ATTITUDINAL DIFFERENCES TOWARDS ROBOTICS COMPETITIONS OF MALE AND FEMALE STUDENTS PARTICIPATING IN A SOUTHEASTERN STATE ROBOTICS COMPETITION

by

Jesse Eligha Neece

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

Some of the most dynamic and demanding careers are in the areas of science, technology, engineering, and mathematics (STEM). However, when analyzing gender, there are great disparities among gender in STEM. Statistics indicate females are vastly underrepresented and males are employed double the rate of females. Leading STEM companies are creatively trying to attract future STEM laborers by means of science and engineering competitions. The purpose of this quantitative causal comparative study was to investigate if there are differences in attitudes between male and female students participating in a robotics competition. A convenience sample of public school students (N = 194) from grades 7-12 that participated in a southeastern state robotics competition were used in this study. The sample consisted of 69 females and 125 males. The researcher administered a modified version of the *Student's Attitude toward Science Fairs Survey* customized for use at a robotics competition. The instrument measured students' overall attitudes toward science and engineering competitions and further explored two constructs: usefulness (utility value) and enjoyment (intrinsic value) of the competition. A one-way multivariate analysis of variance (MANOVA) was used to determine if differences existed between male and female students' attitudes towards science and engineering competitions and results were disclosed. The MANOVA results determined that there are no significant differences found among male and female students and their enjoyment, value (usefulness), and total (overall attitude) values towards a robotics competition, Wilks's $\Lambda = 1.00$, $F(2, 191) = 0.10$, $p > .05$, partial $\eta^2 = 0.001$. Thus, the researcher failed to reject the null hypothesis. Implications of this investigation and future recommendations for future studies were discussed.

Keywords: robotics competitions, attitude, gender, usefulness, enjoyment

Dedication

I dedicate this dissertation to the Neece Family, specifically my father and mother (Farley Wayne and Linda Caroline Neece). I also would like to include my paternal and maternal grandparents, my extended family present, and all my cherished family members that have passed from this walk of life. I want to extend an indebted thanks to all of you for showing me continual love and support throughout my life and educational endeavors. I would also like to dedicate this work to the many wonderful and effective educators that have helped shape and mold me throughout my educational journey. I would not be the student I am today without your persistence and devoted determination to educate and serve individuals like me. I have been and continue to be very blessed and thank my Lord and Savior Jesus Christ for all the many blessings bestowed upon me in my life and to You I give all the praise.

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There are many special individuals and entities that have played meaningful roles throughout my educational journey. The first that serves as the cornerstone in my life is my Lord and Savior Jesus Christ. I have always strived to complete all tasks in my life by embracing the firm promise from God that "I can do all things through Christ which strengtheneth me" (Philippians 4:13, King James Version). Having faith in my divine Creator and Heavenly Father has made this process come to fruition and may He receive all the praise and glory for giving me the strength to be successful.

Next, I would like to recognize my father and mother (Farley Wayne and Linda Caroline Neece) for always being a pillar of continual encouragement and support in my life. I cannot put into words my sincere appreciativeness for them always being there to meet my every need and influencing me to strive to work hard to reach my full potential.

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List of Abbreviations

Boosting Engineering, Science, and Technology (BEST)

Director of Programs (DOP)

Expectancy-Value Theory (EVT)

For Inspiration and Recognition of Science and Technology (*FIRST*)

FIRST LEGO League (FLL)

FIRST Tech Challenge (FTC)

FIRST Robotics Competition (FRC)

Gender Schema Theory (GST)

Institutional Review Board (IRB)

Junior *FIRST* LEGO League (Jr. FLL)

Multivariate Analysis of Variance (MANOVA)

Student's Attitude towards Robotics Competitions (SATRC)

Student Science Fair Attitude Survey (SSFAS)

Student's Attitude towards Science Fairs Survey (SATSFS)

Science, Technology, Engineering, and Mathematics (STEM)

World Robot Olympiad (WRO)

CHAPTER ONE: INTRODUCTION

Overview

This chapter will introduce the reader to the concept of student attitudes towards robotics competitions. It will expound on pertinent background information that establishes the importance of robotics competitions as a means for attracting individuals to the science, technology, engineering, and mathematics (STEM) workforce. This section will also explain the problem within the STEM workforce and establish the clear purpose for this research study. The significance of the study will be outlined, and research questions will be established that directly relate to the stated problem and purpose of the study. The researcher will conclude this chapter by defining key terms that are necessary for the reader to understand the context of the research study as it pertains to student attitudes towards robotics competitions.

Background

One of the most innovative and competitive career fields within the modern global workforce is within the areas of science, technology, engineering, and mathematics (STEM). These careers in STEM are crucial for the competitiveness of a nation and direct the future of the global workforce (Langdon, McKittrick, Beede, Khan, & Doms, 2011; National Science Board, 2010, 2015, 2016). The STEM workforce has expanded fervently in recent years. Landivar (2013a) revealed that economic developers/leaders throughout the globe cite their primary goal is to expand and promote the STEM workforce to strengthen and create competitive global markets. According to reports by the United States Census Bureau, employees within the STEM workforce comprise approximately 6% (i.e. upwards of nine million workers in 2015) of the overall workforce in the United States (Landivar, 2013b; Noonan, 2017). In such a demanding and competitive employment area, there are notable inconsistencies present when examining

STEM workforce demographics. One example is the evident disparity gender gap, specifically among female presence, within the STEM workforce (National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon, Schunn, Higashi, & Baehr, 2016). This disproportionality between males and females in STEM has fueled initiatives that seek to narrow the disparity gap. Gender disparity is an apparent problem within the STEM field. Rationale for this problem is due to the overwhelmingly untapped potential of skilled females not represented in the STEM workforce, gender identity issues influenced by societal pressures, and expectancy/value relationships interpreted by genders in pursuit of STEM fields. There have been variations of disparity among ranges in the age of females within the STEM workforce. Specifically, recent data emphasized that younger women have demonstrated a smaller amount of improvement (Landivar, 2013a). Furthermore, Landivar (2013a) highlighted that females are exceedingly underrepresented in specific STEM fields that comprise the bulk of the STEM workforce, such as engineering and computer science, in an arena where men are employed at a ratio of 2:1 to the opposite sex. Many initiatives to close the disparity gap are evoked by STEM employers.

According to Van Langen and Dekkers (2005) leading STEM companies and numerous countries are investing significant capital in sponsorship of scientific and engineering competitions such as robotics competitions and related educational programs to attract the next generation of laborers (i.e. highly qualified men and women) to effectively sustain the demands of the STEM workforce. The area of robotics has become extremely popular among school-age boys and girls around the globe and continues to grow due to its technical and innovative nature (Menekse, Schunn, Higashi, & Baehr, 2015). These robotics competitions allow young men and women to demonstrate their scientific knowledge and fine-tune their problem-solving skills as they apply them to real world scenarios (Aroca et al., 2016). These qualities are greatly pursued by employers in the STEM industry. As a result, these competitions seek to attract young men and women into the competitive and demanding STEM work areas and get participants excited about STEM fields.

Historically, the idea of scientific and engineering competitions such as robotics competitions began in the form of science fairs, beginning in the early part of the 20th century (Westbury, 2016). Over time, these competitions became more specialized and diverse. Due to the stringent industrial demands of society and potential competitiveness of foreign countries, the field of robotics was mainly developed as an outgrowth of the Industrial Revolution (Petrina, 2008). The field of robotics has been used to effectively increase production in the manufacturing industry. As the supply and demand of materials and goods persisted to increase, the robotics industry was being heavily relied upon to meet the demands of consumers (Petrina, 2008). This phenomenon, in turn, increased the need for large numbers of skilled men and women laborers within STEM careers to fuel the global marketplace. Workers that were attracted mainly to STEM careers historically held jobs in areas that were mostly dominated by males (Iskander, Gore, Furse, & Bergerson, 2013; Mann & DiPrete, 2013), and this trend has contributed to the gender disparity within the STEM workforce (Beede et al., 2011; Landivar, 2013a; National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon et al., 2016). In recent decades, there has been progress made to narrow the gender gap in the STEM workforce (Wang & Degol, 2016), but disparity still persists, and STEM employee shortfalls are being projected for the future.

