.71	-1.043	67	0.301	-0.14457	0.13859	-0.4212	0.13206
	Equal variances not assumed			-1.059	27.96	0.299	-0.14457	0.13652	-0.42424	0.1351

Table. 7

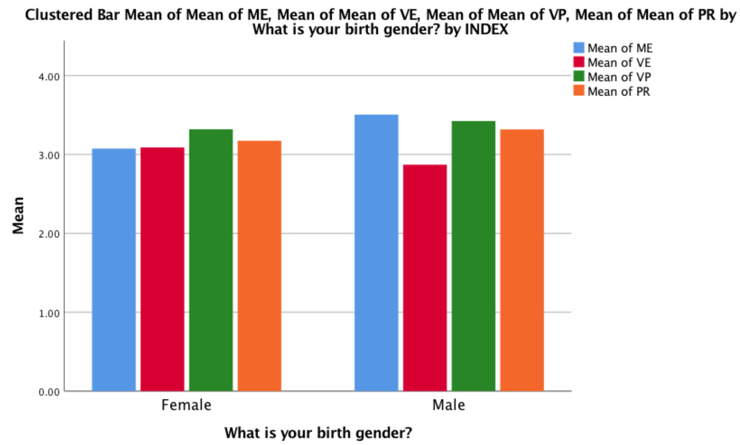

Figure 7. Birth Gender Compared to Self-Efficacy

Figure 7 displays the visual difference being compared within self-efficacy. Males self-efficacy scores are higher in all areas expect for Vicarious Experience. Vicarious Experience is defined as how people view the world around them and how their perceptions impact them (Bandura, 1997). This is the concept of viewing/observing people like you, within an area that interest one's abilities. Role models and people of influence can have a large effect on this category.

Hypothesis 2: When comparing females' to males' self-efficacy scores from the data provided by the survey results, females will have a higher level of self-efficacy within their STEM-related classes when compared to their male counterparts.

Rejected: Hypothesis 2 has been rejected because males' self-efficacy within STEM is shown to be higher than females in STEM classes. Hypothesis 2 stated that females would have the higher self-efficacy within STEM majors.

Null Hypothesis 2: When comparing females to males' self-efficacy scores by the data provided by the survey results, females and males will have an equal level of self-efficacy within their STEM-related classes.

Rejected: Null Hypothesis 2 has been rejected because males' self-efficacy within STEM is shown to be higher than females in STEM classes; whereas the null hypothesis stated that there would be no difference found.

Alternative Hypothesis 2: When comparing females' to males' self-efficacy scores by the data provided by the survey results, males will have a higher level of self-efficacy within their STEM-related classes when compared to their female counterparts.

Accepted: Alternative Hypothesis 2 has been accepted because males' self-efficacy within STEM is shown to be higher than females' self-efficacy in STEM classes.

Summary of Hypothesis 2

Hypothesis 2 and the null hypothesis 2 were rejected due to the fact that the males within STEM majors have a higher self-efficacy when averaging all of the areas of self-efficacy. Hypothesis 2 and the null hypothesis 2 have been rejected due to the data analysis showing that males have higher self-efficacy than females within STEM classes. As seen in Figure 8, females $\bar{x}$=3.16 compared to males $\bar{x}$=3.28. This suggests that the alternative hypothesis 2 was correct due to the fact that males within the self-efficacy survey had a higher score of self-efficacies compared to their female counterparts.

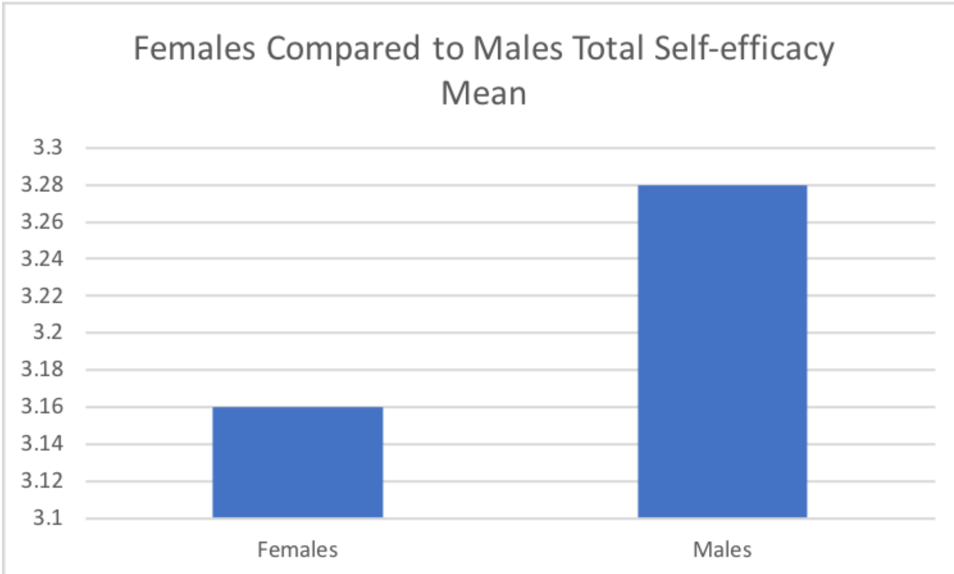

Figure 8. Females Compared to Males Total Self-Efficacy Means

Research Question 3: Analysis of Data

Research Question 3: What area of Bandura's self-efficacy scale (mastery experience, vicarious experiences, verbal persuasion, or physiological reaction) is the highest scored in females who chose to major in STEM?

