EVALUATING PARENTAL STEM KNOWLEDGE AND AWARENESS AS A PREDICTOR OF ADVANCED LEVEL COURSE ENROLLMENT

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Abstract

In four years of existence, a new high school in a moderately small rural city in Middle Tennessee has seen a significant skewing of male representation in high-level mathematics and computer science courses. While the numbers in this school are higher than the national average, this school's population represents an overall trend in our nation that observes females and minorities having a clear underrepresentation in STEM fields. It is imperative that no student is overlooked when seeking out talent to fill these future demands.

This survey-based research study analyzed parental STEM awareness through two separate Likert-type scale surveys. The first survey measured parental knowledge of STEM and the second measured parental attitudes towards STEM education. The study was established to determine if parental awareness made an impact on student enrollment in upper-level STEM courses. Parents at the selected middle Tennessee high school, participated in an online survey to gather data about parental knowledge and attitudes about STEM education. Data were compiled from the survey, and knowledge and attitude scores were calculated for each respondent. Parents also indicated whether their student was enrolled in, or planning on enrolling in any upper-level STEM courses. The data were analyzed using a binary logistic regression which revealed that both knowledge and attitude scores of parents were significant factors in the probability of a student enrolling in upper-level STEM courses. Findings from this study support the education of parents to improve knowledge about and attitudes toward STEM education and careers.

Keywords: *STEM education, engineering, self-efficacy*

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Dedication

This work is dedicated to my phenomenal wife Tammy, who has had an unmeasurable amount of patience with me throughout this process. It was her encouragement for the last three years that have prodded me to finish this process. She sacrificed almost every weekend during this process to allow me to complete a plethora of papers. She managed to continue to make our house a home in my absence and refused to let me give up during the process. When our vows stated, “for better or worse”, her portion of worse was tested during this phase, but she showed me unconditional love and support. I am forever grateful for her partnership in this process and this life. I would not be where I am today without her.

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CHAPTER 1: Introduction

STEM, an acronym for Science, Technology, Engineering, and Mathematics is an encapsulation of multiple disciplines that pave the way for students to pursue careers in a highly rewarding and lucrative field after graduation. While the demand for qualified persons is growing at an incredibly fast rate, the level of students leaving school to enter those fields is not keeping pace with that demand. When observing STEM classrooms in most public schools, it becomes apparent that several student subgroups that have no representation in those classes.

A vast majority of STEM-related classes display a dominant presence by males with a low percentage of those students coming from minority groups including females (Xu, 2008). Not only does the lack of these subgroups pose a problem for providing adequate resources for the growing demand for these highly trained people, but the lack of diversity also poses the problem of tunnel vision solutions. When the variety of STEM fields increases, the potential for solving universal problems becomes more feasible. This very problem made itself evident during the development of voice recognition software (Margolis, Fisher, 2002). The lack of diversity in the engineering team that was developing this technology inadvertently excluded variations in the speech that were associated with diverse groups in society. This lack of diversity hampered the development and caused delays in a project that could have been completed in a shorter period had diversity been accounted for in the lab.

The opportunity exists for all in STEM; however, some groups are more likely to engage in STEM courses than others. Underrepresentation of subgroups does not come from clear bias such as dictating who can and cannot enroll in STEM courses, but rather from implicit bias such as beliefs about ability or gender stereotypes (Ware & Lee, 1988). When one believes that they are not supposed to be good at a discipline or that they do not belong in a particular field, due to their gender, those individuals avoid those areas and pursue avenues in which they feel like they are skilled (Wang, 2013). Therefore, when students believe they are good at something, they have the will to pursue that course of study and exhibit poise and determination.

Statement of the Problem

While the need for more highly trained STEM workers is growing at a faster rate than our educational system can provide, the pool of available workers remains constant. Our schools must encourage underrepresented members of our population to seek out areas that they might have never considered due to self-assessment of their abilities (Oakes, 1990).

High-level STEM courses are incredibly skewed in representation by Caucasian males. According to studies, male representation in STEM courses that go beyond the scope of required courses in schools is double that of females (Benderly, 2013).

Therefore, to keep pace with the demand for STEM-ready students, schools must determine what factors inhibit female students from pursuing STEM-related courses. Once those factors are identified, schools can be more focused on removing those barriers that squelch females from enrolling in such classes.

Purpose and Significance of the Study

In four years of existence, a new high school in a moderately small rural city in Middle Tennessee has seen a significant skewing of male representation in high-level mathematics and computer science courses. In just four years, there have been 102 students who attempted AP Calculus, and of those 102, only 12 of those have been females. While these numbers are far more severe than the national averages, those numbers represent an overall national trend that demonstrates females having a clear underrepresentation in STEM fields.

While studies reveal a pattern that indicates boys do score higher on standardized STEM-related tests, those gaps have been closing over the years. This data suggests that old theories about gender specific abilities are not accurate and that females are more than capable of "keeping up" with boys in STEM-related courses (Crisp, Nora, & Taggart, 2009).

The purpose of this study was to ascertain the underlying ideas and attitudes of students and parents to determine if there are factors that local schools have an impact on, which can balance the male and female population in STEM-related courses.

Theoretical Framework

According to Bandura, Self-efficacy refers to an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments (Bandura, 1997). Self-efficacy reflects confidence in the ability to exert control over one's motivation, behavior, and social environment.

The perception of one's self-efficacy is described as a person's ideas of their ability to perform at certain acceptable levels in tasks that have a direct impact on their lives. A person's self-efficacy beliefs affect how they feel about their capacity to reason, encourage themselves and perform. Such opinions produce these various effects through four major progressions. They include cognitive, motivational, affective and selection processes.

A robust awareness of efficacy improves an individual's achievement and personal security in many ways. People with high self-confidence in their abilities approach challenging tasks as problems to be conquered rather than as dangers to be avoided. Such a helpful attitude nurtures intrinsic concentration and deep engrossment in activities. People with high levels of self-efficacy set themselves inspiring goals and preserve a strong commitment to those aims. Rather than backing down from a challenge, individuals with a high degree of self-efficacy intensify and sustain their efforts, even when presented with the possibility of failure. These same people find it easy to recover their sense of efficacy after disappointments or setbacks. Failure to individuals with a high self-efficacy is attributed to poor effort or limited knowledge and skills which are attainable. This group approaches intimidating circumstances with an assurance that they can and will succeed. This overall outlook produces a high level of personal success, reduces stress and lowers susceptibility to despair.

In contrast, people who distrust their abilities tend to shy away from challenging tasks which they view as personal risks. Individuals with low self-efficacy have small ambitions and anemic commitment to the goals they choose to chase. When confronted with challenging assignments, this group tends to dwell on their personal insufficiencies, the hindrances they will confront, and the plethora of adverse outcomes rather than focusing on how to perform successfully. Unlike their counterparts, this group is slow to recover their sense of efficacy ensuing failure or setbacks. Since they perceive inadequate performance as deficient ability, the level of failure required to drain their confidence level is minuscule. This group is easily disposed to stress and depression.

Conceptual Framework

Students are products of their environment and therefore, the major influences in their lives can play a major role in helping them to determine the direction of their future career (Bandura, 1997). A student's self-efficacy can be greatly impacted by his or her parents. This study was based on the premise that underlying influences determine a student's attitude toward pursuing an education in STEM fields. The study focused on the attitudes and demographics of students' parents to determine if environmental factors influenced the propensity for students to seek out a career in a STEM field.

Research Question

The research study will be guided by the following research questions:

1. Is parental STEM awareness a predictor of student enrollment in advanced level STEM courses in high school?

Limitations and Delimitations

The limitations to the researcher may come from respondents providing meaningful responses rather than simply filling in responses to complete the survey in the fastest manner. Another limitation may come from participants not understanding the questions posed to them due to a lack of exposure to STEM education. Also, the population of the study will focus on a specific suburban high school in Middle Tennessee which in turn could reveal factors that are only relevant to this school.

Definition of Terms

STEM Education. STEM Courses are those courses included in the following disciplines of Science, Technology, Engineering, and Mathematics.

Advanced STEM courses. Advanced STEM courses are those courses in the following disciplines of mathematics and science that are taken beyond the scope of required core subjects. These courses more specifically are from the selection set of pre-calculus, AP Calculus, AP Computer Science and AP Statistics.

STEM Awareness. STEM awareness is defined as the combination of parental knowledge of STEM and their attitudes towards STEM (Yun, Cardella, Purzer, Hsu & Chae, 2010).

Organization of the Document

Chapter one introduces the study, explaining the problem and the importance of a better understanding. Chapter One also explains the theoretical and conceptual theories that are being used to focus the study, as well as the research question that will be used to guide the inquiries. Limitations and Delimitations are presented as well as defining terms that may be unclear. Chapter Two is a review of the literature, examining the concepts of STEM education and the impact that STEM education has on our local and global economy. The review of literature analyzes the disparity of women in STEM fields. Chapter Three explains the research methodology of this study, depicting how the study was undertaken, who was involved, what instrument was used, and how the data will be analyzed to answer the research question. Chapter Four focuses on the results of the study, displaying what information was garnered from the research and determining how that information relates to the research questions. Chapter Five is a discussion of the results, exploring their implications and the conclusions that can be drawn from them. This chapter will also contain a summary of the entire study and recommendations for further study.

CHAPTER 2: Review of Literature

There are very few facets of our society that do not feel the impact of Science, Technology, Engineering, and Math (Tyson, Lee, Borman & Hanson, 2007). The conglomeration of these four disciplines is referred to as STEM, and these four subjects together are actively involved in providing many of our modern conveniences. However, as fast as technology is changing, the supply of adequately trained individuals that can continue this progress is not maintaining the same pace of growth. According to the U. S. Department of Commerce, STEM occupations are growing at a rate of 17%, while other occupations are growing at a much slower rate of 9.8%(Medina, 2015). As well as the increase in the number of jobs, individuals who possess a degree in some STEM field are found to have a higher income even in non-STEM careers (Medina, 2015). Science, Technology, Engineering and Mathematics workers have a critical role in the continued development and strength of the U.S. economy and are a significant factor in helping the U.S. remain relevant in the world economy. STEM education is responsible for creating critical thinkers, educating students to be mindful of scientific impacts, and enables the next generation of trendsetters (“Stats in Brief: students who study science”, 2009). The innovation from those educated in STEM leads to new technologies and ideas that sustain our economy. In order to ensure cutting edge innovation and science literacy, our schools have to make sure that all students are given an opportunity to develop a solid knowledge base in STEM disciplines. As the rate of advancements in technology and science increase each year, it becomes evident that a greater number of employees will require a basic understanding of math and science to remain hirable in this changing world economy. However, despite the growing need for employees with STEM training, our schools are not providing adequately trained workers for filling these requirements.

While the demand for qualified persons is growing at an incredibly fast rate, the level of students leaving school to enter those fields is not keeping pace with that demand. When observing STEM classrooms in most public schools, it becomes obvious that several student subgroups are not represented in those classes. A vast majority of STEM-related classes are dominated by males with a low percentage of those students coming from minority groups (Drew, 2015).

The STEM Curriculum

The STEM curriculum is formulated on the idea of instructing students in four specific subjects; science, technology, engineering, and mathematics, in an interdisciplinary and application based approach (Costa, 2012). Rather than approaching each topic as a separate entity, STEM curriculum attempts to integrate all four into a unified learning model based on real-life applications. Rather than teaching a simple mathematics lesson or a singleton science unit, STEM education emphasizes incorporating all four disciplines together to allow students to develop real-world skills that will ensure their future success in the constantly evolving workforce.

The Importance of STEM Education

Educational reform in the United States tends to focus on STEM initiatives. The term (STEM) seems to be at the center of every politician, teacher, or school leader’s agenda. While there are some who feel, that STEM is simply an axiom for more standardized tests or a detractor on humanities education, there are those who believe in STEM education (Drew, 2015). STEM education means an increased devotion to making American schools globally competitive by training students for a job market that is becoming progressively more dependent on science and technology skills (Medina, 2015).

STEM disciplines are considered imperative to the national economy. With growing concern about the U.S.' ability to maintain a competitive force in the world economy, many attempts have been introduced to produce a greater number of STEM-ready students. (National Academy of Sciences, Committee on Science, Engineering & Public Policy, 2007). Increasing and improving the available workers in STEM fields is a top priority for government, industry leaders, and educators alike.

Although the United States has historically been a leader in STEM fields, fewer students have been concentrating on these topics recently. According to a 2015 report from the U.S. Department of Education, only 16% of high school students surveyed are interested in a STEM career and have proven proficiency in mathematics. Nearly 28% of high school first-year students declare an interest in an STEM-related field, per the U.S. Department of Education, but 57% of these students will lose interest by the time they graduate from high school. Thus, the Obama administration announced the 2009 "Educate to Innovate" crusade to inspire and encourage students to excel in STEM disciplines (Obama, 2013). This initiative also addresses the insufficient number of competent teachers required to educate students in these subjects. The goal of this effort is to get American students to rise from a mediocre presence in science and math globally to being exceptional in the international arena.