As the former generation of STEM laborers approach retirement, the demand for highly-skilled and trained young men and women are needed to fill the demands of the STEM workforce. Although trends tend to forecast an immense shortage of workers in STEM careers (Welch, 2010), country leaders have made bold initiatives to increase the production of highly-skilled and trained laborers that possess 21st-century skills to seek positions in the STEM field (Brown, Thoman, Smith, & Diekman, 2015). To attract the needed workforce in STEM, programs such as *FIRST* (For Inspiration and Recognition of Science and Technology) have been developed to promote STEM learning and showcase STEM careers through distinct types of robotics competitions based on age appropriateness.

Developed in 1989, *FIRST*, a non-profit international organization founded by Dean Kamen was developed to promote STEM initiatives for young men and women students and to enhance their interest in the STEM field with hopes of those individuals securing future careers within the STEM workforce (FIRST At A Glance, 2017). These robotics and engineering competitions are very beneficial to students and promote needed skill sets that embody STEM from multiple academic disciplines (Andic, Grujicic, & Markus, 2015). Student participation in these robotics competitions fosters complex learning concepts through a hands-on learning approach and forces students to develop team building skills and solve complex problems based on real-world scenarios (Aroca et al., 2016; Shen & Prior, 2016). These learning concepts are rooted within various theoretical ideologies and frameworks.

The theoretical basis underlining the concept of student attitudes obtained from participating in robotics and engineering competitions are rooted in three ideologies: expectancy-value theory, gender schema theory, and intersectionality theory. The expectancy-value theory (EVT) establishes "positive relationships between students' subjective task values and academic achievement" (Westbury, 2016, p. 15). The EVT articulates an individual's belief regarding their ability to accomplish a specific task (Wigfield & Eccles, 2000). An individual that believes he/she can accomplish a specific task naturally would have a positive attitude towards completing the task (i.e. sense of confidence). The participation in robotics and engineering competitions can also be rooted in gender schema theory. The gender schema theory (GST) establishes that the driving force of an individual's ideology of gender is highly influenced by stereotypical constructs and cognitive predispositions that are established by societal perspectives (Bem, 1981; Starr & Zurbriggen, 2017). Ultimately, the pressures and influence of society greatly shape an individual's perspectives on the concept of gendering. Another ideology related to this research study is the intersectionality theory. This is a specialized ideology that is specific to the analysis of issues related to gender, social class, and race and ascertains that complex issues as these must focus on the interconnections (i.e. or "intersectionality") of multiple variables related to the situation/problem being studied (Crenshaw, 1989, 1991). This theory further establishes that the integration of all societal oppression aspects (i.e. related to gender, social class, and race), when analyzed collectively, also establish a cooperative construct that reveals solutions to problems (Collins, 1986, 1998). It is more imperative to study the sum of all parts regarding societal problems than analyzing individual variables one at a time.

The STEM arena has greatly changed over the course of history with the goal of positively impacting society by means of meeting its demands and that of its consumers globally (Andic et al., 2015; Samuels, 2016). The field of robotics was developed to meet the requirements of the global societal market and fueled by consumers' supply and demand. STEM companies became innovative and began investing money in educational programs to ensure they had a highly-trained workforce of men and women that possess the necessary skills to meet 21^{st}-century demands and drive global competitiveness (Brown et al., 2015; Landivar, 2013b; Samuels, 2016). Programs such as *FIRST* were developed in the form of robotics and engineering competitions to attract and recruit young men and women to the STEM community with future aspirations of pursing STEM careers to improve society (FIRST At A Glance, 2017). However, with projected future job shortages and noted disparity gender gaps within the STEM workforce, the challenge persists of how to meet societal demands and future requirements to sustain the future STEM marketplace for future generations. The goal of overcoming this challenge is by means of attracting and recruiting highly-qualified men and women to the STEM workforce and assessing student interest and attitudes towards the STEM field as a potential future career choice.

Problem Statement

In order to have a highly-trained and skilled STEM workforce comprised of talented men and women, it is important to develop and sustain programs such as robotics and engineering competitions, which allow students to apply their scientific knowledge and develop the necessary 21^{st}-century skills to be successful within the field (Andic et al., 2015, Aroca et al., 2016; Shen & Prior, 2016; Van Langen & Dekkers, 2005). Due to anticipated job shortfalls in the future and noted inequalities in gender within the STEM workforce (National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon et al., 2016), it is crucial that these programs and/or competition participants be surveyed to assess their attitudes towards STEM (Huddleston, 2014; Westbury, 2016). It is beneficial for students to have a positive experience and attitude at these competitions in hopes of future recruitments to the STEM field and workforce (Aroca et al., 2016; Drazan, Loya, Horne, & Eglash, 2017; Witherspoon et al., 2016). The attitudes of men and women participants should be investigated at these competitive events so that continual and methodical initiatives can be made to the competition to emphasize the enjoyment and usefulness of these extracurricular academic programs and stimulate future

STEM recruitment. The students' attitude is measured by combining usefulness and enjoyment values. Shumow and Schmidt (2014) characterized usefulness as the value that one feels from completing a particular goal. On the other hand, Wigfield and Eccles (1992) explained that enjoyment is the individual worth received by the participation in an event. The National Science Teacher Association (2016) openly advocates for science competitions such as robotics and engineering competitions because of their value in reinforcing the STEM program in education. Some research studies manifest more positive attitudes expressed by females in comparison to males at these science and engineering competitions (Dionne et al., 2012; Huddleston, 2014) despite the gender disparity within the STEM field (National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon, Schunn, Higashi, & Baehr, 2016). The problem is there are limited studies that specifically examine attitudinal differences and explore the two constructs of usefulness (utility value) and enjoyment (intrinsic value) between male and female students who participate in robotics competitions.

Purpose Statement

The purpose of this quantitative causal comparative study was to investigate differences in attitudes between male and female public-school students participating in a southeastern state robotics competition. The independent variable, the sex of the individual, was used to analyze differences between gender groups (i.e. males and females) in order to investigate attitudes between groups towards robotics competitions. The dependent variable, student attitude, had two separate components that were identified from student responses given as a result of the administration of the survey instrument they completed during the robotics competition. Student attitude responses were measured by the Student's Attitude towards Robotics Competitions (SATRC) survey (see Appendix A), which is a modified version of the Student's Attitude towards Science Fairs Survey (SATSFS), developed by Michael & Huddleston (2014) and abbreviated by Westbury (2016). The instrument was specifically tailored for use at the *FIRST* robotics competition. Overall, student attitude can be defined as "a feeling about the object, like or dislike" (Kind, Jones, & Barmby, 2007, p. 872). The student attitude component of usefulness (utility value) is expressed as how useful the student perceives the life experience or participation in the robotics competition in influencing future career choices. The enjoyment (intrinsic value) component is characterized as the self-gratification/positive meaning acquired by participation in the robotics competition. The integration of analysis between variables of gender and student attitude at the robotics competition through the perspective of usefulness and enjoyment sheds some light on the gender discrepancy within STEM. This research study provided valuable attitudinal information among genders to provide critical feedback on attractive forces present at the robotics competition that can mold future career choices within STEM.