A quantitative method was used to answer the third research question, and the analysis was conducted using descriptive statistics on the female university STEM students' sample of participants *n*=52 (mastery experience *Sd*=0.44.319, vicarious experience *Sd*= 0.42364, verbal persuasion *Sd*=0.43971, and physiological reaction *Sd*=0.49946) to determine whether there was a statistically significant difference between the self-efficacy within the same gender. Females were the single sample that was surveyed about their self-efficacy within the four areas. The Research Collaboration Group of Kansas University gave permission for the researcher to use and modify their survey to fit the needs of the study (Appendix C) (Gaumer et al., 2016). The Duquesne

IRB granted permission to measure students' high school classes and compare efficacy in STEM subject areas.

This section will be discussing the results of the survey conducted during the Spring 2019 semester. Each of Bandura's areas of Self-Efficacy is given means based on the answers in the scoring survey. A Likert Scale was used to survey the 52 participants. Scoring was as follows: 1=Strongly disagree, 2=Disagree, 3=Agree, 4=Strongly agree to questions that were crafted within Bandura's four areas of self-efficacy. The dependent variable being analyzed is Bandura's four areas of self-efficacy compared to the independent variable of gender. A single sample T-test was conducted to compare the four areas of self-efficacy within females. The t-test was used for the purpose of testing hypothesis 3.

One Sample T-Test Comparing the Bandura's four Areas of Self-Efficacy Between Females

	N	Mean	Std. Deviation	Std. Error Mean
Mean_of_Mastery_Experience	52	3.074	0.44319	0.06146
Mean_Vicarious_Experience	52	3.0885	0.42364	0.05875
Mean_Verbal_Persuasion	52	3.3192	0.43971	0.06098
Mean_Physiological_Reaction	52	3.1731	0.49946	0.06926

Table 8

Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction), there will be one area that gives the largest statistical difference on the self-efficacy scale for females within STEM-related majors.

Accepted: Hypothesis 3 has been accepted; there is a statistically difference demonstrating that one area of self-efficacy (verbal persuasion) to be significantly higher than the three others.

Null Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences, verbal persuasion, and physiological reaction), no area will show a significant statistical difference.

Rejected: Null Hypothesis 3 has been rejected due to there being a statistical difference between the four areas of self-efficacy; the null hypothesis stated that there would be no difference found.

Alternative Hypothesis 3: When comparing the four areas of self-efficacy (mastery experiences, vicarious experiences verbal persuasion, and physiological reaction), data pertaining to that will show two or more areas that gives the largest statistical difference on the self-efficacy scale for females within STEM-related majors.

Rejected: Alternative Hypothesis 2 has been rejected because only one area showed the largest difference between the four areas of self-efficacy; the null hypothesis stated that there would be no difference found.

Summary of Hypothesis 3

Hypothesis 3 was supported because there is a significant difference between the levels of self-efficacy as well as one particular area that is more highly scored than the other three areas. Figure 9 shows that verbal persuasion is the significantly highest among the four areas of self-efficacy. Verbal persuasion has one of the largest impacts on learners because it provides student and learners with feedback from authority figures that are influential in their lives (SWE-AWE-CASEE ARP Resources, 2008). As stated before, parents and teachers can be a large factor in student learning.

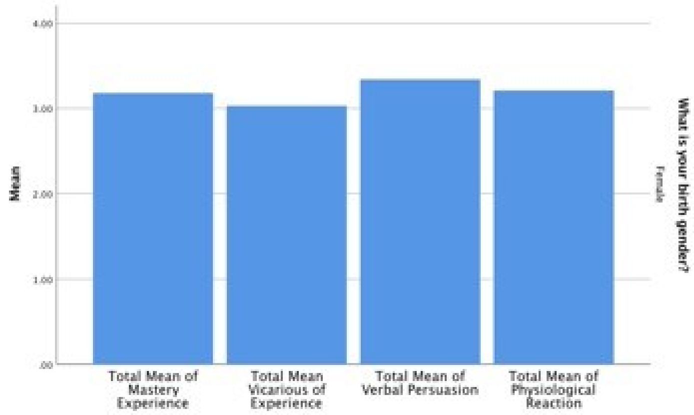

Figure 9. Four Area of Female Self-Efficacy Compared

Research Questions Overview Summary

Review of findings

Research Questions	Method	Findings
RQ 1: What STEM courses did males and females take in high school that had an effect on their selection of a STEM-related major?	Quantitative Methodology	Failed to reject null hypothesis 1 showing that there is a no difference between male and female and high school STEM classes.
RQ 2: What level of self-efficacy do undergraduate females within STEM have compared to their male counterparts within the same major?	Quantitative Methodology	Alternative hypothesis was accepted showing higher male self-efficacy.
RQ 3: What area of Bandura's self-efficacy scale (mastery experience, vicarious experiences, verbal persuasion, or	Quantitative Methodology	Hypothesis 3 was accepted because there is a difference between the levels of self-efficacy one particular area that is more

physiological reaction) is the highest scored in females who choose majors in STEM?		highly scored than the other 4 areas.