This need has not gone unnoticed by our country's leaders. In 2014, President Obama's budget proposed an investment of $3.1 billion in federal monies be spent on STEM education initiatives, with a 6.7% increase over 2012 spending (Obama, 2014). The investments were made to recruit and support STEM teachers, as well as support STEM-focused high schools with

STEM Innovation Networks. The budget also included monies intended for advanced research projects in education, to understand next-generation learning technologies better. All this effort by the Obama administration is to help the U.S. continue its dominance in the world economy as a leader in STEM fields. According to a report by the website STEMconnector.org, by the year 2018, current projections estimate that the need for 8.65 million workers in STEM-related jobs will be a reality. The manufacturing sector also faces a similarly alarmingly shortage of workers with the required STEM skills to compete. With a shortage of approximately 600,000 employees, the manufacturing sector could come to a screeching halt. Projections show that the field of cloud computing alone will have created 1.7 million jobs between 2011 and 2015 that could potentially go unfilled if the adequate number of employees are not trained and ready to enter the workforce. According to The U.S. Bureau of Labor Statistics (2008), their projections show that by 2018, the majority of newly created STEM jobs will consist of the following:

- Computer Science – 71%
- Traditional Engineering – 16%
- Physical Sciences – 7%
- Life Sciences – 4%
- Mathematics – 2% ("Employment Projections: 2008-18 News Release", 2009)

According to statistics, less than 50% of entry-level STEM jobs require a bachelor's degree or higher. While a bachelor’s degree is not mandatory, the benefits of having an appropriate degree will enhance the salary of a new employee. The average marketed starting salary for starting STEM jobs with a four-year degree was 26% higher than other jobs in the non-STEM fields, according to the STEM Connect report (Eisenhart, Weis, Allen, Cipollone, Stich & Dominguez, 2015).

Along with an increase in salary for STEM jobs, there are also more jobs available. For every job posting which required a bachelor's in a non-STEM field, there were roughly 2.5 job postings for a bachelor's degree recipient in a STEM field (Simard, Henderson, Gilmartin, Schiebinger & Whitney, 2008).

This problem is not exclusive to the United States. In the United Kingdom, the Royal Academy of Engineering states that 100,000 STEM graduates will be needed every year until 2020 just to meet the demand for filling these jobs. According to the report, Germany has a shortage of 210,000 workers in the mathematics, computer science, natural science and technology disciplines (Xue, 2014). Therefore, STEM education should be a top priority in our nation as the demand for such workers is failing to be met by our current practices. However, the supply of capable individuals is not the problem, but rather the efficient use of available resources seems to be the real issue. According to estimates by The National Science Foundation, nearly five million people are employed in fields such as science, engineering, and technology which makes up about 4% of the total workforce (Charrette, 2014). While this group is a relatively small portion of the workforce, the contribution they make to our society is considered to be crucial to the economic growth and productivity of the country. Not only do STEM workers enjoys a sense of worth, but they also tend to be compensated at a higher rate and enjoy better job security than do other workers. Workforce projections for 2018 by the U.S. Department of Labor indicate that ninety% of fastest-growing careers that requires at least a bachelor's degree will require significant scientific or mathematical training (Charrette, 2014). If our society is needing more STEM-trained workers, we must tap into the underrepresented subgroups of women and minorities to close this gap.

Women in STEM Education

Females are engaging and excelling in mathematics and science now more than ever before in history; however, this increased success found by girls in math and science disciplines has not translated into similar growth of women's representation in the employment sector as engineers and computer science professionals (Frehill, Abreu, & Zippel, 2015). In 2013, women only possessed 26% of the available computer science jobs, which reveals a significant decrease in the ratio of women in that field from 30 years ago. This percentage demonstrates a step backward as that same level of participation was attained in 1960. Furthermore, in the arena of engineering, women have an even lower representation, with a meager 12% representation of the engineers actively engaged in the workforce in 2013 (Bilimoria & Liang, 2013).

The presence of women in the fields of engineering and computer science is a critical necessity (Eisenhart, 2008). A more diverse group of engineers and computer scientists promotes a higher level of creativity, productivity, and innovation. The technical advancements that we enjoy today are fashioned by the experiences of both men and women. The experiences from both men and women help to inform and guide the course of engineering and technical advancements on a broader spectrum. Simply ignoring the perspectives and ideas of half the population is not the best strategy for the United States to remain relevant in science and technology.

Advocates of diversity in engineering have clamored about the importance of advancing girls and women in science, technology, engineering, and mathematics. While STEM fields lack a sufficient representation of females, engineering and computer science fields are highlighted among the wider STEM category as the fields that have the potential to offer a greater deal of opportunities for talented scientists. Engineering and computing occupations account for more than 80% of the STEM jobs available, which gives those specific disciplines an advantage to offer a higher return on investment and better prospects than jobs in other STEM fields. (Oh & Kim, 2015). If an equitable representation of men and women improves the advancements in STEM fields, then women must be well represented in these areas; otherwise, they lose out on these high-quality employment opportunities.

Even though scores in mathematics and science among boys and girls in lower grades are found to be similar, by the time these same students reach high school, boys show a greater tendency to engage in taking high stakes tests that are most closely associated with the subjects of engineering and computer science (Benderly, 2013). The very same girls who demonstrated similar acumen in those same subjects in earlier grades do not engage in those same high stakes tests such as AP tests, SAT and CLEP Tests. Furthermore, when surveying first-year college students, it was found that the probability of women expressing a desire to major in a STEM field was lower than men (Catalyst, 2013). This imbalance carries over to the graduate level. The workplace is also not immune to this disparity. This gap between men and women continues to widen into the workforce as women show a tendency to leave engineering and computer science jobs at a faster rate than their male counterparts (Shen, 2013).

The issue of non-proportional representation in the number of engineering and computer science bachelor's degrees awarded is in large part a matter of women's underrepresentation, and some women of color are particularly underrepresented. Although black, Hispanic, Native American and Alaska Native women together made up 18% of the population between ages 20 and 24 in 2013, only 6% of computing degrees were earned by this group, and an even lower 3% of engineering bachelor's degrees were conferred upon this group that year. However, men from the very same demographic groups made up a similar 19% of the population between the ages of

20 to 24, yet were awarded 18% of computing bachelor's degrees and 12% of engineering bachelor's degrees. While men of some races and ethnicities are still underrepresented among those who earn degrees in STEM, the proportional representation of these men is more closely aligned than that of their female counterparts (Shen, 2013).

Lack of Women and Minority Representation in STEM

Women have made major gains in the workforce over the past 50 years by acquiring a record number of jobs that were once thought to be meant for men (Eisenhart, 2008). While these gains have been significant, that rate of growth is not present in STEM fields such as engineering or computing. Women have seen growth in fields previously dominated by men such as law, medicine, and business. The number of women that served as judges and lawyers in 1960 was a mere 3%. However that number increased to 33% in 2013. The same pattern held true with female doctors and surgeons. In 1960, the female representation in those fields was again a meager 7%, and following the same trend as the legal professions, women saw a growth in representation that rose to 36% by 2013. Females also saw the same type of growth rate in management over the same time-period by increasing from 14% to 38% (AAUW analysis of U.S. Census Bureau, 1963, and U.S. Department of Labor, Bureau of Labor Statistics, 2014d).

While the growth of women's representation in STEM fields has not kept pace with other professions, some STEM fields have seen an increase in the presence of women. In the field of chemistry, women made up 8% of all chemists in 1960. However, in 2013, women made up 39% of the chemistry workforce. While biology was one of the largest female represented STEM fields in 1960 with close to a quarter of the workforce, women saw a doubling in representation by 2013. While those specific STEM fields saw growth in women's representation, computing saw a decline from 34% of workers in 1990 to barely over 25% in

2013, which was a step back into 1960's numbers. Engineering, on the other hand, has lacked representation for a while. Women comprised less than 1% of workers in 1960. While the level of women in engineering increased to 12% of the by 2013, engineering has been described as the most sex-segregated nonmilitary profession in the world (Charles & Bradley, 2009).

An even more staggering statistic is the lack of female minorities in STEM fields. Over the last 20 years, white women made up 8% of the engineering workforce, while minority females combined only accounted for 3% of that same population. When looking at the overall engineering workforce, including both women and men, over 75% of engineers in the United States were non-Hispanic white indicating another disparity in representation (Drew, 2015).

Computer science, another underrepresented field is only comprised of 17% Caucasian females, while Asian, and Pacific Islander women made up an even smaller 4%. Black and Hispanic women only account for 4% of the total workforce in computer science. The field of computer science, like other STEM fields, is dominated by 69% representation from non-Hispanic whites. Black and Hispanic workers again face the greatest underrepresentation with on 13% of the total computer science workforce (Drew, 2015).

While the demand for STEM workers is increasing, the presence of females and minorities in the STEM workforce is not keeping pace. Therefore, it is imperative to find a way to draw these subgroups into the field. Determining the reasons for lack of representation from over half the population must be a priority in educational reform.

Women and Minority Representation Matters in STEM

Innovation is the underlying reason that women's and minorities' representation in engineering and computing fields is so important. The major challenges that our world will be facing over the next 100 years such as sustained access to clean water globally, disease eradication, and alternative energy sources, requires a greater dependence on highly trained engineers and computer scientists. Diversity provides an opportunity for multiple perspectives to be present when solving problems. However, when women and minorities are absent or barely represented in these fields, many novel solutions that diverse participation brings could easily be overlooked. In a recent study conducted by Reuben, Sepienz and Zingales (2014), it was found that lower-performing men are frequently selected over higher-performing women and minorities for engineering and mathematical work (Reuben, Sapienza & Zingales, 2014a). With an already waning level of workers in STEM fields, U.S. engineering and technology companies are overlooking a massive talent pool which in turn hinders the U.S. from being globally competitive due to they may not be hiring the best people for the jobs. When women and minorities are so noticeably underrepresented, many advancements in science and technology are solely based on the opinions and experiences of white males (Williams, 2014), which in turn overlooks the unique needs of females and minorities. Schiebinger and Schraudner (2011) call for the inclusion of sex, gender and ethnicity in every phase of scientific research to prevent the need to go back to the drawing board and retrofit a solution to meet the needs of those subgroups that were overlooked. As Margolis and Fisher (2002, pp. 2–3) call attention to in their study on the lack of representation of women and minorities in STEM fields, some of the early algorithms of voice-recognition software applications were calibrated only to familiar male voices. This oversight caused a major problem when those software implementations were unable to recognize female voices. Another example of technological advancements that were hindered by the lack of diverse input was in the development of airbags for automobiles. The development in charge of creating this technology was dominantly male in representation and therefore designed the airbags to protect adult males, which in turn led to a design that contributed to the avoidable deaths of some women and children.

The Advantage of Diversity in STEM Fields

Usually defined concerning race, ethnicity, gender, disability status, age, or sexual orientation, diversity is a popular topic in the business community. Business leaders' attention to diversity is rooted in the civil rights laws of the 1960s. In the 1980s and 1990s, some companies began promoting tolerance and multiculturalism in the workplace, having recognized the need to advance working relationships among co-workers of diverse backgrounds (Anand & Winters, 2008). Several discussions have centered their focus on diversity enhancing business performance, which could be missing due to lack of representation from a wide range of individuals (Catalyst, 2013).

The topic of diversity has become an extremely important focus of attention. Based on the foundation of the civil rights laws that were developed in the 1960s, businesses in the 1980s and 1990s began encouraging tolerance and multiculturalism in the workplace. This effort was spearheaded based on the realization that this diversity promoted a better work environment as well as contributing to cutting-edge innovation from a more diverse set of ideas and opinions from a broader representation of society (Anand & Winters, 2008). Several debates have centered their attention about how diversity enhances business performance, which could be missing due to lack of representation from a wide range of individuals (Catalyst, 2013).

Many positive outcomes in business, such as greater innovation and productivity are linked to diversity in the workplace. When the ideas from individuals in a diverse group are combined, a clear advantage is gained as the perspective of the group becomes a much broader representation of society. Undeniably, scholars have determined that a group of diverse people that work together can easily outperform the "lone genius with a high IQ" (Page, 2007). A study by Woolley, et. al determined that gender diversity made a significant impact on the "collective intelligence" of the group (Woolley, Chabris, Pentland, Hashmi & Malone, 2010). Being able to resolve differences among multiple groups is seen as a critical mental process. Although individuals feel a sense of comfort by engaging with others similar to themselves, similarity can squelch the ability to share multiple perspectives on solving a problem (Phillips, Liljenquist, & Neale, 2009).