Significance of the Study

This study investigated the attitudes of students between males and females towards robotics competitions, an area of research that has been minimally studied. Considering future shortages in the STEM workforce (Welch, 2010) and apparent disparities in gender among STEM laborers (Beede et al., 2011; Landivar, 2013a, National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon et al., 2016), this area of research is crucially important because of the need to attract new highly-trained and skilled STEM laborers (Aroca et al., 2016; Drazan et al., 2017; Witherspoon et al., 2016). In order to expand the needed STEM workforce, it is essential to ascertain the attitudes of young men and women participating in robotics and engineering competitions, which are attractive events sponsored by STEM companies, to attract future STEM employees and sustain the field long-term. These competitive events serve as beacons of attraction for future STEM laborers; they are necessary to research in order to develop an understanding of the essential skills that are required to succeed in the next generation of STEM employees. Investigating and analyzing robotics competition participant attitudes of potential future STEM employees is essential. This analysis is important for future improvements of attractive programs (such as scientific competitions) so the needed skilled STEM laborers can be acquired to meet the demands of a thriving global economy and sustain the field for future generations. Although there have been limited studies (i.e., Huddleston, 2014; Westbury, 2016) that investigate student attitudes towards these science competitions by using a surveying instrument such as Student's Attitude towards Science Fairs survey, this study expanded to other competitive events such as robotics competitions to acquire attitudinal knowledge as well as new populations, seeking input from students attending public schools. This research study is significant for a number of reasons due to the need to (a) address the gender disparity gap and assess student attitudes (both males and females) towards these STEM area competitions (National Science Board, 2010, 2015, 2016; National Science Foundation, 2017; Witherspoon et al., 2016), (b) recruit/attract needed men and women to sustain the future of the STEM industry (Aroca et al., 2016; Drazan et al., 2017; Witherspoon et al., 2016), and (c) allow students the opportunity to explore STEM fields and apply their knowledge and skills in a competitive collaborative setting (Andic et al., 2015; Aroca et al., 2016; Brown et al., 2015; Landivar, 2013b; Samuels, 2016; Shen & Prior, 2016).

Research Question

RQ1: Is there a difference in overall attitudes towards robotics competitions between male and female students participating in a southeastern state robotics competition?

Definitions

1. *Enjoyment* - Wigfield and Eccles (1992) explained that enjoyment is the individual worth received by the participation in an event.
2. *Usefulness* - Shumow and Schmidt (2014) characterized usefulness as the value that one feels from completing a particular goal.
3. *Student Attitudes* – Kind et al. (2007) expressed student attitudes as "a feeling about the object, like or dislike" (p. 872).

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this quantitative causal comparative study was to investigate attitudinal differences between male and female students participating in a southeastern state robotics competition. This chapter thoroughly discusses the three theoretical frameworks (i.e. expectancy-value theory, gender schema theory, and intersectionality theory) that are directly related to this research investigation. Moreover, a brief history of robotics competitions is discussed to inform the reader of how these scientific competitions emerged and reveal their importance in recruiting future laborers (i.e. skilled men and women) to the science, technology, engineering, and mathematics (STEM) workforce. This chapter also focuses on specific topical aspects within the STEM field such as attitude and gender categorical characteristics while performing a thorough review of the literature that supports the research question within the study and validates the need for this and more research studies to be conducted that seeks to understand attitudinal and gender differences present within the STEM arena.

Theoretical Framework

Expectancy-Value Theory

One theory that has been extensively utilized within the study of educational ideology and behavior is the expectancy-value theory (EVT). This theory is widely used by scholars in investigating the motivation of an individual's achievement (Flake, Barron, Hulleman, McCoach, & Welsh, 2015; Guo, Marsh, Parker, Morin, & Dicke, 2017; Guo, Marsh, Parker, Morin, & Yeung, 2015; Wigfield & Eccles, 2000; Wu & Fan, 2017). The EVT was developed by Atkinson in the mid 1950's to investigate and understand an individual's attitudes and motivation for achievement of academic tasks. According to Eccles-Parsons et al. (1983), the

EVT, as explored by Atkinson (1957), primarily focused on "individual differences in the motive to achieve and on the effects of subjective expectancy on both this motive and the incentive value of success" (p. 79). The three variables used to establish the EVT are motive, expectancy, and incentive (Atkinson, 1957). These variables can be mathematically formulated into an equation to compute an individual's motivation value. Expectancy is defined as actions that occur within a given situation that leads to an outcome, incentive is conceptualized as a lure or attractant that entices an individual to produce a desired behavior or outcome, and motive is characterized as an individual's determination to be satisfied at a desired level in which they are comfortable or internally fulfilled (Atkinson, 1957). Atkinson's EVT was later improved upon by the work of Eccles-Parsons et al. (1983) that transformed the theory from its traditional motivational roots to a more modern cognitive construct.

The new cognitive construct expanded the classic EVT as presented by Atkinson (1957). The cognitive construct is defined in terms of "causal attributions, subjective expectancies, self-concepts of abilities, perceptions of task difficulty, and subjective task value" (Eccles-Parsons et al., 1983, p. 79). Eccles-Parsons et al. (1983) outlined that this approach is rooted on the assumption of reality interpretation and is facilitated by several factors, such as "causal attributional patterns for success and failure, the input of socializers, perceptions of one's own needs, values, and sex-role identity as well as perceptions of the characteristics of the task" (Eccles-Parsons et al., 1983, p. 81). Eccles-Parsons tended to focus on expectancy and value as related to achievement behaviors. Overall, the EVT establishes that an individual's success to perform a given task is rooted in their confidence to complete the task, subjective task value (or value they put on the task), and the individuals level of interest in the task (Petri & Govern, 2004; Wigfield & Eccles, 2000, 2002; Wu & Fan, 2017). As a result, an individual who has high confidence to complete a given task and that task is deemed of high value to the individual, the more likely they are to have a more positive behavior associated with that choice and result in a higher level of determination to compete the given or sought task (Wu & Fan, 2017). The success of individuals is more prevalent in a task they value as being important. Ball, Huang, Cotton, and Rikard (2017) stated that "students will choose to persist in activities in which they expect to succeed in and for which they personally value" (p. 373). As a result, an individual's personal value of a given task fuels their rate of success.

Within the EVT there are various constructs that comprise and/or influence specific variables. For example, Eccles (1987) established that task value could be framed in multiple components, such as attainment value, intrinsic/interest value, utility value, and cost. The EVT directly correlates with the research question used in this research study. The research focuses on the following criteria: student teams building a robot (task value or task itself) through hands-on learning/achievement, the measurement of student enjoyment (intrinsic value) of building robots and competing against other school robotics teams, the determination/drive of doing well in the competition (attainment value) and sense of pride or self-worth acquired at the competition, the method by which this learning process influences future decisions (utility value) to pursue a STEM career, and the time planning/management involved and/or sacrifices (cost) incurred that detracts from participating in other desired tasks. This research investigation was deeply rooted and representative of the EVT theoretical framework and grows the base of knowledge by investigating EVT through the lens of attitudinal differences among gender of students participating in robotics competitions.

Gender Schema Theory

In embryo, all individuals begin to develop their physical traits that will characteristically define them for their natural lives, especially their gender. However, once born and exposed to the societal environment, individuals are exposed/programmed to societal gendered stereotypes that will greatly shape their social and cognitive development throughout their lives. The gender schema theory (GST), a social-cognitive theory, was developed by Bem in 1981 for the purpose of investigating and focusing the manner that society defines and influences gender by means of stereotypical constructs that influences an individual's cognitive perceptions and social behavior (Bem, 1981; Starr & Zurbriggen, 2017). In other words, gendering is driven by society's perception and influences the individual's cognitive perceptions of gender. Bem (1981) established that GST is primarily derived from sex-typing (rooted in gender specific social behaviors) that establish the gender schema, which are highly influenced by society. On that premise, a society's gender schema is very influential in shaping the cognitive perceptions of children from a very young age (Donnelly et al., 2016; Donnelly & Twenge, 2017; Woodington, 2010). Children are very easily influenced to integrate their society's gender schema into their own perceptions of sex typing and identity (Bem, 1981; Starr & Zurbriggen, 2017; Woodington, 2010). Throughout the child's life, he/she will integrate aspects of the society's gender schema into his/her own. According to Bem (1981), during this shaping of gender schema, the child will also "evaluate his or her adequacy as a person in terms of the gender schema, to match his or her preferences, attitudes, behaviors, and personal attributes against the prototypes stored within it" (p. 355). This also leads into the child's fitting into one of two categories as deemed or defined by society, masculine (or maleness) or feminine (femaleness).