Table 9.

Reliability and Limitations

Reliability

Reliability analysis was conducted on the survey data. In Table 8, the Cronbach reliability is outlined that *n*=69 with all case being included due to all participants completing the survey in its entirety. Table 9 shows the Cronbach reliability value. The reliability value was above a 0.7. In Table 9 the Cronbach reliability value is scored at a 0.813. This demonstrates a strong reliability within the survey and the participants' answers.

Cronbach Reliability

Reliability Statistics	
Cronbach's Alpha	N of Items
0.813	21

Table. 10

Limitations

A total of 69 participants participated in the study (*n*=52 females, *n*=17 males. The number of participants is a limitation. While there is an unequal representation of males to females, the total means of the groups were compared to each other. The total mean showed a close relationship between the genders. Both males and females were equally invited to participate in the survey.

College Factual (2019) points out that Duquesne University gender proportions are 62.8% female and 37.2% male. Due to the majority of students being female, more females responded to the study survey. Respondents were from one university in Pennsylvania. While there is a clear comparison between males and females within this study, males are underrepresented and having a more equal sample size could have an effect on the findings.

Another limitation to be considered with this study is the sample size using convenience sampling, all of the participants came from one university. Due to the size of the university, the study of only STEM majors, and the time frame for this study, the sample size was smaller than other studies that may have been completed on this topic. With the sample being so much smaller, the data might not represent the self-efficacy beliefs of males and females in STEM majors as precisely as a large sample size may have produced.

Only STEM students were surveyed within this study. This can be considered a limitation due to not having data from the non-STEM groups in order to compare self-efficacy and high school class level. Results from other majors besides STEM could add to the reliability of the study. It could be used to expand and compare non-STEM students' self-efficacy with STEM students' self-efficacy and would expand the sample size as well as add more data to review and compare.

Chapter 5 Conclusion

In this chapter, the results of the research discussed in chapter 4 are explained in the context of the study and the literature within the field. The chapter consists of a brief summary of the purpose and goal, a discussion of results from chapter 4, implications, and recommendations for future research.

Purpose and Goal

The purpose of this research study was to identify the characteristics and factors that promote and influence males and females in STEM. A quantitative research study was conducted with a STEM created survey. Results were analyzed using SPSS. The first purpose of this study was to investigate what STEM classes female students took during their high school experience, and how that compared to their male counterparts within STEM-related majors. The second purpose was to investigate the level of STEM female self-efficacy levels compared to their male counterparts within STEM-related majors. The final purpose was to investigate Bandura's four areas of self-efficacy to find the highest area of self-efficacy in STEM females.

The first goal of this study was to explore high school class influences on males and females who are currently majoring in STEM, and the self-efficacy levels in students who are in STEM majors. The second goal was to take a deeper look at females' self-efficacy in STEM majors as well as comparing female self-efficacy to males to build a foundation as to why more males major in STEM than females. The last goal was to compare female participants' self-efficacy in order to find out if an area standout statistically higher than the rest.

Summary of the Study

While the noted underrepresentation of women in STEM studies and careers continues to be an important topic in the United States. As read in chapter 2 there is a large quantity of research being developed in this field. This study takes a deeper look at self-efficacy and how it connects to one's major, especially STEM.

A survey was completed by 69 undergraduate STEM majoring students. The survey took 8-15 minutes to complete. The survey questioned them about academic classes they took in high school. The participants were able to enter a class if it was not represented in the survey options. The second part of the survey asked the participants about their STEM self-efficacy. A four-point Likert Scale was used. There was no neutral option for selection forcing participants to answer each question. All 69 of the participants completed the survey in its entirety.

This study was conducted at a university that had a large population of females in attendance. All the participants in the study are enrolled in a major that will lead them to a STEM career spanning from STEM education, nursing/medical to biology, biochemistry, etc. This study shows that there is no difference between academic STEM classes and gender. This study showed that males have higher self-efficacy than females. Lastly, the study's findings confirm that there is one area of self-efficacy in females that stands higher among the four. The total male and female respondents to this survey was a total 69 participants. They had a variation of GPA's as well as academic year at the university.