Studies conducted by Catalyst in 2004 and 2011, specifically concentrating on diversity in gender, have established a strong connection between the diversity of a group and their ability to perform in the corporate world (Catalyst, 2004, 2011). In their study on the Representation of Women in Information Technologies, the National Center for Women and Information Technology determined that when a higher representation of women existed at all levels in organizations, those organizations experienced healthier outcomes (National Center for Women and Information Technology, 2014b).

While diversity is a critical component of a successful organization, that diversity, if not handled properly can introduce conflict into the workplace. Side effects of ill-implemented diversity plans can include decreased cooperation, reduced cohesiveness, and lower moral, imposed from, an "us-versus-them" attitude (Roberge & van Dick, 2010). In Triana's(2013) study of women's representation on managerial boards in the United States, it was found that diversity could obstruct or drive strategic change, depending on the economic circumstances of the company. Diversity for the sake of diversity is not a strategic plan that guarantees success.

The benefits of diversity are not necessarily guaranteed; however, the rewards for being inclusive present a great deal of attainable rewards (Campbell, Mehtani, Dozier & Rinehart, 2013). If organizations want to see the rewards of diversity, they must change the way they think to a "diversity mindset." A diversity mindset is defined as learning and building from diversity, rather than just imposing diversity for the sake of compliance (Van Knippenberg, van Ginkel & Homan, 2013). A diversity mindset becomes a valuable tool for any work that involves investigation, originality, and higher ordered thinking. When organizational leaders change their beliefs about diversity by adopting a diversity mindset, they can impact the thought processes of their organization to understand the benefits of diversity and thereby eliminating many of the negative mindsets that look at diversity as an imposed proposition (Nishii, 2013).

Reasons for Lack of Female Representation in STEM

There is a great deal of academic research on this topic which reveals that there are three common themes found in the literature. The first issue that is discovered is the stereotype that men are genetically superior in the field of mathematics which in turns makes them naturally better matched to STEM fields than women. While this may seem absurd in our modern society, this remains a common belief. A large number of articles concentrating on intellectual gender differences are used as an explanation for the small numbers of women in STEM fields. A second theme focusses on the perception that girls lack interest in STEM work. And finally, a third issue involves the STEM workplace for women and the issues they face which range from work and life balance to bias in the workforce.

There was a time when the average math performance of males was significantly better than that of females. However, that gap no longer exists in the general school population (Hyde et al., 2008). However, when discussing the issue of cognitive ability differences among males and females, including mathematical knowledge, is still a passionately contested topic. Lynn and Irwing (2004) revealed in their research that there were minimal or no differences in average IQ between males and females. This finding put to rest the old argument that neither sex is smarter than the other. However, other researchers have found that females and males tend to have different reasoning strengths and weaknesses. Boys perform better on tasks using three-dimensional orientation and imagining on certain quantitative tasks that rely on those skills. Girls overtake boys on tests relying on verbal skills, especially writing, as well as some tests involving memory and perceptual speed (Hedges & Nowell, 1995).

When cognitive skill comparisons are made between sexes, one of the largest gender gaps in reasoning skills is identified as the ability of males to rotate an object in three-dimensional space, while female counterparts score significantly lower on such tasks (Linn & Petersen, 1985). Spatial skills are considered by many experts to be vital for success in STEM courses. However, the evidence that connects spatial abilities to success in STEM careers is not as clear (Ceci, 2009). While the debate continues over if strong three-dimensional skills are critical for success in STEM fields, research conducted by Baenninger and Newcombe (1989) suggests that those same three-dimensional skills can be enhanced relatively easy with proper training (Baenninger & Newcombe, 1989). Research findings from Sheryl Sorby indicate that proper curriculum development can improve spatial skills of those who are lacking. Sorby, Baartmans (2000) and their colleagues developed and implemented a course designed to help improve the spatial and visualization skills of engineering students who were identified as having inadequate special skills. More than 75% of female engineering students that took this experimental course found a greater level of comfort and could endure the stress of the engineering program. On the other hand, the female students who did not take the course were changing their major from engineering to some other field at a rate of 50%. While poor or underdeveloped spatial skills may inhibit girls from pursuing math or science courses or careers, research shows that these skills can be improved relatively fast.

While spatial skills are important to the development of successful engineers, there is evidence that females simply lack interest in STEM fields. Polling data indicates that there are great number of girls and women that indicate they have no interest in STEM fields. In a poll conducted in 2009 by the American Society for Quality, students ranging in ages from eight to seventeen were asked if they were interested in a career in engineering. 24% of boys who took the survey indicated that they were interested in a STEM field, while only 5% of the girls in the same study said they were interested in a career in STEM. Another recent poll found that a staggering 74% of college-bound boys ages 13–17 said that computer science or general computing would be a good college major for them as compared to 32% of females who responded (Cuny, 2012). While young males express interest early on in fields of mathematics and science, young girls show a much smaller level of interest in such areas (Lapan, 2000). Studies by Lubinski and Benbow (2006) also show that even females who exhibit high levels of aptitude in mathematics early on do not necessarily seek out courses in STEM fields. In the same study of students with high aptitudes for math and science, the females in that study were more likely to pursue a career in humanities, life sciences, and social sciences. Men in the same study, on the other hand, show an extensive interest in areas of STEM (Lubinski & Benbow, 2006).

When one believes they can succeed in a given profession, interest in that occupation begins to grow (Eccles, 1983). In her work, Shelley Correll (2001) demonstrates that girls evaluate their mathematical abilities lower than do boys with equal past mathematical success. Correll also indicated in her study that girls are harder on themselves about their performance in courses such as math or science, areas in which males are considered to excel. Correll determined that due to this self-imposed critical self-analysis, girls have a tendency to doubt their aptitude in STEM fields and therefore avoid higher levels of those courses, which in turn translates into a lower percentage of interest in a career that is STEM related.

Frank Pajares (2005) found that there are major differences in gender self-confidence when approaching STEM subjects. He found that this trend begins in middle school and slowly increases as students enter high school. His study also showed that this trend even carried into college. Females report having less confidence than boys when self-assessing their abilities in math and science. Pajares explained that boys tend to develop greater levels of confidence in STEM through experience. This confidence and experience in STEM fields allow boys to develop relevant skills at a much faster rate than that of girls their same age. Several studies indicate that gender differences in self-confidence seem to dwindle when previous success in STEM fields or opportunities to learn are experienced (Lent, Brown & Larkin, 1986).

When students don't believe in their abilities in their math or science, they will most likely avoid activities that require them to use those specific skills. A lack of confidence is a prime motivator for students to abandon a certain task or subject in the face of adversity. Females may be especially vulnerable to losing confidence in STEM areas. According to the research of Carol Dweck and E.L. Leggett(1988), students have the ability to redirect their internal thoughts of aptitude to improve their own self-confidence. Dweck & Leggett's research also shows that when a girl does not accept the notion that girls are not as good as boys in STEM fields, that same girl is likely to be successful in STEM.

While the self-efficacy in STEM is a significant factor, it is not the only influence that determines whether a student will pursue a career in STEM. There are traditional gender roles that are assigned to children early on in their lives, which have a direct impact on a student's sense of acceptability in pursuing an occupational path (Low, Roberts, & Rounds, 2005). Per a review of child vocational development, Hartung (2005) found that children, especially girls, develop ideas that an occupation is not suitable for specific genders and therefore concentrate their efforts on careers that society has deemed appropriate for their specific gender. Over the last 30 years, Jacquelynne Eccles, a leading researcher in the field of occupational choice, has collected data and created models to explain gender-specific occupational choices. Eccles suggests that individuals choose an occupation based on their personal beliefs as well as the ability to see themselves advancing in such a career (Eccles, 1983). Eccles data also suggests that evidence supports the notion that women tend to pursue careers that have a direct social impact (Jozefowicz, Barber & Ecles 1993; Konrad, 2000; Margolis, 2002; Lubinski & Benbow, 2006; Eccles, 2006). Men see their impact on society in terms of solving problems, while women see their societal impact on a more personal basis. There is a great deal of deliberation as to why this variance exists between men and women. One side of the argument insists that this variance is purely instinct while others argue it is a result of societal projections of gender specific roles. According to NAE, many do not view STEM jobs as have a direct societal impact (National Academy of Engineering, 2008). Therefore, women tend to avoid such careers as they do not see the immediate benefit to society (Eccles, 1994). There are however a handful of STEM disciplines that have a much clearer impact on society. Careers such as biomedical and environmental engineering have a direct impact on human beings and their environment. Therefore, these specific STEM fields have been able to gather more interest from females than other STEM fields (Gibbons, 2009).

While Gibbons (2009) research indicates that girls have a lower stated interest in science and engineering as compared to boys, recent studies by Turner & Lapan have suggested that there are girls can indeed have their interests piqued about STEM careers (Turner & Lapan, 2009). This same study that girls showed a greater interest in STEM fields after being told a 20-minute story that was told by a computer-generated woman about the lives of female engineers and the positive aspects of being an engineer. The story contained positive aspects of being a female engineer as well as dispelling and preconceived societal notions that engineering was exclusively for men. The story also demonstrated to girls how engineering has a direct impact on the well-being of all members of society. Another continuing study and outreach project by Eisenhart is putting an emphasis on working with highly successful minority female students, to educate them on the direct impact that STEM fields have on society. When girls first entered the study, the vast majority knew nothing about engineering. However, of the 66% of girls who remained in the program, 80% of those girls indicated that they were seriously considering a career in some STEM field (Eisenhart, 2008). The Engineer Your Life website (www.engineeryourlife.com), has also been useful in increasing high school girls interest in choosing to enter the field of engineering as a career. In a survey by Paulsen and Bransfield (2009), 88% of 631 girls surveyed, indicated that this useful website was helpful in guide them to potentially pursue a career in STEM.

When one takes a look at not just gender disparity, but the ethnic disparity in combination, it becomes evident that there are some characteristics that are deemed unacceptable for a white female to possess. However, characteristics that may be unacceptable for a white female may be perfectly acceptable for a black female. Characteristics as brazenness and being extremely forward are quite acceptable for a black female. Both of those characteristics can provide an advantage in obtaining success in STEM fields (Hanson, 2004). These characteristics can account for the greater number of African American females expressing a greater interest in pursuing careers in STEM fields than do young white women. Still, the number of African American women in STEM remains low, which suggests that other obstacles are significant for this community (Hanson, 2004).

Over time, stereotypes have changed, and today, career fields that were once considered to be ideal jobs for males have opened up to the acceptance of women. While the STEM fields are progressively changing, life and health sciences are still seen as the more appropriate occupation choice for women, while the physical, high ended sciences and engineering fields are considered manly domains (Farenga & Joyce, 1999).

Parental Role in Guiding Students Educational Decisions

Parental participation in their student's education has been positively attributed to student achievement. Parents find multiple ways to stay involved in the schooling of their children. Whether they help with homework, attend school events or regularly communicate with teachers about progress, these involvement areas are linked to successful student achievement. The tangible signs of positive influence include teacher report card comments, student grades, and achievement test scores (Deslandes, Royer, Potvin, & Leclerc, 1999). Parental involvement is also attributed to lower rates of grade-level retention, lower drop-out rates from school, a greater level of on-time high school graduation, as well as a higher rate of participation in advanced courses (Barnard, 2004). Parental involvement has also been associated with emotional processes and attributes that support student success (Grolnick, Ryan, & Deci, 1991). These qualities assist success across a wide variety of student groups, including special education students and those students to be considered at-risk (Grolnick, Kurowski, Dunlap, & Hevey, 2000). Parents and teachers have a direct impact on student motivation, intellect, and social, and development. These traits encompass a student's sense of personal aptitude and ability for learning. Students with a high level of self-efficacy believe they can perform well in school (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). Mastery orientation, a perception that one has control over their school outcomes is another characteristic attributed to parental involvement (Gonzalez, Holbein, & Quilter, 2002). Students whose parents are actively involved in their education also show self-regulatory knowledge and skills. In other words, these students feel like they can do the work that is presented to them (Xu & Corno, 2003). A natural attribute that follows the characteristics mentioned above is the student's willingness to remain engaged in their schoolwork as well as positive beliefs about the importance of their education (Fantuzzo, 1995).

According to research by Hoover-Dempsey (2005), parents' involvement is motivated by two belief systems: role construction for involvement, and sense of efficacy for helping the child succeed in school (Hoover-Dempsey, et al., 2005). Parental role construction embraces a sense of personal or shared accountability for the child's educational results and simultaneous beliefs about whether one should be engaged in supporting the child's learning and school success. Parents sense of efficacy comes from their belief that their assistance can truly make an impact on the education of their child.