The dichotomy of ideologies related to masculinity and femininity for individuals are heavily influenced by societal factors. Bem (1972, 1981) emphasized that these gender schema characteristics or dichotomies are conceptualized as an "internalized motivational factor" (p. 355), and the individual will equivocate their behavioral characteristics to fit into one of these categories as defined by their culture. These categorical sex-typing constructs are viewed as "sex-typed individuals not primarily in terms of how much masculinity or femininity they possess, but in terms of whether or not their self-concepts and behaviors are organized on the basis of gender" (Bem, 1981, p. 356). Essentially, the degree to which an individual's society/culture establishes masculinity or femininity determines that individual's gender schema. GST directly correlates with the present research study due to the fact of the presence of societal sex-typing (Bem 1981, 1984, 1993) and inequality of gender prevalence within STEM careers (Beede et al., 2011; Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; MacPhee, Farro, & Canetto, 2013; National Science Foundation, 2017; Simon, Wagner, & Killon, 2017). This societal sex-typing of individuals calls for further research to investigate its effects related to specific gender dominated career paths.

Intersectionality Theory

When investigating research studies/topics related to gender, race, social classes, and/or disparities among one or any of the topics mentioned, a theoretical framework that surfaces is intersectionality theory. In 1989, Crenshaw, a skilled legal scholar of feminism and a prominent civil rights activist, developed the intersectionality theory. Crenshaw (1989, 1991) established that topical studies regarding race and gender, mostly involving Black women, should not be studied or examined via variable isolation, but by investigating the interactions among the variables related to societal issues, such as issues among gender, race, and social classes. Thus, one must look at the sum of the parts as they interact instead of looking at just one independent variable. Crenshaw (1989) stated, for example, that “because the intersectional experience is greater than the sum of racism and sexism, any analysis that does not take intersectionality into account cannot sufficiently address the particular manner in which Black women are subordinated” (p. 140). It is important to analyze the interrelatedness of the variables to fully assess and understand the problem.

The intersectionality theory was also expanded and broadened by Collins (1986, 1998). Collins involved the issues and societal aspects of the 1990s and tried to modernize the theory based on new societal impacts and ideologies. Collins (1998) stated that it is important to study the family structure and “as opposed to examining gender, race, class, and nation, as separate systems of oppression, intersectionality explores how these systems mutually construct one another” (p. 63). It is implied that the variables examined build upon one another and are interdependent. Collins (1998) focused on the traditional family and how the variables of gender, race, and nation intersected. One particular aspect of study in the traditional family system was the concept of home and the variable that impacted the home, such as place, space, and territory. Collins (1998) established the traditional societal establishment of men and women, particularly related to gender. Collins (1998), for example, established the observation that “within gendered spheres of private and public space, women and men again assume distinctive roles” (p. 67). The traditional idea of male and female roles during that time period was identified to suggest that men are providers of the family and household while women are caregivers for the children and their “place” is within the home (Collins, 1998). On the other hand, this ideology establishes that the role of men is to “support and defend the private, feminized space that houses their families” (Collins, 1998, p. 67). Although this ideology for the traditional role of women has been disavowed by feminist (Collins, 1998), Collins still agreed with Coontz (1992) that this rationale is still thriving and accepted by much of society. Intersectionality theory associates with the present research study due to the presence of gender disparity within the STEM workforce (Beede et al., 2011; Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; MacPhee et al., 2013; National Science Foundation, 2017; Simon et al., 2017) and the need to further investigate the intersections (Collins, 1992, 1998; Crenshaw, 1989, 1991) of traditional family roles of men and women (Collins, 1992, 1998) and that pronounced disparity.

Related Literature

History of Robotics Competitions

One of the most exciting and growing aspects within the STEM field is within the realm of robotics. Since ancient times, the idea of robotics was first envisioned as "mechanical machines" (Petrina, 2008). Some of the first "mechanical machines" were observed in the early 16th century. Leonardo da Vinci, well known for his sensational painting ability, is also known for intertwining that talent with the early forms of engineering to produce a mechanical lion for the King of France, Francis I (Petrina, 2008). Da Vinci intended for the lion to walk towards the king and take him lilies which were enclosed in the lion's chest (Burke, 2006). The actual term "robot" did not become known until much later, specifically in the early part of the 20th century and the term "robotics" did not become well known until 1942 by the famous scientist, Isaac Asimov (Petrina, 2008).

The concept of robotics competitions for school age children began in the late 1980's. In 1989, a non-profit organization known as *FIRST* (For Inspiration and Recognition of Science and Technology) was developed by Dean Kamen. *FIRST* is recognized and known internationally around the world as a leader in the promotion of STEM initiatives (FIRST Vision and Mission, 2017). *FIRST* was primarily developed as an attractant to entice new and young faces to the STEM workforce, promote STEM learning, and showcase STEM careers through distinct types of robotics competitions based on age appropriateness such as Junior *FIRST* LEGO League (Jr. FLL) for ages 6-9, *FIRST* LEGO League (FLL) for ages 9-14, *FIRST* Tech Challenge (FTC) for ages 14-18, and *FIRST* Robotics Competition (FRC) for ages 14-18. Each of these competitions is based on a specific challenge or project and expose young men and women to STEM concepts through hands-learning applications (FIRST Educators, 2017). The mission of *FIRST* is "to inspire young people's interest and participation in science and technology, and to motivate them to purse education and career opportunities in STEM fields" (FIRST At A Glance, 2017, p. 1).

In 1990, the First Robot Olympics was launched in Scotland and developed by Peter Mowforth (Buckley, 2015). The competition was sponsored by The Turing Institute. This was the first international robotics competition of its kind in the world (Buckley, 2015). The competition consisted of various categorical events, and winners would be judged on three criteria: quality of material used, complexity of robot movements, and innovation (Buckley, 2015). Only three years later, in 1993, another robotics competition was developed called BEST (Boosting Engineering, Science, and Technology) Robotics that is very similar to *FIRST* Robotics Competitions, specifically the *FIRST* Tech Challenge designed for ages 14-18 (Strobel et al., 2014). BEST Robotics is a yearly robotics competition that is held in the United States. The competition was founded by Ted Mahler and Steve Maruum, engineers for Texas Instruments (Best History, 2017). According to Strobel et al. (2014), BEST Robotics is identified as "a project-based robotics competition in which students learn to analyze and solve problems using the engineering design process" (p. 390).

In 1997, another prominent robotics competition was developed called RoboCup. RoboCup is a conceptual idea in which the game of soccer is played by robots; it was first envisioned by Alan Mackworth, professor for the University of British Columbia, Canada ("A Brief History of RoboCup," 2017). RoboCup is an international robotics event and is held in various countries throughout the globe. The RoboCup organization has a primary objective that "by the middle of the 21st century, a team of fully autonomous humanoid robot soccer players shall win a soccer game, complying with the official rules of FIFA, against the winner of the most recent World Cup" ("RoboCup Objective," 2017). Just one year later, the Eurobot robotics competition, an international contest, was developed by Planète Sciences, a French association and the producer company VM Group ("Eurobot History," 2017). The objective of the Eurobot is to expose youth to a fun and exciting robotics event where they can learn fundamental principles that will prepare them for future avenues and all robots developed for this competition are completely autonomous robots ("Eurobot Objective," 2017). This event is set up similarly like the *FIRST* Robotics Competitions in which a new yearly scenario or game is developed that requires the robot to be programmed to perform specific tasks.