Theoretical Findings and Connection to Current Study

This study parallels with contemporary studies of the past ten years. Jordan and Carden (2017) pointed out in their research that females seem to have less confidence than males when it comes to their academic abilities. The study was conducted at a small, private university. The study had 69 participants complete the study from general and upper division science courses who were currently in a STEM-related major. The majors consisted of biology, physics, or chemistry. They were investigating to see if females had lower academic self-efficacy skills than their male counterparts. Through their quantitative study, they found there was no difference between males' and females' academic self-efficacy. They also found that self-efficacy and femininity are not correlated. (Jordon & Carden, 2017)

The study mentioned above is similar to this study due to the academic findings. Research question 1 for this current study looked into high school academic classes. It was hypothesized that females would have taken a higher number of high school academic STEM classes. The findings showed that there was no difference between gender and academic classes. There was no statistical difference found, this study failed to reject the 1st null hypothesis. Comparing both males' and females' STEM classes showed that females take a similar number of classes to their male counterparts. Biology I was the most consistent class taken among both males and females. Within the survey conducted, there were six classes in which no student recorded taking was: Application Development: Mobile, 3D Printing, Introduction to Engineering, Computer Integrated and Manufacturing, Computer Hardware, and Environmental Chemistry. Only one male student recorded taking Computer Programming: Python and only two males recorded taking Web Design. Biology II was recorded by fourteen females and three males.

Morton and Beverly (2017) completed a study with an intervention engineering program. They wished to compare males' and females' self-efficacy skills after the summer program intervention. Their result showed that after the summer program females' confidence showed an increase, but by the end of the first academic year females' confidence had decreased. The females' scores remained close to the scores they had before they took the summer program. The first finding showed that both male and females' major confidence in the field of engineering increases after participation in the pre-college summer transition program, but by the end of both males and females' first academic year, their engineering major confidence resembled the reported levels that the participants had at the beginning of the study. In this study the researchers compared male and female engineering major confidence before and at end of their first year of college. They found that there was not a statistical difference between males' and females' engineering confidence. While their findings showed that females had a lower confidence level after the summer program than their male counterparts, the difference that they found between the genders was on average "negligible". (Morton & Beverly, 2017)

While this study did not conduct an intervention program, the findings showed there was a difference between males and females. For research question two, this study showed that there was a small difference between female and male self-efficacy. The males had a larger self-efficacy mean than their female counterparts showing three of the four categories had a higher level of self-efficacy. These findings showed that alternative hypothesis 2 was accepted due to it stating females would have higher self-efficacy levels.

The Hoogerheide, Wermeskerk, Nassau, & Gog (2018) study consisted of researching models. They had participants watch videos with different gender models. They found the participants recognized the same-gender models as more similar to them compared to opposite-gender models. The researchers document that the participants found “tasks as more appropriate for males than females”. In their finding, the research team found male participants performed somewhat better than females. Male participants also demonstrated higher confidence gains. They found that the gender model did not affect the participant achievement. Additionally, they found that “there is no need to take the model's gender into account when designing video modeling examples”. (Hoogerheide et al., 2018)

Research question 3 compared Bandura’s four area of self-efficacy among females. Verbal persuasion was the one area of self-efficacy that had the highest levels for the females in this study. Much like Hoogerheide et al. (2018) findings, having models seems to increase self-confidence and personal belief. Whether it is the same gender or not, the findings in this study show there is an area that might have an impact on females in STEM. Hypothesis 3 was accepted due to there being one area of self-efficacy measuring a higher level than the other.

Discussion and Future Research

The results from this study vary based on the research question and that more females participated in the study. Males and females showed that there was no difference in the STEM classes that were taken in high school. These findings can lead to the possibilities for future research. Researching high school students, comparing major choices, and STEM classes they are currently taking in a high school setting could create a deeper look into what motivates females and males to major in STEM. The comparison of high school male and female STEM classes could guide future research.

The hypothesis 1 was not accepted because the data presented that when males and females move into STEM majors in college, they have statistically similar high school STEM classes. Null hypothesis 1 was accepted due to there not being a statistical difference between the two genders and STEM classes. One possibility for the results could be connected to the age that boys and girls start considering college majors in high school. Another possibility to explore is how middle school students (4^{th}-8^{th} grade) personal confidence levels in STEM affect their outlook at possibly working the STEM field when they are adults.

Self-efficacy was compared between male and female STEM students. The statistical data presented males having a statistical mean of self-efficacy higher than their female counterparts. While more females than males completed the survey, it showed a clear difference between the two genders in Bandura's four areas of self-efficacy. Females did show a slightly higher mean in the area of vicarious experience. Vicarious experience is the viewing of other people in a role in which you could or want to see yourself in. Assumptions could be made that both males and females working with a role model or having one can help guide them in a career choice or field.

While the male population of this study showed a m=3.26 and females showed a m=3.16, hypothesis 2 was rejected and the alternative hypothesis was accepted. One possibility could have attributed to the uneven number of gender participants. With more responses recorded from the females gives more room for the mean to be adjusted. Future research conducted could explore more universities across the United States or compare a private STEM university to a public STEM university to see the different self-efficacy levels among a larger population, building a larger sample size.

Self-efficacy was compared among females in STEM to analyze the last research question. Hypothesis 3 was accepted due to verbal persuasion scoring statistically higher than the other three areas. This occurs when people within the participants life supports them verbally and that support assist in building a personal belief system with the person. Comparing *n*=52 females, statistically the population was even represented for this research question.