Parental role construction is defined as a parents' belief about what they are expected to do about their child's education and the patterns of parental conduct that follow those expectations. Parents' internal beliefs about their role in their child's education play a major influence on their actual participation in that child's education. Role construction is also fashioned by external groups in the parents' life that have helped shape their opinions as to how involved a parent should be in a child’s education (Drummond & Stipek, 2004). Parents of children often emulate the parental involvement that they experienced.

Role construction is a socially formed precept that is fashioned by the expectations of significant parental social groups and similarly related personal beliefs. Role construction is developed from parents’ involvements over time with individuals and groups related to education. These associations often include the parent’s personal experiences with their education, prior experience with participation in schools, and continuing experiences with others related to the child’s schooling. For example, a parent might not value education nearly as much as another parent because of differing experiences while attending school themselves. Because role construction is socially constructed, parents’ role construction for involvement could easily mutate based on a variety of experiences. This role construction changes in response to differences in social conditions, and it may change in reaction to deliberate efforts to alter role construction (Biddle, 1986).

Drummond and Stipek (2004), who spent considerable time studying parents of African American, Caucasian, and Latino elementary students, identified that role construction stimulated parents’ participation practices in their children’s education (Drummond & Stipek, 2004). This conclusion simply reinforced the theoretical work on stability and change in role construction of parents over time (Biddle, 1986). Drummond and Stipek also observed that social influences can change parents' notions about how involved they should be in their child's education. For instance, when teachers offered suggestions to parents about they could help with their child’s education in specific areas, those same parents changed their beliefs about the significant they were in the of life of their child. Sheldon’s (2002) study of the parents of elementary students from urban and suburban schools revealed that role construction could forecast a parents' home and school based participation activities. A study conducted by Grolnick, Benjet, Kurowski, and Apostoleris (1997) also confirmed the positive impacts that parents made when they believed their influence had a real impact on their students' education.

When studying diverse cultural groups, Chrispeels and Rivero (2001), reported that Latino immigrant parents' philosophies about how, when, where and how they should be involved in their child's education determined their actual involvement, as well as how they respond to invitations from the school to be involved. Parents who do not understand their role in their child's education are more likely to avoid involvement altogether. Chrispeels and Rivero (2001) were also able to determine that if a parent was involved in a program to inform parents on the importance of their involvement in their child's education in a parent education program, their involvement and role beliefs changed to accommodate those expectations. Gonzalez and Chrispeels (2004) consequently reported that parental role construction, or their beliefs of how involved they should be, was the strongest indicator of participation among Latino parents of elementary and secondary students before partaking in a parent education intervention program. Involvement in the program improved parents' knowledge of the schools and strengthened parents' active role construction. When parents were made aware of their importance, those parents became strong advocates for their students. Trevino (2004) was able to determine that parents of high-performing immigrant Latino students has a strong role construction and were found to be highly active in their child's school. Scribner, Young & Pedroza (1999) found a positive correlation between schools that emphasize strong cooperative relationships with parents that parents that have a strong sense of importance to the school.

A second personal motivator of parental involvement is self-efficacy, or belief in one's abilities to act in ways that will produce desired outcomes (Bandura, 1997). When parents believe that they can help their children, they are more likely to invest the time to do so. Self-efficacy is a substantial factor in choices about the goals one elects to chase as well as effort and persistence in working toward the accomplishment of those ambitions (Bandura, 1997). The self-efficacy theory, therefore, proposes that parents determine how involved they must be to obtain the desired results for their student (Hoover-Dempsey, Bassler, & Brissie, 1992). Self-efficacy also stresses that parents cultivate behavioral goals for their involvement based on their evaluation of their abilities in the situation (Bandura, 1989). Therefore, when parents show a higher aptitude in certain areas, those parents will most likely be active in the education of their child; further, they will not give up in the face of adversity. When parents possess a weaker self-efficacy, their expectations for their child's performance are very low and therefore avoid participation in school functions and activities (Hoover-Dempsey & Sandler, 1997).

Self-efficacy, like role construction, is socially constructed. Bandura (1997) proposes that self-efficacy is established from personal experiences in four major areas. The first area is personal mastery experiences. In this area, the student feels the triumph in accomplishing goals in the particular field. The second area is common experiences. The student observes those with personal similarities and witnesses those similar persons finding success in achieving goals in related areas. The third area is verbal persuasion. In this domain, the student receives reassurance from significant others that they are qualified to be successful in their pursuits. The last area is physiological arousal. It is here that the student evaluates their own physical and emotional states to determine if they are capable of handling the current goals with their acquired skill set.

Research has reinforced the anticipated relations between parental efficacy and several aspects of parental involvement. Bandura (1996), reported that parents with greater efficacy for managing their student's academic development were more likely to support children's educational activities than were lower-efficacy parents. Shumow and Lomax (2002), reporting on a national sample of middle and high school students, found that a broad measure of parental efficacy predicted parental involvement and parental monitoring of students. When parents were aware of their impact on their student's education, they were more likely to be and stay involved. Parental involvement is also a predictor of student success. Those parents who invested the time in their student's education found that success was attained at a much higher rate than that of students whose parents were not involved. Grolnick(1997), who studied elementary parents' opinions of personal efficacy concerning children's education, reported higher participation among parents with stronger efficacy across all three domains of involvement. The first domain of involvement being behavioral in which parents are found to be participating in school activities as well as helping their student at home. The second of those three domains is cognitive-intellectual. This domain is measured by parents' engagement with children in intellectually stimulating activities, and being actively attentive to their child's school progress.

In their study of parental efficacy, Shumow and Lomax(2002) examined parents from varying ethnic backgrounds and found a connection parents' self-efficacy and their involvement behaviors at home and the school did indeed exist (Shumow & Lomax, 2002). According to another study conducted by Wentzel(1998), critical parental characteristics that affect student learning are directly connected to parental efficacy. Parents with higher levels of efficacy have goals for their students and do not wane from their commitment (Wentzel, 1998). In the study "Making it work: Low-income working mothers' involvement in their children's education.", Weiss et al. (2003), draw the conclusion that when parents can balance a possible pathway between staying involved in their child's schooling and employment responsibilities, as well as having a strong sense that they can make a difference through supporting their child's educational interests, have a clearer path to success. Those parents who can find a stable balance of involvement in their children's education help to improve their students' self-efficacy in school, which in turn enhances the probability of success in school for their student.

As with role construction, research on efficacy offers considerable support for its influence as a motivator of parental involvement. Likewise, these findings appear across groups that vary in socioeconomic circumstance, ethnicity, student school level, and type of student educational program, thus underscoring the power of both constructs as motivators of parental involvement in children's education (Soodak et al., 2002). When self-efficacy is strong in parents, students develop similar outlooks on life.

Summary

It is evident that the need for STEM active employees is growing at a faster rate than can be produced by the U.S. education system. While the number of students in schools is a variable that cannot easily change, the U.S. must be more strategic on training the current students enrolled in schools. The underrepresentation of females in STEM courses provides a pool of untapped resources to begin filling this need. More studies must be conducted to determine not only first-hand factors that navigate women away from STEM fields but also to ascertain underlying factors that contribute to these choices. Our society can no longer rely on male students to carry the bulk of responsibility for advancing STEM fields; we must insist on the diversity that women can bring to the workforce and find ways to make STEM a welcome option for females.

Self-efficacy is a clear predictor of parental involvement in the schooling of their children, which in turn can either be beneficial or detrimental to the student, depending on the efficacy level of their parent. A strong efficacy displayed by a parent has a direct impact on the success of their student. Therefore, a possible predictor of student engagement in STEM fields could be directly related to the efficacy of their parents and their belief that their child can succeed in these fields.

CHAPTER 3: Research Methodology

This project is a survey-based research study utilizing a Likert Scale survey to examine both the attitudes towards STEM education and knowledge of STEM education of students' parents. Demographic information is collected in this survey as well to contribute to future findings. This study will utilize comparative descriptive statistics to compare the Likert Scale answers obtained from the chosen instrument and student enrollment in advanced level STEM courses. The nature of a Likert Scale survey study is to create ordinal data that can describe the attitude of the respondent. The benefit of the Likert Scale is that they are the most widespread method for survey collection; therefore, they are easily comprehended and familiar to participants. The responses are easily quantifiable and subjective to the computation of some mathematical analysis. Since the Likert Scale does not require the participant to provide a simple and concrete yes or no answer, the survey does not force the member to take a stand on a topic but allows them to select a response within a degree of agreement; which in turn makes question answering easier on the respondent. As well, the responses presented allow for neutral or undecided feelings of participants. Responses are very easy to code when accumulating data since a single number represents the participant's response. Likert surveys are also quick, efficient and inexpensive methods for data collection. They have high versatility and can be sent out through the mail, over the internet, or given in person.

Attitudes of the population for one item exist on an infinite scale. However, the Likert Scale is one-dimensional and restricts the respondent to one response, and the space between each choice cannot possibly be equidistant. Therefore, it fails to measure the correct attitudes of those surveyed. Also, it is not likely that peoples' answers will be influenced by previous questions, or will heavily concentrate on one response side (agree/disagree). Frequently, people avoid choosing the “extremes” options on the scale, because of the negative implications involved with “extremists,” even if an extreme choice would be the most accurate. Therefore, a greater amount of responses can help to determine the overall feelings of respondents and determine outliers in the mix.

Population and Sample

This project focused on a new high school in a moderately small rural city in middle Tennessee. This high school is the newest high school to be added to the growing family of schools in a thriving school district in Middle Tennessee. This school serving close to 42,000 students ("Tennessee School District Demographic Profiles"). This high school is now in its fourth year of existence and in that time, has increased in student population from 1400 students to 2100 students. Students at this high school were comprised of various ethnicities which include: 70% White, 18% Black or African-American, 7% Hispanic or Latino, and 5% "other." Among those, 34% of the students were identified as economically disadvantaged. Males comprise 49.7% of the student body while females comprise 50.3% of the school population.

To gather data that most accurately represents the attitudes and demographics of this high school in middle Tennessee the survey was open to the parents of every student in the school. One parent per household was encouraged to participate. The minimum acceptable sample size was calculated to be 153 respondents with $p<.05$, a power of .80 and a median effect size of .30 based on the current population of 2100 students.

Description of Instrument

The instrument utilized in this study was the Purdue Parent's Engineering Awareness Survey (PEAS) (Yun, Cardella, Purzer, Hsu & Chae, 2010) which was adopted based on its previous validity tests and its ability to determine attitudes of parents towards engineering as well as their knowledge of engineering. This survey was adapted to be an online survey that allows respondents to provide demographic information as well as answering the Likert Scale items to develop a Likert Scale Survey set of data. The reliability test of the instrument was performed using Cronbach's coefficient alpha with the criterion of being above 0.7 (Yun, Cardella, Purzer, Hsu & Chae, 2010). The knowledge section of the instrument achieved an alpha value of 0.94 for its 16 items. The attitude section produced an alpha value of 0.91 for its 20 items.
Because the research question focuses not just on engineering course taking, but STEM course taking overall, the PEAS survey was edited to replace "engineering" with "STEM" in every instance. Due to the word change from "engineering" to "STEM," Cronbach's alpha was recalculated for each of the two sections to ensure that the instrument remained reliable.

Research Procedures and Term of the Study

After receiving IRB approval from Carson-Newman University and Rutherford County Board of Education, the researcher developed an invitation letter to send home to parents soliciting their participation in this study through the created online survey. Since every student is enrolled in a math course throughout their four years of high school, the study was opened to all families whose child attends this high school by sending home the letter through each student's current math course. A letter of introduction was created explaining the nature of the study and asking parents to take 20 minutes of their time to help the researcher gather data. In the letter of introduction, parents were informed that upon completion of the survey, their name would be entered a drawing for a $50 Target gift card. Parents were also informed that they were only allowed to respond once and that their responses had no bearing on the ability to win the gift card. Along with the letter of introduction, an explanation of the study was included and how the data would be used. As well as the introduction letter, the beginning of the survey introduced an initial screen presenting the participant with an informed consent statement in which they agree to the terms before entering the study. For a participant to enter the study, they were required to click a consent button that proceeded to take the participant to the actual survey. Before releasing the letters to students, a mathematics department meeting was called to discuss the nature of the study and the procedure for ensuring that each student was given a copy of the study invitation and information, Information for Participants (see Appendix A) letter to take home to their parents. Math teachers were informed that their only responsibility was to ensure that each student was given a copy of the letter and to discuss with students the benefits of filling out the survey.