In 2001, the RoboRAVE International robotics competition was created in New Mexico. RoboRAVE International was developed by Russ Fisher-Ives and is a program of Inquiry Facilitators, Inc. The program seeks to educate students about how to develop a functional robot by design, building, and programming that can complete a specific task ("About RoboRAVE," 2017). The event is the largest robotics competition of its kind in New Mexico.

In 2004, two other robotics competitions were developed called World Robot Olympiad (WRO) and RoboGames. The World Robot Olympiad was developed by four founding countries: China, Japan, Korea, and Singapore. The mission of WRO is "to bring together young people all over the world to develop their creativity, design and problem-solving skills through challenging and educational robot competitions and activities" ("WRO Association Introduction," 2017, p. 1). The WRO has various learning objectives established for their competition participants. The WRO seeks to promote STEM learning across the globe, advocate a forum for young people to come and learn about the field of robotics in hopes of expanding and inspiring students to pursue STEM careers, and develop the necessary 21st-century skills necessary to be successful in STEM ("WRO Association Introduction," 2017).

RoboGames is a robotics competition that is held in California, founded by David Calkins, and is considered the world's largest robotics competition as reported by Guinness Book of World Records (RoboGames History, 2017). RoboGames is a multidimensional robotics competition in which robots can be entered in a variety of events, such as Humanoids, Combat, Sumo, Autonomous Humanoid Challenges, Robot Soccer, Open Categories, Art Bots, Jr. League, and Autonomous Autos ("RoboGames Event Schedule and Rules," 2017). These complex challenges force the robot designer to apply knowledge from real-world scenarios and apply scientific principles. These robotics competitions are rich learning environments that foster complex problem-solving skills, team building principles, and expose young people to the STEM arena, which is widely responsible for a competitive global economy (Andic et al., 2015; Aroca et al., 2016; Haynes & Edwards, 2015; Melchior, Burack, Hoover, & Marcus, 2017; Melchior, Cohen, Cutter, & Leavitt, 2005; Nugent, Barker, Grandgenett, & Welch, 2016; Petrina, 2008).

Attitudes in STEM

One of the most critical issues within the science, technology, engineering, and mathematics (STEM) arena is the need to attract competent young men and women to the field to meet the global demands, fueled by societal needs, for future generations. In order to attract the needed workforce to sustain the future STEM needs around the globe and attract new men and women, it is essential to create positive attitudes of individuals towards STEM for those who are exposed to the highly-energetic workforce (Ali, Yager, Hacieminoglu, & Caliskan, 2013; Najafti, Ebrahimitabass, Dehghani, & Rezaei, 2012). The attitude that an individual possesses towards a specific task is a key factor in determining behavior intentions and the likelihood for future participation in the task (Huang, Chiu, & Hong, 2016). One area conducive to fostering more positive attitudes towards STEM begins in schools. Alsup (2015) stated "educational reforms that help maintain high attitudes towards STEM subjects any improve the likelihood of high-attitude students pursuing STEM-related careers, regardless of academic level" (p. 33). Attitudes are rooted in various constructs that can contribute to the desired meaning as it relates to this research investigation and illuminate a more thorough understanding of the overall attitude of an individual. Alsup (2015) postulated that an individual "responds to ideas, concepts, and in this context, school subjects, with conditional thought patterns based on internalized opinions" (p. 33). Thus, an individual essentially pre-forms opinions as to various stimuli and completion of task and that pre-determined judgement is greatly influential in developing one's attitude towards a specific concept.

The term *attitude* can be interpreted in many approaches. However, for the purposes of this research study, the attitude of an individual can be defined and conceptualized as "a feeling about an object, like or dislike" (Kind et al., 2007, p. 872). Attitude can be conceptualized in terms of the intrinsic (enjoyment) value and utility (usefulness) value. According to Alsup (2015), the term attitude can be conceptualized in terms of "internal perception of a target" and the ability of that target to position itself "on the continuum between favor and disfavor" (p. 34).

These variables complement and influence the overall attitude of an individual. An individual that finds enjoyment in a particular task will also foster a positive attitude towards the task (Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). Likewise, an individual that finds a task useful has a greater probability of having a positive attitude towards the performed task because the task has meaning to their overall cognitive ideology (Ali et al., 2013). However, little research has been conducted regarding overall attitudes among gender of individuals involved in robotics competitions. There is justification that research needs to be conducted to analyze attitudinal differences at robotics competition.

Gender in STEM

A distinguishing factor that has been studied extensively within the dominion of the STEM workforce and is very apparent when looking at STEM recruitment initiatives is interconnected to the concept of gender. Since the emergence of the STEM initiative, one repeated characteristic that has not subsided within the STEM workforce is the apparent gender disparity among male and female laborers occupying STEM careers in society (Beede et al., 2011; Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; MacPhee et al., 2013; National Science Foundation, 2017; Simon et al., 2017; Yonghong, 2015). The research is still completely unclear as to the severity of gender disparity prevalent in the STEM workforce. Some research has suggested that disparity regarding gender has improved while other studies still suggest underrepresentation of females in STEM is increasingly apparent and still a significant issue (Beede et al., 2011; Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; MacPhee et al., 2013; National Science Foundation, 2017; Simon et al., 2017; Yonghong, 2015) that must be given attention to successful resolve issues and recruit needed men and women for future STEM positions. Gayles & Ampaw (2014) emphasized the need to resolve the gender issue and explained that “the rate at which women persist in and obtain undergraduate degrees in some science, mathematics, engineering, and technology (stem) majors is an issue of national concern” (p. 439). There have been studies that have attempted to explain methods of making the prevalence of gender difference more equitable (Reilly, Rackley, & Awad, 2017; Wang & Degol, 2016), but none have found an ideal solution to completely close the gender disparity gap.

Some research suggests that societal stereotypes (Starr & Zurbriggen, 2017) influence this gender dichotomy. However, it is not definitive if societal stereotypes are the primary reason of underrepresentation of females in STEM. Many researchers agree (as cited in Gayles & Ampaw, 2014) that there may be various causes for this underrepresentation and “several explanations have been put forth to account for why women remain underrepresented in STEM, such as bias and gender stereotypes, biological differences between men and women, and lack of female role models in STEM fields” (p. 440). From the onset of child development, gender stereotypes are instilled into children from birth throughout adulthood by societal influences and/or parental rearing. Alsup (2015) explained the possible mindset of females to be one where they “may view science as incompatible with aspirations for relationship-oriented careers or jobs conducive to family life” (p. 44). It is possible that society has molded females to only like certain types of content. Archer et al. (2013) explained that more boys are interested in science than girls, and girls tend to see themselves within careers with a high degree of socialization, innovation, and occupations that allow them to spend ample times with their families. Although there are more women working in the workforce than men, women tend to leave the STEM workforce to fulfill “family responsibilities” and end up in a work environment that does not conflict with family life (Heilbronner, 2013, p. 41). As a result, there are apparent differences between males and females and their pursuit in the STEM field and conceptualization of an ideal workforce. Many research studies suggest that STEM careers are primarily male dominated (Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; National Science Board, 2016; National Science Foundation, 2017).