Future research conducted could expand the research comparing STEM females to non-STEM females within the same single population. Looking at levels of non-STEM female undergraduate students could create insight to which of the four areas could be increased in females. This could lead to a study that could start with high school students and their transition into college. Adding an intervention to the weakest areas of self-efficacy. Expanding the research further, a study at multiple universities could show more of a difference in one or all four areas of self-efficacy.

Future research should compare female STEM majors at more than one university, where there may be a larger female and male STEM student population to draw from. Research focus should be extended to more deeply examine differences in the self-efficacy of minority groups compared to the Caucasian population. Ethnicities were not identified in the current study. Examining GPA's of male and female STEM students could help explain any gap in self-efficacy of STEM belief.

Within future research, studying the male perspective on gender in STEM may be an interesting contrast. Males can be affected by the expectations of STEM and being a part of a male dominated major. Comparing male undergraduates of all majors and their self-efficacy would be helpful insight to why more males do or do not go into alternative career paths outside of STEM. Exploring the male perspective on gender bias in both the high school or college setting would be valuable insight on the STEM-based community.

Other research studies could be built off of the foundation of this study. Completing a mixed (qualitative and quantitative) study could investigate deeper into STEM self-efficacy. Adding an interview to the study could give a deeper understanding to why the participants feel the way that they do within their self-assessment survey. It could help to bring clarity to why there is a difference between males and females in the field of STEM. Understanding the why can assist research dig deeper in the reasoning behind what drives both men and women into STEM.

Adding an interview aspect to this study can assist researcher(s) get clarity on the weakest areas of STEM self-efficacy with both males and females. That could bring to additional information that could be applied to other studies; for example, as an intervention with younger students in a middle and/or high school setting. Exploring all ages and genders within STEM can add clarity to the deep divide that still being explored and debated today.

Conclusion

In conclusion, the area of gender and STEM is still a concept that has researchers guessing. Assumptions can be made concerning why there are less females in the STEM field, but more research is needed in order make a substantial conclusion. Parental guidance, teacher support, and the possibility of a mentor can have an influence on female self-efficacy in STEM based on the areas of statistical value in the study conducted.

There was a large population of female participants in this study and the females did outnumber the male participants by 75%. Even though females did outnumber the males, there were interesting responses to some of the questions when analyzing just one gender at a time. For example, for the survey statement: I feel that men and women have an equal opportunity with the STEM fields and majors. Only 45% of the females in STEM majors agreed or strongly agreed. While the survey statement: I have had a role model of the same gender that influenced my decision to pursue a STEM-related major received an equal 45% of female participants responding in a positive agree or strongly agree. Whereas 94% of the female participants felt that their professors treated their students equally no matter the gender. For the survey statement: I believe that men and women are equal when working with technology, 75% of the females surveyed recorded an agree to strongly agree.

Comparing the male answers to these questions can give a small insight to how males view the “gender gap” in STEM-majors and careers. For example, for the survey statement: I feel that men and women have an equal opportunity with the STEM fields and majors, 94% of the male participants answered agree to strongly agree to this statement compared to their female counterparts at 45%. A finding to note is that when the two genders were compared in this study only 88% of males answered agree to strongly agree that their professors treated students equally no matter the gender. When surveyed about men and women being equal when working with technology, 94% of males answered agree to strongly agree. While the females' responses were high at 75%, the males who participated expressed a lot of confidence in females and their own self-efficacy with this survey response.

A very positive outcome of this survey was to see how positive women in STEM view themselves within the major. While more research is needed in this field, exploring gender, STEM, and self-efficacy could be the first step. The equality of answers between the males and females is encouraging to continue with research in the area. Building a connection with self-efficacy and its effect on all STEM majors could possibly be a guide to new findings. Working with the genders equally could show new data to the possibility of a gender (if any) divide in STEM.

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Glossary

Emotional growth: Defined as the emotional development that is developed by a child's experience, expression, and management of their emotions and their ability to establish positive and rewarding relationships with others (Cohen, Onunaku, Clothier, and Poppe 2005).

Gender: Defined as the socially constructed conclusion to the biological determination of and physical expression of sex. The formation of gender concepts and gender behaviors are framed by an expansive network of social influences. These influences include, but are not limited to, family, friends, people in everyday life, and the media. Within these influences, there are notations of underlying biological constraints and deterrents. (Butler, 1988)

Gender Role: Defined as the behavior that is learned by a person as applicable to their gender, determined by the predominant cultural norms set for that gender (Oxford Dictionary, 2018).

Gender Stereotype: Defined as how men and women are perceived differently and assigned different qualities based on their gender (Bolliger, 2008).

Self-Confidence: Defined as “a feeling of trust in one's abilities, qualities, and judgement” (Oxford Dictionary, 2018).

Sex: Defined as a biological physical characteristic that determines whether a human is male or female (Bolliger, 2008).

STEM Majors: Any major within the STEM field.