In the Information for Participants letter, participants were given a website address which would take the respondent to the online survey. When entering the site for participation, participants were presented with the purpose of the study as well as procedures for completing the survey. Participants were also informed on this landing page that should they desire to enter the drawing for the $50 Target gift card; they would be asked to provide their email address which would be destroyed after the drawing took place. Once participants agreed to the conditions set forth in the informed consent, they were presented with a series of Likert Scale Items as well as demographic items in which to record a response. Responses were recorded electronically and stored in a secure Google spreadsheet. Once the data collection window closed, the survey was taken offline to ensure that no more data were collected beyond the scope of the study. The data was then imported into the Statistical Analysis Software (SAS), University Edition, for data analysis. The window for responding to the survey was open for two weeks, providing ample time for respondents to enter their data.

Procedure for Data Analysis

The data, compiled in Microsoft Excel after the response window closed, provided the data necessary to perform statistical analysis in SAS. Each participant was assigned a score based on their responses from the survey. The first section of the survey focused on determining the STEM knowledge of parents with sixteen questions, each having a score ranging from one to five with a score of one being little or no knowledge and a score of five indicating a high level of STEM knowledge. An overall score was calculated by adding the response values of each question which produced an overall knowledge score that ranged from sixteen to eighty. A score of sixteen indicated very little parental knowledge of STEM education while a score of eighty indicated a parent with a high level of STEM education knowledge. The second portion of the survey focused on parental attitudes towards STEM education. Each question in this part of the survey had the participating parent rank their beliefs about STEM education with answers ranging from one to five. A response of one indicated a belief that strongly disagreed with given statement about STEM education while an answer of five indicated a statement that the participant strongly agreed with. Each participant was also given an overall attitude score that was calculated by adding the numerical values of all responses. As well as calculating the attitude and knowledge scores of parents, the survey also asked parents to determine whether their student was enrolled or planning on enrolling in an advanced level STEM course.

Once all responses were collected and attitude and knowledge scores were calculated, those scores were compared to the enrollment status variable. Since the dependent variable, enrollment status of the student, is binary (yes indicated that the student is enrolled or planning to enroll, with no indicating that the student is not enrolled or planning to enroll), a binary logistical regression was used to determine if parental knowledge and attitudes of STEM are indicators of student enrollment in STEM courses. Binary logistic regression estimates the probability that a characteristic is present (e.g. estimate probability of "enrolled") given the values of explanatory variables. Both independent variables, knowledge of STEM and attitude toward STEM were used as the explanatory variable. Each variable was tested against the binary variable of enrolled status to determine if either variable was a predictor of student enrollment.

The binary logistical regression was then tested with Tjur's coefficient of discrimination, D (Tjur, 2009). D is the difference in the average of the event probabilities between the groups of observations with observed events and nonevents. The properties of D according to (Tjur, 2009), like R^2, D ranges from 0 to 1. $D \geq 0$. $D = 0$ if and only if all estimated probabilities are equal then the model has no discriminatory power. $D \leq 1$. $D = 1$ if and only if the observed and estimated probabilities are equal for all observations, then the model discriminates perfectly.

CHAPTER FOUR

Analysis of Data

The purpose of this study was to evaluate parental STEM knowledge and awareness as predictors of advanced level course enrollment. Parents of students attending a large suburban high school in Middle Tennessee were asked to take an online survey that was administered via Google forms. The *Parental STEM Awareness Survey* (Appendix B) utilized in this study was a modified form of the Purdue Parent's Engineering Awareness Survey (PEAS) (Yun, Cardella, Purzer, Hsu & Chae, 2010) which was adopted based on its previous validity test and its ability to determine attitudes of parents towards engineering as well as their knowledge of engineering. This survey was adapted to be an online survey that allows respondents to provide demographic information as well as answering the Likert Scale items to develop a Likert Scale Survey set of data. The reliability test of the instrument was performed using Cronbach's coefficient alpha with the criterion of being above 0.7 (Yun, Cardella, Purzer, Hsu & Chae, 2010). The knowledge section of the instrument achieved an alpha value of 0.94 for its 16 items. The attitude section produced an alpha value of 0.91 for its 20 items.

Because the research question focuses not just on engineering course taking, but STEM course taking overall, the PEAS survey was edited to replace "engineering" with "STEM" in every instance. Due to the word change from "engineering" to "STEM," Cronbach's alpha was recalculated for each of the two sections to ensure that the instrument remained reliable with the knowledge portion maintaining its 0.94 alpha value for its 16 items while the attitude portion maintained a similar score of 0.90 for its 20 items. In addition to answering survey statements, respondents were also asked to provide demographic information including age range, profession category, annual income range and education level.

An email was sent to every students' parents through the school messenger application used by the school district. This email contained the link to the google forms page that collected the input from the user. The window for data collection was left open for a period of two weeks with a reminder email sent to all parents once during that time frame. Once the data collection window closed, the survey was shut down to prevent any further responses.

Data were then exported from the Google form to Microsoft Excel where the attitude and knowledge scores were calculated by adding the response values of the respondents. Once these scores were calculated, the data were then imported into the Minitab data analysis software for further analysis. As described in Chapter Three, demographic data were aggregated to determine the descriptive statistics of the data gathered, as well as comparing knowledge and attitude scores, which make up the two components of parental STEM awareness, to student enrollment in upper level STEM courses through a binary logistic regression to address the research question of:

> Is parental STEM awareness a predictor of student enrollment in advanced level STEM courses in high school?

This chapter presents the findings of the study. Results are reported in text, table and graph form.

Demographic Data

Parents of students attending a Middle Tennessee high school, school during the 2016-2017 school year were invited to participate in the study. Of the 2087 students enrolled in the school, 227 parents chose to participate in the study. This response rate exceeded the 130 responses required as described in Chapter Three. Data analysis was conducted on the sample of 227 parents.

As table 4.1 illustrates, of the 227 respondents, 176 parents (77.5%) were females while 51 parents (22.5%) were males.

Table 1

Respondent Gender

Gender	N	%
Female	176	77.5
Male	51	22.5

When considering the age range of respondents, as illustrated in table 4.2, 4 (1.7%) respondents were between the ages of 30-34, 34 (15.0%) respondents were between the ages of 35-39, 82 (36.1%) respondents were between the ages of 40-44, 68 (30.0%) respondents were between the ages of 45-49, 28 (12.3%) respondents were between the ages of 50-54, 9 (4.0%) respondents were between the ages of 55-59, and 2 respondents (0.9%) were 60 and over in age.

Table 2

Age of Respondents

Age	N	%
30-34	4	1.7
35-39	34	15.0
40-44	82	36.1
45-49	68	30.0
50-54	28	12.3
55-59	9	4.0
60 & Over	2	0.9

Respondents were asked to describe their current household makeup within the parameters of the survey choices. As illustrated in Table 4.3, 188 (82.8%) respondents described their household as Married Couple, Children Living at Home, 31 (13.7%) respondents described their household as Single, Children Living at Home, 4 (1.8%) respondents described their household as Unmarried Couple, Children Living at Home, while 4 (1.8%) respondents described their household as Other.

Table 3

Household Description

Household	N	%
Married Couple, Children Living at Home	188	82.8
Single, Children Living at Home	31	13.7
Unmarried Couple, Children Living at Home	4	1.8
Other	4	1.8

Another demographic statistic collected in the survey was the level of education of the respondents. As illustrated in Table 4.4, 1 (0.4%) respondent indicated that their education level as not completing high school, 20 (8.8%) respondents indicated their education level as completing high school, 41 (18.1%) respondents indicated the acquisition of an associate's degree, 86 (37.9%) respondents indicated their education level as having obtained a bachelor's degree, 44 (19.4%) respondents said they had earned a master's degree, 8 (3.5%) respondents declared a doctoral degree and 1 (0.4%) respondent indicated other as their level of education.

Table 4

Education Level

Education	N	%
Less than High School	1	0.4
High School Graduate	20	8.8
Some College	41	18.1
Associates Degree	26	11.5
Bachelor's Degree	86	37.9
Master's Degree	44	19.4
Doctoral Degree	8	3.5
Other	1	0.4

Respondents were also asked to describe their current occupation in the demographic collection portion of the survey. 14 (6.1%) respondents indicated that they were a homemaker, 38 (16.7%) respondents indicated that they were a Manager/Executive, 74 (32.6%) declared they were a Professional, 17 (7.5%) respondents identified as an employee in Sales/Service, 58 (25.6%) respondents indicated that they were a Teacher/Educator, 4 (1.8%) respondents declared their occupation as Technician/Operator, while 22 (9.7%) respondents declared Other as their occupation (See Table 4.5).

Table 5

Respondent Occupation

Occupation	N	%
Homemaker	14	6.1
Manager/Executive	38	16.7
Professional	74	32.6
Sales/Service	17	7.5
Teacher/Educator	58	25.6
Technician/Operator	4	1.8
Other	22	9.7

As a final demographic question, participants were asked if they held a degree in any of the STEM disciplines. As indicated in Table 4.6, out of all the respondents, 5 (2.3%) indicated that they held a degree in engineering, 6 (2.6%) indicated that they held a degree in mathematics, 33 (14.5%) indicated that they held a degree in science, 1 (0.4%) respondent indicated a degree combination of science and mathematics, 1 (0.4%) respondent indicated a degree combination of science, mathematics and engineering, 1 (0.4%) respondent indicated a degree combination of science and technology, while 10 (4.4%) respondents identified as having strictly a technology degree, 2 (0.9%) respondents stated that they had a combined degree of technology and engineering, and 168 (74.0%) respondents indicated that they held no degree in any of the STEM fields.

Table 6

Do you have a degree in any of the following STEM Fields

Degree	N	%
Engineering	5	2.3
Mathematics	6	2.6
Science	33	14.5
Science/Mathematics	1	0.4
Science/Mathematics/Engineering	1	0.4
Science/Technology	1	0.4
Technology	10	4.4
Technology/Engineering	2	0.9
No, I do not hold a STEM degree	168	74.0

Parental Knowledge Data

Parental knowledge overall scores were calculated by summing each of the survey's individual components. The mean knowledge score was 46.9 with a standard deviation of 15.5. The following paragraphs analyze the data collected for each individual statement in the survey.

As part of the Parental STEM Awareness Survey, respondents were asked to respond to a Likert scale survey that was composed of two portions. The first portion determined the knowledge level of parents by asking respondents to rank their knowledge level from one 1). I do not know to 5). I am confident enough in my own understanding to explain to others, to a series of sixteen STEM Knowledge statements.

As illustrated in Table 4.7, considering the statement, *I know how those in STEM fields use engineering design principles*, the average score obtained was 2.69 with 72.4% of the respondents selecting a score of 3 or less, indicating a lack of knowledge as to how those in STEM fields use engineering design principles.

When considering the statement, *I know how those in STEM fields use problem-solving strategies,* the average score obtained was 2.82 with 65.3% of the respondents selecting a score of 3 or less, indicating a lack of knowledge as to how STEM fields use problem solving strategies.

Regarding the survey statement, *I know what those in STEM Fields do,* the average score recorded was 3.01 with 65% of the respondents choosing 3 or higher. This score indicates an average level of knowledge as to what those in STEM fields do.

Most respondents, 82.9%, scored themselves three or higher to the statement, *I know how STEM is related to science, mathematics, and technology*. With an average score of 3.59 indicating a strong knowledge of STEM relationships to science, mathematics and technology.

In response to the survey statement, *I know how STEM can be used to help society,* 91.2% of the participants scored themselves three or higher. This provided an average score of 3.85, indicating a strong knowledge of STEM impact on society.

When responding to how STEM differs from other disciplines, all three statements generated similar scores. In reference to the question, *I know how STEM is different from science,* 78.1% of the respondents selected a value of three or higher creating and average score of 3.4. When responding to the statement, *I know how STEM is different from mathematics,* 75.4% of the respondents chose a score of three or higher with an average score of 3.35. When responding to, *I know how STEM is different from technology*, 73.2% of the participants selected a self-score of 3 or higher which resulted in an average score of 3.29. All three of these scores indicate an average differential knowledge of the four disciplines.

The following four statements of the survey shared a similar thread of parental confidence in STEM. When presented with *I know how to teach STEM skills to my child(ren),* 75.4% of those responding scored themselves 3 or below with an average score of 2.54. In a similar statement, *I know how to apply STEM-related concepts in my daily life,* had a similar response with an average score of 2.76 with 68.4% of the respondents scoring themselves three or below. The average score on the statement *I know how to explain STEM-related concepts to my child(ren),* 2.67 with 71% of the respondents scoring themselves 3 or below. The last of the similar statements *I know how to help my child(ren) develop his/her STEM ideas and skills,* had an average score of 2.67 with 71.1% of the respondents scoring themselves as 3 or below. When analyzing these four similar statements, the scores indicate that parents are not as confident in helping their students realize their potential in some STEM field.

About the statement, *I know how to identify and solve problems,* 86.4% of the people who responded scored themselves 3 or higher. This provided an average score of 3.71 which indicates that those surveyed find themselves confident in solving problems.