The disparity can also be traced back to secondary and post-secondary educational training. Female students in post-secondary education that take classes within the STEM disciplines do not complete the needed coursework to obtain a completed degree and/or pursue STEM careers (Bergeron & Gordon, 2017; Tyson, Lee, Borman, & Hanson, 2007). Although females take STEM courses in college, they tend not to be enrolled at as high enrollment frequencies as males. Bergeron & Gordon (2017) stated specifically that "females have significantly higher enrollment frequencies in six of the STEM subjects, while males have significantly higher enrollments in nine of the STEM subjects" (p. 436). These statistics are perplexing due to relevant statistical outcome of college enrollment between men and women. Gayles & Ampaw (2014) established that "women outnumber men in college enrollments" and, despite these numbers, women are still "severely underrepresented in terms of undergraduate degree attainment in critical areas of study (such as STEM) in comparison to their male peers" (p. 439).

It is obvious that research is not definitive as to the reasons of gender disparity within STEM and the present study sought to investigate attitudinal difference between males and females participating in robotics competition. As stated previously, the literature is inconclusive as to the reason for this underrepresentation of women among STEM careers. The lack of gender studies investigating differences in attitudes regarding robotics competitions validated the need for this research study.

Research Studies Investigating STEM Competitions

Huddleston. Huddleston (2014) conducted research related to survey instrument development to assess student attitudes at scientific competitions within the STEM field. Specifically, Huddleston (2014) stated the purpose of the study was to “further develop and refine a valid and reliable instrument to measure Student Attitudes towards Science Fairs” (p. 15). The researcher conducted an extensive literature review and found that few studies could be identified with focus particularly on survey instrument development that seek to assess the attitudes of students participating in science fairs. As a result, Huddleston (2014) developed a survey instrument, originally researched by Michael (2005), that integrated nine areas important in assessing attitudes of students towards science fairs. The resulting survey instrument that was produced consisted of 45 questions and assessed nine domains for student attitude. Huddleston (2014) developed the survey instrument by building from the original survey instrument, developed by Michael (2005), that assessed overall attitudes of students at science fairs by utilizing Osborne’s (2003) nine domains. The survey used to collect the data for this research study was the Student Science Fair Attitude Survey (SSFAS).

The SSFAS was developed by incorporating nine domains that assess the attitudes of students towards science fairs. The nine domains are achievement, anxiety, enjoyment, motivation, self-efficacy, social influences of parents, social influences of peers, social influences of teachers, and value (Huddleston, 2014). Each domain specifically examines student attitudes from a specific perspective. For example, achievement examines an individual’s aptitude to complete a specific task (Huddleston, 2014). The next domain that examines attitude is anxiety, which is explained as a negative emotional state that examines the dichotomy of an individual’s feelings towards participating in a competitive environment such as a science fair (Huddleston, 2014). Another domain that was defined is enjoyment. This term is explained as a positive emotional state acquired by an individual as a result of completing or participating in a specific academic task (Huddleston, 2014). Motivation is another domain that is examined in the SSFAS. This refers to an individual's inner ambition and/or value placed on performing a specific behavior/task (Huddleston, 2014). The SSFAS also assesses the domain of self-efficacy. That is conceptualized much the same as self-esteem or the belief in oneself regarding how they relate themselves to a specific situation/circumstance (Huddleston, 2014). The next three domains are related to social influences from various external entities, such as parents, peers, and teachers. Social influences of parents are simply the attitudinal actions of an individual as a result of parental association in a given task or event (Huddleston, 2014). Much is the same with peer involvement. Social influences of peers are explained as the effects of peer relationships on influencing an individual to perform a specific task (Huddleston, 2014). The next social influence integrated into the survey instrument is that of teachers. This domain is where individuals are inclined to participate in academic events due to teacher motivation and support (Huddleston, 2014). Lastly is the domain of value. Value is an individual's worth placed on a task or "judgement by people as to what is important in their lives" (Huddleston, 2014, p. 16).

Huddleston (2014) conducted a quantitative research study. This study postulated three research questions ascertaining validity, reliability, and number of dimensions comprising the Students' Attitudes towards Science Fair scale (Huddleston, 2014). The researcher documented the results of the research study in three parts. Part I yielded statistical analysis of demographics from the study. The sample size for this study was 111 middle school students from two different inner-city schools. Student participants were enrolled in either seventh (69 students) or eighth grades (41 students). Huddleston (2014) stated that the final sample was 110 students, due to one survey being dismissed due to submission of one incomplete survey. Students in the sample were predominantly white, female, seventh-grade students, and their science fair projects were primarily entered among one of three categories: behavioral & social sciences, chemistry, and physics & astronomy (Huddleston, 2014). Data was also analyzed regarding awards and student participation in science fairs. According to Huddleston (2014), most of the research subjects participating (97.3%) reported the science fair was a required part of their educational program. Most subjects had participated in at least two science fairs in the past, and many (59%) were given an award for the science fair, the majority placing second (Huddleston, 2014).

Part II of the results focused on the attitude of students towards science fairs. The original unpublished survey developed by Michael (2005) with integrated research from Osborne et al. (2003) initially consisted of 45 questions (Huddleston, 2014). Through principal component factor analysis and scree plot results, the domains of the survey instrument were decreased from nine to two domains, enjoyment and value. Huddleston (2014) explained that the results guided to the reduction of the survey instrument from 45 questions to only 10 questions and was named the Student's Attitude towards Science Fairs Survey (SATSFS). A principal component factor analysis with a Varimax rotation was then performed on the remaining 10 survey questions focused on the two domains of enjoyment and value (Huddleston, 2014). Internal consistency and reliability was reported using Cronbach's alpha and yielded good internal consistency and reliability among the two domains of enjoyment and value. The results of the factor analysis yielded a high correlation between the domains of enjoyment and value. There is a significant relationship found between enjoyment and value domains. Huddleston (2014) concluded that "if a student enjoyed participation in science fairs, then they valued the experience, and vice versa" (p. 68). Part III of the results focused on future subject selections and career choices of students participating in science fairs. According to Huddleston (2014), the results concluded the following: (a) the majority of students participating in the science fair (39.4%) do not intend to choose a STEM career, (b) the bulk of participants report (71.6%) that the science fair did not influence their future career choice, (c) participants in the science fair (27.8%) do not seek to enroll in advanced science courses; however, 25% of students state they will enroll in AP Biology as a result of the science fair, and (d) student participants overwhelmingly (70.0%) stated that participation in the science fair did not help them determine future class selection.

This study discussed gender relationships regarding student attitudes towards science fairs. During this research study, survey demographics of the sample concluded that females tended to have more positive attitudes towards science fairs than males; female participation and engagement were greater than males (Huddleston, 2014). Research implications were also deduced regarding ethnicity, science fair categories, and awards. There was no difference in attitudes among ethnicities and science fair categories entered; however, there were differences identified between attitudes and awards. Huddleston (2014) stated that "about half of all participating students received an award of first, second, third, or fourth place" and "students who placed high in their category were rewarded by continuing onto a regional science fair" (p. 72). The researcher cited recommendations for future research studies, establishing the need for future perfections of instrument design and development to access student attitudes towards science fairs, investigating the impacts of influences on students and how that plays role in STEM career selection, and evaluating the relationship of awards on psychological feedback mechanisms of students. Huddleston (2014) concluded the research study by emphasizing the importance of recruiting the needed students required for future STEM careers and having good survey instrument tools that are needed to assess student attitudes regarding science fairs. The researcher explained these tools would positively impact education personnel decision-making in their design of courses in STEM and educational opportunities offered to students to develop the STEM workforce.

Westbury. Westbury (2016) conducted research to evaluate differences in attitudes towards science fairs of students in Christian private schools based on gender. The purpose of Westbury's (2016) research study was to "determine if there is a difference in overall attitudes towards science fairs, enjoyment of science fairs, and usefulness of science fairs of male and female Christian private school students in fifth through eighth grades" (p. 18). The researcher performed a thorough review of the literature discussing the historical account of science fairs and establishing the theoretical context and framework for the research study. Westbury (2016) also focused the literature review on targeted attitudinal domains such as value, enjoyment, and motivation extracted from Huddleston's (2014) research study previously mentioned. Other major targeted areas in this research study focused on gender and religiosity implications regarding student attitudes within STEM. Westbury (2016) used the Student's Attitude towards Science Fairs Survey (SATSFS), as revised by Huddleston (2014) from the original work of Michael (2005). The researcher altered the demographic section of the survey instrument to align with her research study and to assess religious affiliation to later assess relationship on student attitudes towards science fairs.