- Science: Biochemistry, Biology, Chemistry, Environmental Chemistry, Environmental Science, Forensic Science and Law, Health Management, Nursing, Occupational Therapy, Pharmacy, Physics, and Pre-medical
- Technology: Computer Science, Computer System Technology, Cybersecurity, Digital Media Arts, and Information Systems Management
- Engineering: Binary Engineering, Biomedical Engineering, Civil Engineering, Software Engineering, Electrical Engineering, and Mechanical Engineering
- Mathematics: Accounting, Finance, and Mathematics

Implicit Stereotype: Defined as the unconscious connection of certain qualities to a member of a certain group (Steffens & Jelenec, 2011).

STEM: Defined as an acronym for science, technology, engineering, and math. STEM jobs include technical support, engineering, technology, the mathematic, computer, physical and life science (Beede et al., 2011).

Appendix A

Self-Efficacy within STEM

Self-efficacy within STEM

This survey is being used to collect data for a dissertation studying the difference between males and females' self-efficacy within STEM-related majors. Thank you for your participation.

* 1. Signed Consent

Purpose: You are invited to participate in a research project entitled "analyzing self-efficacy within Gender in STEM-related majors" which is being conducted at the Duquesne University under the direction of Dr. David Carbonara, Committee Chair. The purpose of this study is to identify and analyze the differences within gender self-efficacy and the prominent area of self-efficacy based on gender. the purpose is to assist in identifying self-efficacy factors and why females and males pursue STEM-related majors.
STEM is defined as: Science, Technology, Engineering, and Math.

Description of Procedures: Your portion of this research study will take place on any computer of your choosing. You will be asked to complete a questionnaire using Survey Monkey. This is an online data collection platform. The survey itself should take between 15-20 minutes to complete. The purpose of this questionnaire is to identify self-efficacy factors that have influenced you in choosing your STEM-related major .

Potential Risks: There are minimal risks to participation in this study. Confidentiality will be protected due to no identifying information will be collected, including loss of confidentiality. If any question or participating in the survey causes you anxiety, you many stop at any time and your data will not be used.

Confidentiality: The researcher is making every effort to protect all participants personal information. Data collection within this survey will not ask for any identifying characteristics like name or any other identifiable information. Gender and major will be the only identifying information being asked within this survey. The data will be kept confidential and the computer will be locked in a home safe that contains any of the research data. There is a low risk to the participants that this confidentiality might be breached.

Voluntary Participation: You are free to refuse to complete this survey at any time. There will be no penalty for not completing this survey. Also, you may discontinue participation at any time without any penalty.
Please click agree below if you choose to take this survey. Otherwise, please close out the this survey.

Contact Information: If you have any questions at any time before, during, or after your participation, please contact a dissertation member chair: Dr. David Carbonara--carbonara@duq.edu, or Lori Grata--gratal@duq.edu.

○ I have read the signed consent form and agree to take this survey

Appendix B

2. What is your birth gender?

- ◯ Female
- ◯ Male

3. What is your current grade year?

- ◯ Freshman- 1st year
- ◯ Sophomore-2nd year
- ◯ Junior- 3rd year
- ◯ Senior- 4th year
- ◯ Other (please specify)

4. What is your current major within the university?

5. What is your current GPA?

6. What technology classes did you take in high school? (Please select all that applies)

- ☐ Application Development: Desktop
- ☐ Application Development: Mobile
- ☐ Computer Programming: Java
- ☐ Computer Programming: Python
- ☐ Web Design: HTML
- ☐ Design Thinking
- ☐ 3D Printing
- ☐ Robotics
- ☐ Principles of Technology
- ☐ CAD: Computer Aided Design
- ☐ Introduction to Engineering
- ☐ Civil Engineering and Design
- ☐ Computer Integrated Manufacturing
- ☐ Computer Hardware
- ☐ Computer Science I
- ☐ Computer Science II
- ☐ Computer Science A
- ☐ Computer Science Principles
- ☐ Other (please specify)

7. In high school, what science classes did you take? (Select all that applies)

- ☐ Life Science
- ☐ Geology
- ☐ Introduction to Science
- ☐ Biology I
- ☐ Biology II
- ☐ AP Biology
- ☐ Environmental Science
- ☐ Chemistry I
- ☐ Chemistry II
- ☐ AP Chemistry
- ☐ Physics I
- ☐ Physics II
- ☐ AP physics
- ☐ Physics - Conceptual
- ☐ Physics - Mechanics
- ☐ AP Physics - Mechanics
- ☐ AP Physics - Electromagnetism
- ☐ Astronomy
- ☐ Anatomy & Physiology
- ☐ Environmental Chemistry
- ☐ Other (please specify)

8. In what grade level did you decide to major in STEM?

- ◯ Middle School 4th
- ◯ Middle School 5th
- ◯ Middle School 6th
- ◯ Middle School 7th
- ◯ Middle School 8th
- ◯ High School 9th
- ◯ High School 10th
- ◯ High School 11th
- ◯ High School 12th
- ◯ Other (please specify)

STEM and Gender

Please answer each question with strongly disagree, disagree, agree, and strongly agree.