Table 7

Online Parental STEM Awareness Survey Knowledge Portion

Statement	1	2	3	4	5	Avg Score
I know how those in STEM fields use engineering design principles	26.8%	15.8%	29.8%	16.7%	11.0%	2.69
I know how those in STEM fields use problem-solving strategies	24.1%	16.2%	25.0%	22.4%	12.3%	2.82
I know what those in STEM Fields do	20.6%	14.5%	22.4%	28.1%	14.5%	3.01
I know how STEM is related to science, mathematics, and technology.	5.7%	11.4%	27.2%	29.8%	25.9%	3.59
I know how STEM can be used to help society	3.1%	5.7%	23.7%	38.6%	28.9%	3.85
I know how STEM is different from science	7.9%	14.0%	28.5%	29.4%	20.2%	3.40
I know how STEM is different from mathematics	7.9%	16.7%	27.6%	28.5%	19.3%	3.35
I know how STEM is different from technology	10.5%	16.2%	25.9%	28.9%	18.4%	3.29
I know how to teach STEM skills to my child(ren)	27.2%	25.0%	23.2%	16.2%	8.3%	2.54
I know how to apply STEM-related concepts in my daily life	23.2%	18.9%	26.3%	21.9%	9.6%	2.76
I know how to explain STEM-related concepts to my child(ren)	25.9%	19.7%	25.4%	19.7%	9.2%	2.67
I know how to help my child(ren) develop his/her STEM ideas and skills	25.9%	20.2%	25.0%	19.3%	9.6%	2.67
I know how to identify and solve problems	5.3%	8.3%	25.4%	31.6%	29.4%	3.71
I know how to find more information to help my child(ren) learn more about STEM	12.7%	14.5%	24.6%	28.1%	20.2%	3.29
I know where to search to find more STEM-related information	14.0%	14.5%	21.1%	30.3%	20.2%	3.28
I am aware of STEM activities at my child(ren)'s school.	7.9%	16.7%	27.6%	28.9%	18.9%	3.34

Note. n=227

Parental Attitude Data

In the second part of the Parental STEM Awareness Survey, respondents were asked to respond to Likert scale survey statements that determined the attitude level towards STEM of parents by asking respondents to rank their attitude level from one 1). Strongly Disagree to 5). Strongly agree to a series of 22 STEM attitude statements. The mean score for respondents was 84.5 with a standard deviation of 15.1.

As illustrated in Table 4.8, The overall average score on all 22 statements was 3.84 with a standard deviation of 0.69. This overall score indicated a strong positive attitude towards STEM education. There were however three statements that had extremely low scores that affected the overall mean. Two of those three statements were polarizing statements that asked parents to determine if it was more important for boys or girls to learn STEM. The first of those two statements were worded as follows: *It is more important for girls to learn STEM than it is for boys to learn STEM,* while the second was similarly worded with: *It is more important for boys to learn STEM than it is for girls to learn engineering.* The average score on the first was 2.1 with 88.6% of the respondents leaning towards disagree with a ranking of 3 or less on the statement. The average score on the second was even lower with 1.92 and 94.7% of the respondents leaning towards disagree with a ranking of 3 or less. The one statement in the attitude portion of the survey that countered both of these statements was, *It is equally important for girls and boys to learn STEM.* This statement had an average score of 4.58 with 95.2% of the respondents selecting a ranking score of 3 or higher. This data indicates that parents believe that gender plays no role in the importance of learning STEM. The third of the scores that was extremely low was, *I would like my child to learn STEM, but the school day is already too full for my child's school to include engineering*. This statement earned an average score of 2.77 with

76.8% of the respondents selecting a score of three or lower. This data indicates that parents consider STEM to be an important part of what their students learn during their school day.

Table 8

Online Parental STEM Awareness Survey Attitude Portion

Statement	1	2	3	4	5	Mean Score
a. I believe STEM plays a role in improving our quality of life.	1.3%	2.6%	22.4%	31.6%	42.1%	4.11
b. I believe those who work in STEM make our life more convenient.	1.8%	2.2%	22.4%	31.1%	42.5%	4.11
c. STEM is worth studying.	0.9%	2.6%	17.5%	25.4%	53.5%	4.28
d. STEM improves our society.	0.9%	2.6%	19.7%	29.8%	46.9%	4.19
e. I believe work in STEM helps people.	0.4%	2.2%	21.5%	27.2%	48.7%	4.21
f. I believe those who work in STEM fields make my child(ren)'s lives easier.	0.4%	3.5%	20.6%	32.9%	42.5%	4.14
g. I would like my child(ren) to pursue a career in STEM.	1.3%	7.5%	29.4%	29.8%	32.0%	3.84
h. My child(ren) would enjoy studying STEM in college.	2.2%	9.2%	30.7%	32.9%	25.0%	3.69
i. I believe that learning STEM ideas and skills would be good for mychild(ren).	0.9%	3.1%	21.5%	30.3%	44.3%	4.14
j. STEM skills would be useful for my child(ren)'s career.	0.4%	5.3%	22.4%	30.7%	41.2%	4.07
k. My child(ren)'s school should teach STEM concepts and skills.	0.9%	3.5%	17.1%	27.2%	51.3%	4.25
l. My child(ren) would enjoy learning STEM in K-12.	0.4%	5.7%	25.9%	23.7%	44.3%	4.06
m. Learning STEM in K-12 will allow my child(ren) to better understand other subjects, such as science, mathematics, and technology.	0.4%	3.1%	18.0%	29.4%	49.1%	4.24
n. I believe my child(ren) would have an improved quality of life if they learn STEM in K-12.	2.6%	3.9%	22.4%	29.4%	41.7%	4.04
o. I want my child(ren) to learn STEM skills.	0.9%	3.1%	20.2%	27.2%	48.7%	4.20
p. I want my child(ren) to understand what those in STEM fields do.	0.4%	2.6%	16.7%	28.5%	51.8%	4.29
q. It is more important for girls to learn STEM than it is for boys to learn STEM.	50.0%	8.8%	29.8%	4.4%	7.0%	2.10
r. It is more important for boys to learn STEM than it is for girls to learn engineering.	53.5%	10.1%	31.1%	1.8%	3.5%	1.92
s. It is equally important for girls and boys to learn STEM.	0.9%	3.9%	8.8%	8.8%	77.6%	4.58
t. I am interested in attending workshops about STEM at my children's school.	9.2%	11.8%	31.1%	28.1%	19.7%	3.3
u. I think it is necessary to learn about STEM fields as early as possible.	3.1%	6.6%	25.9%	28.5%	36.0%	3.88
v. I would like my child to learn STEM, but the school day is already too full for my child's school to include engineering.	18.4%	20.2%	38.2%	12.3%	11.0%	2.77

Note. n=227

Knowledge and Attitude Scores as Predictors of Enrollment

At the end of the Parental STEM Awareness survey, parents were asked to indicate if their student was enrolled or planning on enrolling in upper level STEM courses in high school. Each respondent was given a knowledge score and attitude score which was calculated by adding the cumulative scores from each respective section. The knowledge score ranged from 16 to 80, while the attitude score ranged from 22 to 110. Each of these scores was then paired with the response variable of "Is your student enrolled or planning on enrolling in upper level STEM courses?". Since this variable is binary in nature with only two possible answers of "Yes" or "No", a binary logistic regression was used to determine if each individual score of parental knowledge or attitude could be used as a predictor to determine whether a student would enroll in upper level STEM courses.

The knowledge score data was analyzed through Minitab statistical analysis software to determine the binary logistic regression model for this data. Minitab calculated the following probability equation $P(yes) = \frac{e^{(-1.3075+0.033241*knowledge\ Score)}}{1+e^{(-1.3075+0.033241*knowledge\ Score)}}$ with a p-value of 0.0038. As illustrated in figure 4.1, as a parent's knowledge score increased along the independent axis, the probability increased as well. As Figure 1 illustrates, a parental knowledge score of 16 would indicate a 31.53% probability of student enrollment in an upper level STEM course. On the opposite end of the spectrum, a score of 80 would indicate a 79.44% probability of that parent's

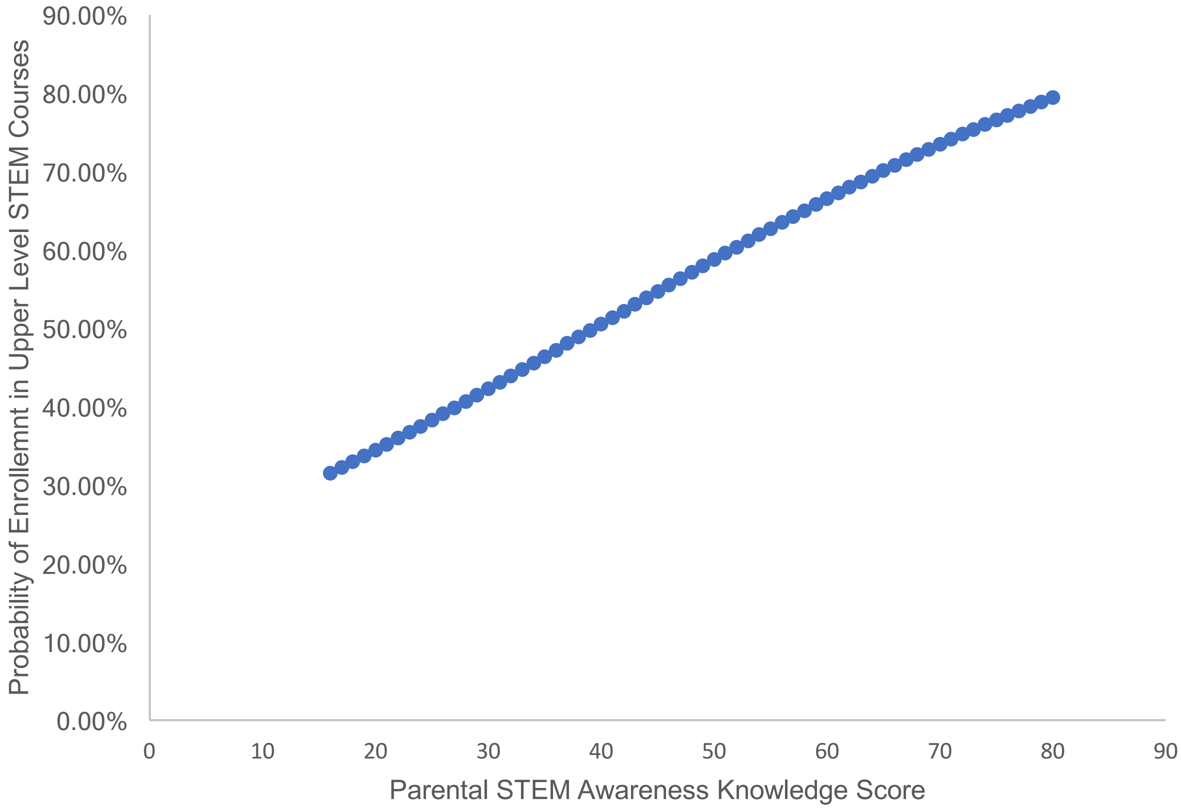

Figure 1. Parental STEM Awareness Knowledge Score as a Predictor of Enrollment. This figure shows the predicted probability of student enrollment based on parental knowledge score.

With the same data in use, the odds data were calculated to determine an increase in odds based on a knowledge score increase in parents. Based on the data in Figure 2, a student whose parent increases their knowledge score by 20 points was 94.4% more likely to be enrolled in upper level STEM courses. A student whose parent saw an increase in 40 points on their knowledge score was 277.97% more likely to be enrolled in upper level STEM courses.