Westbury (2016) conducted a quantitative research study using a causal comparative design. The researcher examined one research question evaluating differences of Christian private school students between gender as related to attitudes towards science fairs (Westbury, 2016). The sample size for this study was 146 students (consisting of 72 males and 74 females), chosen by convenience sampling methods from four private, Protestant schools containing students in grades K-12. According to Westbury (2016), the sample consisted of students in grades five through eight from schools participating in science fairs within the school district being surveyed. The average age for both male and female groups were between the ages of 10 and 14. Westbury (2016) reported among the male group, the majority of students were from grade seven and eight (consisting of 25 students in each grade level participating in the research study) while within the female group, the majority of student participation originated from grade eight (comprising of 30 student participants of the overall female group). The researcher revealed sample ethnicity results and recognized the majority of participants in the study identified themselves as Caucasian subjects in both male (95.8%) and female (86.5%) groups. When religious affiliation was assessed on the SATSFS instrument, Westbury (2016) revealed that research subjects identified themselves from one of three affiliated groups: Baptist (38.4%), Methodist (19.9%), and Non-denominational (17.1%). The researcher also inquired as to the number of years that research subjects within the study had participated in science fairs. Westbury (2016) established that responses ranged primarily from one of three time-frames: one year (25.3%), three years (24.7%), and two years (21.2%). Lastly, the researcher assessed science fair projects by the categorical discipline to which they were related; the majority of participants in the research study entered projects either related to chemistry (24.1%), other (20.7%), or physics & astronomy (14.5%) overall. As previously mentioned, the entirely of the data was gathered by administration of the Student’s Attitude towards Science Fairs Survey (SATSFS) to student research subjects.

The results and findings from the research study were carefully documented after administration of the SATSFS. Westbury (2016) stated that "a one-way multivariate analysis of variance (MANOVA) was conducted to determine the difference in attitudes between male and female participants towards science fairs on the dependent variables, overall attitude, student's usefulness, and student's enjoyment" (p. 65). The researcher established that prior to administering the MANOVA, the data was screened for outliers and all testing assumptions were maintained. The descriptive statistics revealed that the female group had marginally higher attitudes towards science fairs than the male group; however, males were observed to find science fairs more useful than females, and females tended to find science fairs more enjoyable than males (Westbury, 2016). Student participant grade level group comparisons were also assessed. Westbury (2016) revealed that overall (i.e. combined enjoyment and usefulness scores) fifth grade students had the highest totals while eighth grade participants had higher scores in usefulness and fifth grade students had higher scores in enjoyment. Data analysis was also conducted among groups related to religious affiliation and years of participation in science fairs. Overall, students who identified themselves in the Episcopal group had the highest overall average and greatest individual averages in enjoyment and usefulness; the same result was found in years of participation within science fairs where students identified the science fair as year one of participation had the highest overall average and greatest individual averages in enjoyment and usefulness. As mentioned previously, prior to administering the MANOVA, the data was screened for outliers and all testing assumptions were tenable. As a result, the MANOVA was conducted and revealed "there are no significant differences on the dependent variables (enjoyment, usefulness, and overall attitude toward science fairs) by gender of fifth through eighth-grade students in Christian private schools" and "null hypothesis one failed to be rejected" (Westbury, 2016, p. 81).

Upon completion of reporting the results of the research study, the researcher discussed the conclusions revealed in the investigation and how results are related to other studies investigating similar research subjects and content. As stated earlier, the null hypothesis failed to be rejected as there were no significant differences found between the variables and gender. The results of this research study were also compared to similar research studies. The results of this study were compared to Huddleston's (2014) research. Westbury (2016) stated that initially the results "appear to contradict the study of Huddleston (2014, p. 63) who found a significant gender difference in attitudes between seventh and eighth-grade students" (p. 83). The researcher explained that although the focus of the research studies were different, overall both Huddleston's (2014) data and data from Westbury's (2016) study correlated regarding gender implications/effects in relation to science fairs. These findings and correlating agreement among researchers strengthen the data produced within these research investigations. Westbury (2016) also suggested that the data collected and analyzed in this study agreed with results of other research in the field. Furthermore, there is also agreeing research among studies investigating religious affiliation as well as school environment types (i.e. private and public-school models). Westbury (2016) revealed that other research correlates with information found in this study that "religious affiliation did not have any influence on students' attitudes towards science fairs" (p. 83) and, related to school environment types, as correlated with Huddleston's (2014) study, "both private Christian school and public-school students share a positive attitude towards science fairs" (p. 83).

In reflecting on the research study, Westbury (2016) made some prominent conclusions from assessing the data. As established previously, Westbury (2016) identified that from the initial review, this study contradicted some results of Huddleston's (2014) research study in four specific circumstances. The circumstances that were different between the research studies are "the instrumentation, the participants, time the survey was administered to the students" as well as school types surveyed (Westbury, 2016, p. 84). The structure and mechanics of the survey instrumentation was a stark difference. The original and revised surveys used and produced in the Huddleston (2014) study were based on a four-point Likert scale and altered to a five-point Likert scale in this research study (Westbury, 2016). There were several notable differences identified among the student populations investigated between each study. One significant difference was among student academic backgrounds being investigated. The students in Huddleston's (2014) study were those taking advanced science courses as opposed to this study defined by a student population that were sampled from various backgrounds of scientific understanding (Westbury, 2016). Another change was observed with grade levels of students being surveyed. Westbury (2016) revealed that her study used a wider range of grade levels (i.e. used grades five through eight) versus Huddleston's (2014) study that focused on grades seven and eight. There was also the difference among school demographics, specifically of school location types. Westbury (2016) explained that students from her study were from private, Christian schools versus students in Huddleston's (2014) study that were comprised of students from public inner-city schools. Lastly was the difference regarding survey administration and timing. The survey administered in Huddleston's (2014) study was not given to students while the science fair was taking place but after the fact, whereas Westbury's (2016) study was conducted during the science fair. These four-distinct differences are noteworthy and should, according to Westbury (2016), be investigated further to ensure that future data results are not prone to possible deficiencies in data gathering and analysis methodologies. The researcher offered future research study areas and suggests that emphasis should be placed on studies that focus on relatedness and differences among genders, different grade levels (i.e. such as focus given to high school students), and studies that compare ethnic diversity. Westbury (2016) explained that focusing on these future research topics may lead to much needed growth in diverse individuals pursuing STEM careers.

There is a multitude of various factors that cause students, both males and females, to pursue STEM career pathways. Although the research tends to suggest that STEM careers are typically male dominated (Iskander et al., 2013; Landivar, 2013a, 2013b; Mann & DiPrete, 2013), females are also being drawn (Venture, 2014; Welch & Huffman, 2011; Witherspoon et al., 2016) to STEM careers by means of attractive factors. One stimuli that can draw both males and females to the STEM arena is by means of scientific competitions (Aroca et al., 2016). Research studies establish that scientific competitions, such as robotics competitions, offer excellent benefits other than recruiting individuals to the STEM workforce. Robotics competitions have been noted to increase academic achievement in a variety of learning subgroups. The primary goal of a robotics competition is “the development of skills, interest, and awareness toward STEM and computing, a focus on the ability to effectively work in teams, and the development of cooperation and respect towards the other teams participating in the competitions” (Menekse et al., 2015, p. 1). By participating in robotics competitions, students enhance their complex problem-solving skills, develop leadership qualities, and are more apt to seek college admission (Melchior et al., 2017; Melchior et al., 2005; Morgan, Gelbgiser, & Weeden, 2013). The participation in these scientific competitions also foster needed team building skills (Abernathy & Vineyard, 2001; Grote, 1995; Hayes & Edwards, 2015, Melchior et al., 2017; Melchior et al., 2005; Welch & Huffman, 2011). Students also tend to perform better on standardized tests and are more apt to take more science and mathematics classes, which lead to pursuit of STEM majors in college (Nugent et al., 2016; Shen & Prior, 2016).