9. I believe that men and women are equal when working with technology.

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

10. Males are more as capable/ have a higher ability than females when in math and science subjects.

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

11. Due to my gender, I have had second thoughts about my STEM-major.

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

12. I feel that men and women have an equal opportunity with the STEM fields and majors.

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

Self-efficacy and STEM

Please answer each question with a strongly disagree, disagree, agree, and strongly agree.

13. I can always manage to solve difficult problems in a STEM-related if I try hard enough (ME).

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

14. I believe that men are better at science classes than women. (ME)

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

15. I believe that men are better at math than females (ME).

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

16. Based on my past experiences in STEM, I believe in my ability to perform well in high level STEM classes. (ME)

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

17. I believe that I will success within my STEM major. (ME)

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

18. If I practice math everyday, I can develop my skills. (ME)

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

19. I can figure out anything that is being taught to me in my STEM classes. (ME)

- ◯ Strongly agree
- ◯ Agree
- ◯ Disagree
- ◯ Strongly disagree

20. I have had a role model of the same gender that influence my decision to pursue a STEM-related major. (VE)

- ◯ Yes
- ◯ No

21. Society views STEM-majors or careers as males. (VE)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

22. Through my experiences, I have seen or experiences a gender bias within STEM (VE)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

23. I have experience gender bias within STEM-classes, that influences how I view STEM. (VE)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

24. My family supports my STEM-major decision. (VP)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

25. Based on my previous teachers feedback, I believe my hard work pays off when it comes to my STEM-related major. (VP)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

26. When I tell myself that I can complete a tack within my major, It is easy for me to stick to my aims and accomplish my goals in STEM classes. (VP)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

27. I have the ability to succeed at the highest levels in STEM classes. (PR)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

28. I use positive self talk to aid me in participation within my STEM classes. (PR)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

29. I think no matter who you are, you are able to succeed in STEM. (PR)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

30. Being the only female or male in a STEM classes causes me stress. (PR)

- Strongly agree
- Agree
- Disagree
- Strongly disagree

Appendix C

Hi Lori,
Yes, you may use the Self-Efficacy Questionnaire or questions from the questionnaire with an appropriate citation. You are also welcome to add or modify items. In our continued research on self-efficacy, a limitation we've found to the questionnaire is that it is not content or context specific (i.e., students can have high self-efficacy in some areas like sports, music, algebra, but low self-efficacy in other areas such as reading). Modifying to fit the specific aspects of your project will likely improve the questionnaire. Please note that we have not yet developed any peer-reviewed publications on the survey, it is not normed, and there are no reverse-scored items. I have attached the most recent technical information on the questionnaire. We use it primarily as a student reflection tool and teacher planning tool. If you launch the survey through http://researchcollaborationsurveys.org/ it will automatically create a summary report for each student and provide you with composite data (in a summary report and excel download).

Also if possible, we'd love to see the results of your study if you are willing to share.
Thank you,
Amy

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Research Collaboration

Self-Efficacy Questionnaire (2016 Version)

Overview

What This Questionnaire Measures

In the context of education, self-efficacy refers to a student's confidence in his or her ability to achieve specific academic tasks. A wider definition encompasses a belief that ability is not fixed but can grow with effort. Research conducted by Zimmerman (2000) found that students with higher levels of self-efficacy will engage more, work harder, and persist longer when they encounter difficulties.

The Self-Efficacy Questionnaire is designed to measure a student's perceived level of proficiency in the two essential components of self-efficacy, which are:

1. Believe that ability can grow with effort.
2. Believe in your ability to meet specific goals and/or expectations.

How This Questionnaire Is Accessed

Teachers can launch questionnaires and view both individual and aggregate student results by visiting http://ResearchCollaborationSurveys.org, creating an account, and following the instructions provided on the website. This website is free and available to all educators. Once students have completed the questionnaires, teachers can see graphed results for individual students as well as in aggregate. Teachers can also download a raw data file in MS Excel.

How This Questionnaire Is Completed

Teachers make the questionnaire available to students by providing the URL to the survey site and a survey code. Students then enter the survey code and a student number assigned by the teacher. Students complete the questionnaire by self-rating items on a 5-point, Likert-type scale. This scale ranges from 1 (*Not very like me*) to 5 (*Very like me*). The results are automatically graphed for students and available to them once they complete the questionnaire. This enables them to immediately reflect on results.

The following example items represent each of the two essential components:

- *I believe hard work pays off.* (Ability Can Grow)
- *I can figure out anything if I try hard enough.* (Belief in Own Ability)

The items on the questionnaire are written at an eighth grade reading level, per the Flesch-Kincaid[1] readability score. Accommodations should be provided when appropriate and may include reading the items aloud, explaining the items, and having a scribe fill in the response option.

[1] Kincaid, J.P., Fishburne, R.P., Rogers, R.L., & Chissom, B.S. (1975). Derivation of new readability formulas (automated readability index, fog count, and flesch reading ease formula) for Navy enlisted personnel. Research Branch Report 8–75. Chief of Naval Technical Training: Naval Air Station Memphis.