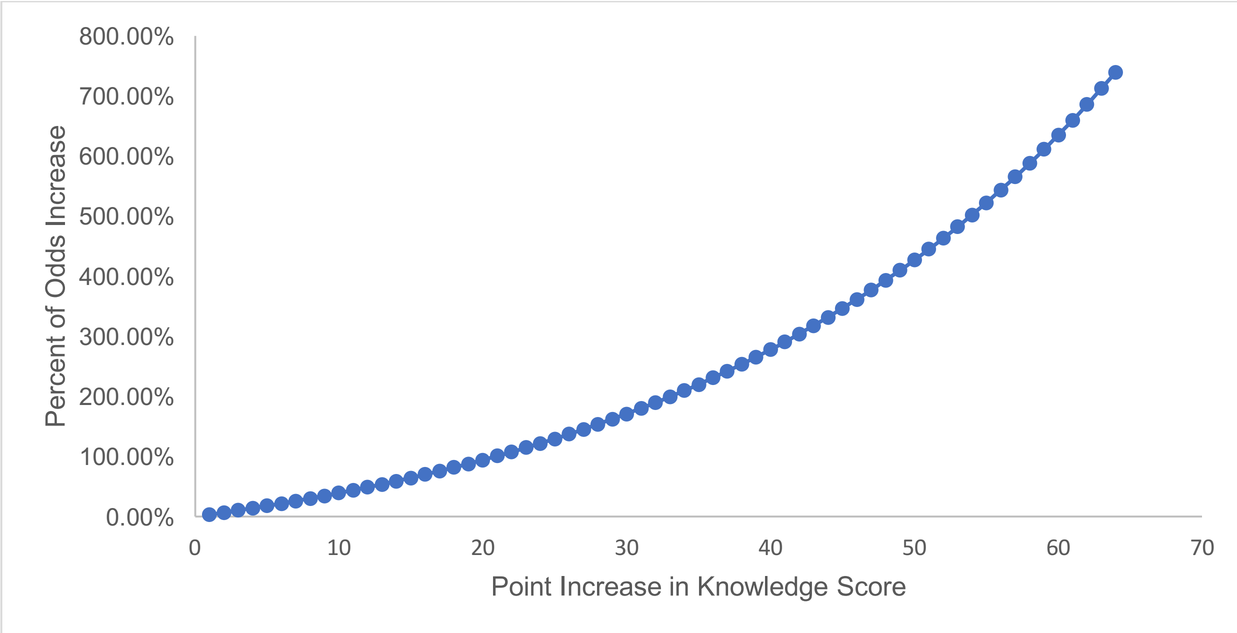

Figure 2. Knowledge Score Increase - Odds of Enrollment Increase. This figure demonstrates the odds increase of student enrollment in upper-level STEM courses associated with an increase in parental knowledge score.

Each respondent was also given an attitude score which was calculated by adding the cumulative scores from each respondent's answers to the attitude portion of the survey. The attitude score ranged from 22 to 110. Each of these scores was then paired with the response variable of "Is your student enrolled or planning on enrolling in upper level STEM courses?". Again, since this variable is binary in nature with only two possible answers of "Yes" or "No", a binary logistic regression was used to determine if each individual score of parental attitude could be used as a predictor to determine whether a student would enroll in upper level STEM courses.

The attitude score data was also analyzed through Minitab statistical analysis software to determine the binary logistic regression model for this data. Minitab calculated the following probability equation $P(yes) = \frac{e^{(-1.6914\, +\, 0.024020 * \text{ Attitude Score})}}{1+e^{(-1.6914\, +\, 0.024020 * \text{Attitude Score})}}$ with a P-Value of 0.008. As illustrated in figure 4.3, as a parent's attitude score increased along the independent axis, the probability of student enrollment in upper level STEM courses increased as well. As the Figure 3 illustrates, a parental attitude score of 22 would indicate a 23.81% probability of student enrollment in an upper level STEM course. On the opposite end of the spectrum, a score of 110 would indicate a 72.13% probability of that parent's student being enrolled in an upper level STEM course.

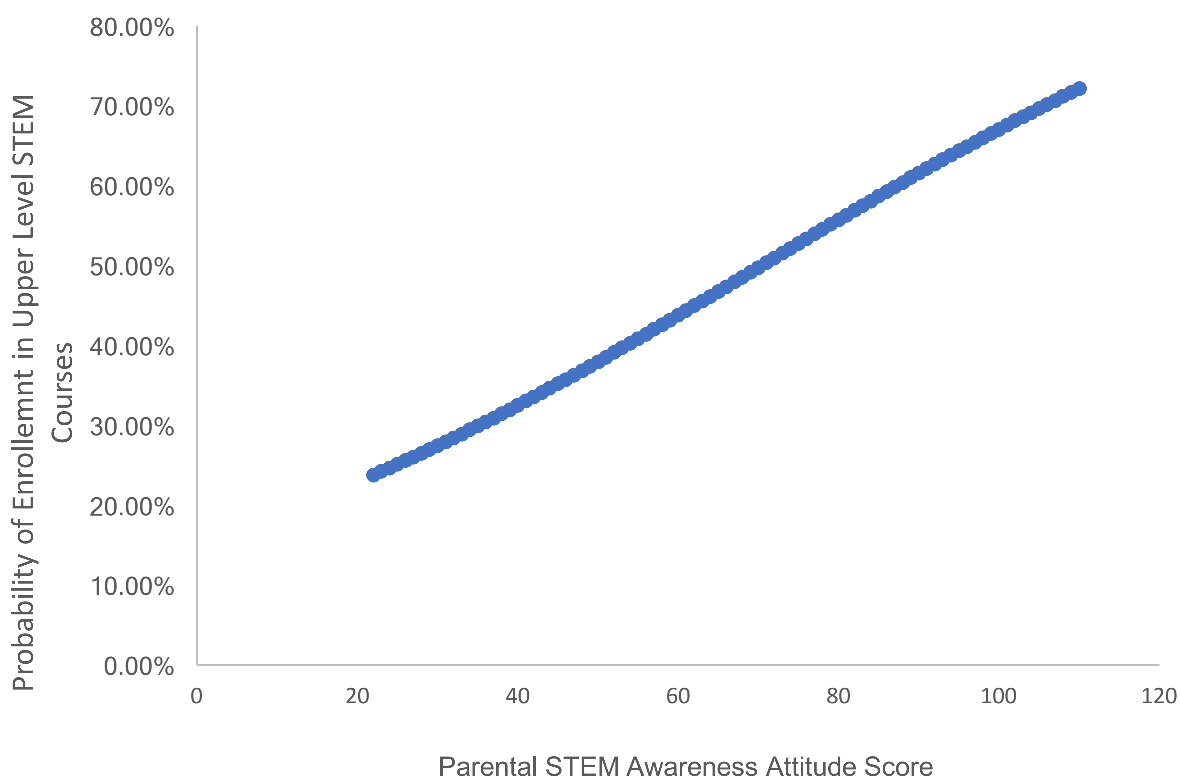

Figure 3. Parental STEM Awareness Attitude Score as a Predictor of Enrollment. This figure shows the predicted probability of student enrollment based on parental attitude score.

Again, with the attitude data in use, the odds data was calculated to determine an increase in odds based on an attitude score increase in parents. Based on the data in Figure 4, a student whose parent increases their attitude score by 20 points was 61.7% more likely to be enrolled in upper level STEM courses. A student whose parent saw an increase in 40 points on their attitude score was 161.4% more likely to be enrolled in upper level STEM courses. As the point increase trend upwards, the odds of that student enrolling in upper level STEM courses improves greatly.

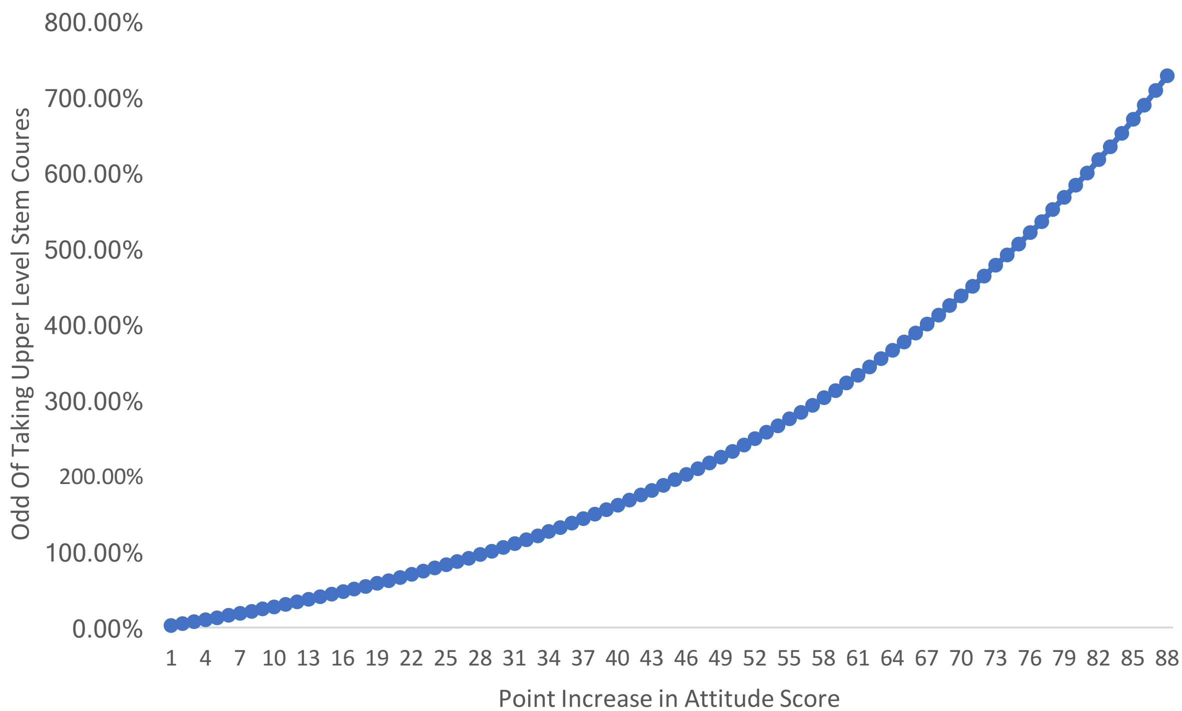

Figure 4. Attitude Score Increase - Odds of Enrollment Increase. This figure demonstrates the odds increase of student enrollment in upper-level STEM courses associated with an increase in parental attitude score.

Conclusion

This study examined Parental STEM Awareness as a predictor of student enrollment in upper level STEM courses. In this study, data were collected from parents of students attending a large high school in a suburban area in Middle Tennessee during the month of February 2017. The research question was: Is parental STEM awareness a predictor of student enrollment in advanced level STEM courses in high school? All data were derived from an online survey with 227 responses.

This chapter presented descriptive statistics including demographic information and survey responses. This chapter provided data relating to parental STEM awareness, which was broken down into two distinct sections that define awareness. The first component of awareness was “Knowledge” which was comprised of sixteen statements to which the respondents ranked themselves on a Likert scale survey. The second component, “Attitude” was ranked in the very same manner. This chapter presented findings of the data disaggregated by demographic information as well as survey components.

While the attitude portion indicated that higher parental scores indicated a greater probability of student enrollment in upper-level STEM courses, the probability was not as significant as higher knowledge scores. When comparing the odds ratios of attitude and knowledge, attitude had an odds ratio of 1.02431 while knowledge had an odds ratio of 1.03380. This indicated that a one point increase in parental STEM knowledge improved a student’s odds of enrollment by 3.38%, while a one point increase in parental STEM attitude only contributed to 2.43% odds increase.

Chapter 5 provides a summary of the study, a discussion of the research findings, and recommendations for future research.

CHAPTER FIVE

Conclusions, Implications, and Recommendations

The purpose of this study was to determine if parental STEM awareness was a predictor of student enrollment in upper-level STEM courses. This study investigated parental STEM awareness as a composite of knowledge and attitude components and compared those scores to the enrollment status of their student in upper-level STEM courses. Parents with students enrolled at a large public high school in a Middle Tennessee completed an online survey (See Appendix B) consisting of Likert-type items, and demographic information. The data were analyzed with procedures including descriptive measures and binary logistic regression. The research question guiding this study was:

> Is parental STEM awareness a predictor of student enrollment in advanced level STEM courses in high school?

This chapter provides a summary of the findings, conclusions, implications, and recommendations for further study.

Summary

The population for this study included all parents of students enrolled in the selected middle Tennessee high school as of January 2017. Of the 2087 students enrolled, 227 students' parents chose to participate in the study. The estimated mean age of participants was 44.6, with the largest number of participants falling between the ages of 40 and 44. Most respondents were female with 176 females responding, representing 77.5% of those participating. One hundred eighty-eight respondents described their household as a married couple with children living at home. This represented 82.8% of those participating in the study.

Conclusions

1. A logistic regression was performed to ascertain the effects of parental knowledge on the likelihood that participants' student is enrolled or will enroll in upper-level STEM courses. The logistic regression model was statistically significant, $X^2(1) = 15.21$, $p < .0001$. The model correctly classified 68.1% of cases indicating that higher attitude scores were associated with an increased likelihood of student enrollment in upper-level STEM courses.
2. A logistic regression was performed to ascertain the effects of parental attitude on the likelihood that participants' student is enrolled or will enroll in upper-level STEM courses. The logistic regression model was statistically significant, $X^2(1) = 7.03$, $p < .008$. The model correctly classified 60.8% of cases indicating that higher knowledge scores were associated with an increased likelihood of student enrollment in upper-level STEM courses.

Implications

The findings of this study indicated that both knowledge and attitude scores, the components that comprise parental awareness, are indeed predictors of student enrollment in upper-level STEM courses. Parents with higher attitude and knowledge scores on the Parental STEM Awareness Survey (Appendix B) demonstrated a greater probability of student enrollment in upper-level STEM courses.

If STEM education is responsible for creating critical thinkers, educating students to be mindful of scientific impacts, and enables the next generation of trendsetters ("Stats in Brief:

students who study science", 2009), then increasing the number of students who study STEM must be a priority for our schools. Parents are an extremely important component to student success in school and the choices they make about their education. Students whose parents are actively involved in their education also show self-regulatory knowledge and skills. In other words, these students feel like they can do the work that is presented to them (Xu & Corno, 2003). A natural attribute that follows the characteristics mentioned above is the student's willingness to remain engaged in their schoolwork as well as positive beliefs about the importance of their education (Fantuzzo, 1995). When one believes they can succeed in a given profession, interest in that occupation begins to grow (Eccles, 1983). Therefore, we must work on increasing the STEM knowledge and attitude levels of parents in an effort to make an impact on increasing the number of students who seek out courses and careers in STEM.

Recommendations

Future study should include a larger population of respondents. This study was conducted at a large, public high school in suburban community in Middle Tennessee. The study could be repeated at other high schools of varying sizes varying demographics.

Future research could study correlations between parental demographics and knowledge scores. This study could include demographics such as parental education level, household income, or parental profession.

Future research could be conducted as a longitudinal study by comparing parental knowledge and attitude scores over a period that measures pre-education in STEM to post-education in STEM.

Future research could be conducted to compare high schools with STEM feeder middle schools to non-STEM feeder middle schools to determine the difference in parental scores.

Future study could be conducted on faculty of the school and its feeder schools to determine the attitude and knowledge scores of those faculty to those of the parents whose students are enrolled in those respective schools.

Conclusion

This study evaluated the possibility of parental STEM knowledge and awareness as predictors of student enrollment in upper-level STEM courses. As a result of the findings of the researcher, there is a statistically significant connection to parental knowledge and attitude to student enrollment in upper-level STEM courses.

The data indicate that the probability of student enrollment upper-level STEM courses increases as parental knowledge and attitudes increase. This data indicates that an improved effort on educating parents in STEM may have an overall impact on increasing the number of students who aspire to seek out courses and careers in STEM. Parents with low scores in STEM knowledge and attitude may not be able to provide appropriate opportunities for their students to foster an appreciation for courses related to STEM careers. In addition to improving the opportunities for students in STEM education through courses, materials and opportunities, schools must additionally create opportunities for parents to be exposed and learn about STEM.

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Appendix A

Online Consent Form

Appendix A

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Evaluating Parental Stem Knowledge and Awareness as a Predictor of Advanced Level Course Enrollment

Online Consent Form

You are invited to take part in a research survey about Evaluating Parental Stem Knowledge and Awareness as a Predictor of Advanced Level Course Enrollment. Your participation will require approximately 20 minutes and is completed online at your computer. There are no known risks or discomforts associated with this survey. By taking part in this survey your name will be entered into a drawing for a $50 Target gift card. Your chances of winning the gift card are not improved by your responses and the odds of winning the card are dependent on the number of total responses received from the online survey. Taking part in this study is completely voluntary. If you choose to not be in the study you can withdraw at any time without adversely affecting your relationship with anyone at your students learning institution. Your responses will be kept strictly confidential, and digital data will be stored in secure computer files. Any report of this research that is made available to the public will not include your name or any other individual information by which you could be identified. If you have questions or want a copy or summary of this study's results, you can contact the researcher at the email address above. If you have any questions about whether you have been treated in an illegal or unethical way, contact the Carson Newman Institutional Research Board chair, [CARSON NEWMAN IRB CHAIR INFORMATION]. Please feel free to print a copy of this consent page to keep for your records.

Clicking the "Next" button below indicates that you are 18 years of age or older, and indicates your consent to participate in this survey.

Appendix B

Parents' STEM Awareness Survey

Appendix B

Parents' STEM Awareness Survey

The goal of this study is to better understand what parents think about engineering education and about including engineering topics or engineering-related materials in K-12 schools.

The following definition may be useful while taking this survey: Engineering is a discipline, art, skill and profession. Engineers learn and apply scientific, mathematical, economic, social, and practical knowledge, in order to design, create and build structures, machines, devices, systems, materials and processes.

If you have any questions, please contact Mark Gonyea at markjgonyea@gmail.com

1 a. Do you have any children in K-12th grade? Yes or No

1 b. Are you your student's Mother____ Father___

1 c. Is your student enrolled in, or planning on enrolling in of the following courses: Pre-Calculus, AP Calculus, Computer Programming, AP Physics, AP Chemistry, AP Biology Yes or No

1 d. If yes to 1 c., please indicate courses taken and courses planning on taking. (Circle all that apply). Pre-Calculus, AP Calculus, AP Computer Science, AP Chemistry, AP Biology, AP Physics

2. Choose one response for each of the following statements about your knowledge of engineering.

. 1 = I do not know.

. 2 = I have a vague understanding, but am not confident in my knowledge.

. 3 = I have some understanding, but not enough to explain it to my child.

. 4 = I have enough understanding to explain it to my child, but I am not confident enough to

teach others. 5 = I am confident enough in my understanding to explain it to others.

a. I know how those in STEM fields use engineering design principles.

I do not know 1 2 3 4 5 I am confident

b. I know how those in STEM fields use problem-solving strategies.

I do not know 1 2 3 4 5 I am confident

c. I know what those in STEM Fields do.

I do not know 1 2 3 4 5 I am confident

d. I know how engineering is related to science, mathematics, and technology.

I do not know 1 2 3 4 5 I am confident

e. I know how STEM can be used to help society.

I do not know 1 2 3 4 5 I am confident

f. I know how STEM is different from science.

I do not know 1 2 3 4 5 I am confident

g. I know how STEM is different from mathematics.

I do not know 1 2 3 4 5 I am confident

h. I know how STEM is different from technology.

I do not know 1 2 3 4 5 I am confident

i. I know how to teach STEM skills to my child(ren).

I do not know 1 2 3 4 5 I am confident

j. I know how to apply STEM-related concepts in my daily life.

I do not know 1 2 3 4 5 I am confident

k. I know how to explain STEM-related concepts to my child(ren).

I do not know 1 2 3 4 5 I am confident

l. I know how to help my child(ren) develop his/her STEM ideas and skills.

I do not know 1 2 3 4 5 I am confident

m. I know how to identify and solve problems.

I do not know 1 2 3 4 5 *I am confident*

n. I know how to find more information to help my child(ren) learn more about STEM.

I do not know 1 2 3 4 5 *I am confident*

o. I know where to search to find more STEM-related information.

I do not know 1 2 3 4 5 *I am confident*

p. I know where to search to find more STEM-related information.

I do not know 1 2 3 4 5 *I am confident*

3. Choose one response for each of the following statements about your beliefs about STEM

a. I believe STEM plays a role in improving our quality of life.

Strongly Disagree 1 2 3 4 5 *Strongly Agree*

b. I believe those who work in STEM make our life more convenient.

Strongly Disagree 1 2 3 4 5 *Strongly Agree*

c. STEM is worth studying.

Strongly Disagree 1 2 3 4 5 *Strongly Agree*

d. STEM improves our society.

Strongly Disagree 1 2 3 4 5 *Strongly Agree*

e. I believe work in STEM helps people.

Strongly Disagree 1 2 3 4 5 *Strongly Agree*

f. I believe those who work in STEM fields make my child(ren)'s lives easier.

Strongly Disagree 1 2 3 4 5 Strongly Agree

g. I would like my child(ren) to pursue a career in STEM.

Strongly Disagree 1 2 3 4 5 Strongly Agree

h. My child(ren) would enjoy studying STEM in college.

Strongly Disagree 1 2 3 4 5 Strongly Agree

i. I believe that learning STEM ideas and skills would be good for mychild(ren).

Strongly Disagree 1 2 3 4 5 Strongly Agree

j. STEM skills would be useful for my child(ren)'s career.

Strongly Disagree 1 2 3 4 5 Strongly Agree

k. My child(ren)'s school should teach STEM concepts and skills.

Strongly Disagree 1 2 3 4 5 Strongly Agree

l. My child(ren) would enjoy learning STEM in K-12.

Strongly Disagree 1 2 3 4 5 Strongly Agree

m. Learning STEM in K-12 will allow my child(ren) to better understand other subjects, such as science, mathematics, and technology.

Strongly Disagree 1 2 3 4 5 Strongly Agree

n. I believe my child(ren) would have an improved quality of life if they learn STEM in K-12.

Strongly Disagree 1 2 3 4 5 Strongly Agree

o. I want my child(ren) to learn STEM skills.

Strongly Disagree 1 2 3 4 5 Strongly Agree

p. I want my child(ren) to understand what those in STEM fields do.

Strongly Disagree 1 2 3 4 5 Strongly Agree

q. It is more important for girls to learn STEM than it is for boys to learn STEM.

Strongly Disagree 1 2 3 4 5 Strongly Agree

r. It is more important for boys to learn STEM than it is for girls to learn engineering.

Strongly Disagree 1 2 3 4 5 Strongly Agree

s. It is equally important for girls and boys to learn STEM.

Strongly Disagree 1 2 3 4 5 Strongly Agree

t. I am interested in attending workshops about STEM at my children's school.

Strongly Disagree 1 2 3 4 5 Strongly Agree

u. I think it is necessary to learn about STEM fields as early as possible.

Strongly Disagree 1 2 3 4 5 Strongly Agree

v. I would like my child to learn STEM, but the school day is already too full for my child's school to include engineering.

Strongly Disagree 1 2 3 4 5 Strongly Agree

Demographic Information

What is your gender (the Respondent)? Male___ Female___

5. Which age ranges or grades are your children currently in? (Please check all that apply – Answer this question with all of your children in mind) Infant/Toddler Boy___ Infant/Toddler Girl___ Pre-School Boy___ Pre-School Girl___ 1st Grade Boy___ 1st Grade Girl___ 2nd Grade Boy___ 2nd Grade Girl___ 3rd Grade Boy___ 3rd Grade Girl___ 4th Grade Boy___ 4th Grade Girl___ 5th Grade Boy___ 5th Grade Girl___ 6th Grade Boy___

6th Grade Girl___ 7th Grade Boy___ 7th Grade Girl___ 8th Grade Boy___ 8th Grade Girl___ 9th Grade Boy___ 9th Grade Girl___ 10th Grade Boy___ 10th Grade Girl___ 11th Grade Boy___ 11th Grade Girl___ 12th Grade Boy___ 12th Grade Girl___

6. What best describes your household type? Married-couple, children living at home___ Married-couple, children not living at home___ Unmarried-couple, children living at home___ Unmarried-couple, children not living at home___ Single, children living at home___ Single, children not living at home___ Other___

7. Which of the following age groups do you belong to? Under 20___ 20-24___ 25-29___ 30-34___ 35-39___ 40-44___ 45-49___ 50-54___ 55-59___ Over 60 ___

8. What is your approximate annual household income? Less than $10,000___ $10,000 - $29,999___$30,000 - $49,999___ $50,000 - $69,999___ $70,000 - $89,999___ $90,000 - $109,999___$110,000 - $129,999___ $130,000 - $149,999___ $150,000 and above___ I do not wish to provide this information___

9. Are you of Hispanic, Latino, or Spanish origin? a. No, not of Hispanic, Latino, or Spanish origin___ b. Yes, Mexican, Mexican American, Chicano___c. Yes, Puerto Rican___ d. Yes, Cuban___ e. Yes, another Hispanic, Latino, or Spanish Origin___

10. Which of the following describes your race? Please check all that apply. a. White___ b. Black or African-American___ c. Asian___ d. American Indian or Alaska Native___ e. Native Hawaiian and Other Pacific Islander___

11. What is your current occupation? (Please choose the primary or more specific one)Manager/Executive___ Technician/Operator___ Professional___ Teacher/Educator___ Sales/Service___Farming/Fishing___Homemaker___ Student___ Retired___Unemployed___Other___

12. Which of the following best describes your highest level of education? (please choose one) Less than high school___ High School___ Associate's degree___ Some College___ Bachelor's degree___ Master's degree___ Doctoral degree___ other___

13. Do you have a degree in any of the following areas? (Please check all that apply) Yes, I have a degree in science___ Yes, I have a degree in mathematics___ Yes, I have a degree in technology___ Yes, I have a degree in engineering___ No___

14. Does your child interact with any engineers? (Please check all that apply) Yes, I am an engineer.___ Yes, my significant other is an engineer___ Yes, another relative is an

engineer___ Yes, a family friend is an engineer___ No______

15. What is your zip code?__________

16. What is your email address (for the purposes of random drawing notification). This information is not stored or associated with your responses and will be destroyed after the drawing. ____