How to Use the Results

Self-Efficacy Questionnaire results can be used by both teachers and students. To ease interpretation, results are displayed on a 100-point scale. These scores can be interpreted similar to grades (e.g., 70-79 is a C). Results by essential component support reflection on relative strengths and areas for improvement.

Students can use the questionnaire results to build an awareness of how their perceptions and beliefs about ability contribute to their academic success. As students better understand that they can positively impact outcomes with effort, they build confidence in their ability to take on more challenging tasks.

Teachers can enhance their instructional practices by determining which perceptions are impacting their students' motivation to succeed. For example, if the student results indicate that students view ability as fixed, teachers can counter that belief by teaching students about growth mindset and incorporating instructional practices that help students see their progress over time. After combining this targeted instruction with ongoing guided and independent practice with feedback, teachers can re-administer the Self-Efficacy Questionnaire and alter their instruction accordingly. This allows teachers to engage in a process of data-driven decision making to increase their students' fundamental ability to understand the positive impact that effort has on ability and believe in their own personal ability to make progress on challenging tasks. Numerous resources for teaching self-efficacy are available at http://Resources.CCCFramework.org.

Technical Information

The Self-Efficacy Questionnaire was developed in 2015 by Research Collaboration (http://ResearchCollaboration.org). An extensive review of related research resulted in the identification of two components that are essential for developing self-efficacy. Following this literature review, it was determined that positive self-efficacy increases when students believe that ability can grow with effort and also believe in their ability to meet specific goals.

The questionnaire was tested for reliability using Cronbach's coefficient alpha[2] with 4,989 high school and middle school students during the 2016-2017 and 2017-2018 school years. Demographic data of grade and gender were added to the questionnaire in fall 2017. Of the 4,333 students that completed the survey since fall 2017, 2,093 (48%) were female, 2,008 (46%) were male, and 232 (5%) did not report gender. The dataset includes 358 students in grade 6, 356 in grade 7, 421 in grade 8, 703 in grade 9, 443 in grade 10, 565 in grade 11, 711 in grade 12, and 328 post-high school.

The overall self-efficacy questionnaire was found to be highly reliable (13 items; α = .894). The belief that *ability grows with effort* subscale consisted of 5 items (α = .805) and the belief in *personal ability* subscale consisted of 8 items (α = .841). When converted to a 100-point scale, the bottom quartile ranged from 20 to 77 and the top quartile ranged from 92 to 100.

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[2] Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297–334.

Cronbach, L. J. (1988). Internal consistency of tests: Analyses old and new. *Psychometrika*, 53, 63–70.

In 2016, the Self-Efficacy Questionnaire was updated based on a reliability and factor analysis. Ten items were removed to improve the overall reliability of the instrument. The questions making up each subscale in the shortened 2016 version of the questionnaire are listed below.

<u>Belief in Personal Ability</u>

1. I can learn what is being taught in class this year.
2. I can figure out anything if I try hard enough.
3. If I practiced every day, I could develop just about any skill.
4. Once I've decided to accomplish something that's important to me, I keep trying to accomplish it, even if it is harder than I thought.
5. I am confident that I will achieve the goals that I set for myself.
6. When I'm struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged.
7. I will succeed in whatever career path I choose.
8. I will succeed in whatever college major I choose.

<u>Belief that Ability Grows with Effort</u>

9. I believe hard work pays off.
10. My ability grows with effort.
11. I believe that the brain can be developed like a muscle.
12. I think that no matter who you are, you can significantly change your level of talent.
13. I can change my basic level of ability considerably.

Questionnaire

Self-Efficacy Questionnaire

Please **CHECK ONE** response that best describes you. Be honest, since the information will be used to help you in school and also help you become more prepared for college and careers. There are no right or wrong answers!

Student ID______________________ **Date** ___________________

	Not very like me → 1	2	3	4	Very like me 5
1. I can learn what is being taught in class this year.	☐	☐	☐	☐	☐
2. I can figure out anything if I try hard enough.	☐	☐	☐	☐	☐
3. If I practiced every day, I could develop just about any skill.	☐	☐	☐	☐	☐
4. Once I've decided to accomplish something that's important to me, I keep trying to accomplish it, even if it is harder than I thought.	☐	☐	☐	☐	☐
5. I am confident that I will achieve the goals that I set for myself.	☐	☐	☐	☐	☐
6. When I'm struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged.	☐	☐	☐	☐	☐
7. I will succeed in whatever career path I choose.	☐	☐	☐	☐	☐
8. I will succeed in whatever college major I choose.	☐	☐	☐	☐	☐
9. I believe hard work pays off.	☐	☐	☐	☐	☐
10. My ability grows with effort.	☐	☐	☐	☐	☐
11. I believe that the brain can be developed like a muscle.	☐	☐	☐	☐	☐
12. I think that no matter who you are, you can significantly change your level of talent.	☐	☐	☐	☐	☐
13. I can change my basic level of ability considerably.	☐	☐	☐	☐	☐

Gaumer Erickson, A.S., Soukup, J.H., Noonan, P.M., & McGurn, L. (2016). Self-Efficacy Questionnaire. Lawrence, KS: University of Kansas, Center for Research on Learning.