One specific type of learning modality that is manifested at a robotics competition is the ideology of learning through doing or hands-on learning. Hands-on learning is a type of experiential learning where students learn complex content, like programming computer code or physically building robotic structures that effectively carry out a specific task. Hands-on learning is a very common learning method in STEM fields. Schwichow, Zimmerman, Crocker, & Hartig (2016) suggested that hand-on tasks are common and are often utilized in training individuals' skills essential to experimentation. Experiential learning was primarily developed from acknowledging that all individuals learn in a unique and preferred manner. These learning methods are done through hands-on learning mechanisms. Research suggests that hands-on learning fosters a learning environment where students maintain maximum retention (Schwichow et al., 2016). This type of learning is effective in that it allows the learner to successfully master content by providing a learning opportunity of learning through doing and many times learning through repetition as well as trial and error. Researchers have documented that hands-on learning is a very effective learning modality where students are more likely to master additional content due to the student being able to associate themselves with the learning activity (Alkan, 2016; Novack & Goldin-Meadow, 2015; Schwichow et al., 2016; Wiek, Xiong, Brundiers, & Van der Leeuw, 2014).

The review of the literature revealed little research on the investigation of differences in attitudes among gender of individuals participating in robotics competitions. It is clear that the present research study should be conducted, due to the many studies that tend to research around the desired topic being presented.

Summary

There have been minimal research studies that investigated student attitudes, especially on the constructs of usefulness and enjoyment of robotics competitions between male and female students participating in robotics competitions. The research study addressed the following theoretical constructs: expectancy-value theory, gender schema theory, and intersectionality theory. The expectancy-value theory was addressed by investigating student enjoyment (intrinsic value) and usefulness (utility value) of robotics competitions as deemed by student participants. The gender schema theory was examined by investigating societal sex-typing and inequality of gender prevalence within STEM careers. The intersectionality theory was evaluated by investigating gender disparity within the STEM workforce and the need to further investigate the intersections of traditional family roles of men and women as related to the disparity. This research also identified gaps in the literature, related to attitudes within STEM and issues related to gender. This research study adds to the body of knowledge as it relates to the differences in attitudes towards robotics competitions between male and female students participating in a southeastern competition. Although gender and attitudinal studies have been conducted on STEM aspects, few studies have focused on robotics specifically. This study is valid and adds to the greater body of knowledge.

CHAPTER THREE: METHODS

Overview

This chapter discusses the research design of the study that investigated differences of attitudes of male and female students towards robotics competitions. The researcher outlines the research question(s) and hypothesis(es) of the study. Moreover, the researcher discusses a detailed perspective of the methodology in this research study, including participants and setting, instrumentation, procedures, and data analysis.

Design

This quantitative research study utilized a causal comparative research design to determine if there is a statistically significant difference in overall attitudes as measured through the lens of usefulness (utility value) and enjoyment (intrinsic value) between male and female students participating in robotics competitions. The causal comparative research design was an appropriate design for this study, due to the independent variable being both categorical and non-manipulated (Gall, Gall, & Borg, 2007). The independent variable in this research study was gender, and this variable is categorical as it was comprised of male and female groups. The dependent variable within this study is student attitude, measured by two sub-scales, usefulness (utility value) and enjoyment (intrinsic value). According to Kind et al. (2007), student attitude can be defined as an individual's emotional response or impression to an object or event, the degree to which the individual likes or dislikes the object or event. Usefulness is described as the value of an individual's experiences from completing a goal or task (Shumow & Schmidt, 2014). Enjoyment refers to individual worth received by the participation in an event (Wigfield & Eccles, 1992).

Research Question

RQ1: Is there a difference in overall attitudes towards robotics competitions between male and female students participating in a southeastern state robotics competition?

Null Hypothesis

$H_0$1: There is no significant difference in the overall attitudes towards robotics competitions, usefulness of robotics competitions, and enjoyment of robotics competitions between male and female students participating in a southeastern state robotics competition.

Participants and Setting

Population and Sample

The population used in this research study consisted of public school student participants from official qualified school robotics teams, recognized by For Inspiration and Recognition of Science and Technology (*FIRST*), participating in a 2018 southeastern state robotics competition, sponsored by a private university. There were 198 public-school students surveyed at the robotics competition. Four student surveys were removed due to incomplete surveys and extreme scores. As a result, a convenience sample of public school students (N = 194) in grades seven through 12 was utilized in this research study. The sample was selected by the researcher from participants by which permissions were granted by either their division superintendents and/or team coaches, depending on their team type (i.e. public-school team or community team). Students that participated in the sample were on a volunteer basis. The researcher provided an incentive for participating in the research study. Each team had the opportunity to be entered in a raffle for a chance to win a $200.00 Visa gift card. The raffle was completed near the end of the robotics competition, prior to closing ceremonies. The adjusted study sample of public school students (N = 194) exceeded the minimum participants required for statistical analysis.

According to Warner (2013), a minimum of 108 participants, with a minimum of 54 participants in each group, is required for this study for a medium effect size with a statistical power of .7 at the .05 alpha level. Table 1 provides the overall sample population demographics observed at the robotics competition.

Table 1

Overall Sample Population Demographics

		Frequency	Percentage
Gender			
	Male	125	64.4%
	Female	69	35.6%
Grade Level			
	Seventh grade	14	7.2%
	Eighth grade	19	9.8%
	Ninth grade	53	27.3%
	10th grade	41	21.1%
	11th grade	42	21.6%
	12th grade	25	12.9%
Age (average)		15.2 (average)	
Ethnicity			
	White		43.3%
	Black		0.5%
	Hispanic/Latino		0.5%
	Asian		50.0%
	American Indian/Alaskan Native		1.0%
	Biracial		1.5%
	Multiracial		2.1%
	Other		1.0%

The sample consisted of 125 males and 69 females. The grade assignments for the sample consisted of 14 students from the seventh grade, 19 students from the eighth grade, 53 students from the ninth grade, 41 students from the 10th grade, 42 students from the 11th grade, and 25 students from the 12th grade. The average age of the sample was 15.2 years old. The ethnicity of the sample consisted of 43.3% White, 0.5% Black/African Americans, 0.5% Hispanic/Latino, 50.0% Asian, 1.0% American Indian/Alaska Native, 1.5% Bi-racial, 2.1% Multi-racial, and 1.0% Other.

Groups

Table 2

Female Group Sample Population Demographics

		N	Percentage
	Total Females	69	
Grade level	Seventh grade	9	13.0%
	Eighth grade	7	10.1%
	Ninth grade	20	29.0%
	10th grade	17	24.6%
	11th grade	10	14.5%
	12th grade	8	8.7%
Age	Average Age	14.9	
Ethnicity			
	White		36.2%
	Black		1.4%
	Hispanic/Latino		1.4%
	Asian		53.6%
	American Indian/Alaskan Native		1.4%
	Biracial		2.9%
	Multiracial		1.4%
	Other		1.4%

The female group consisted of 69 female students. The grade assignments for the female group consisted of nine students from the seventh grade, seven students from the eighth grade, 20 students from the ninth grade, 17 students from the 10th grade, 10 students from the 11th grade, and six students from the 12th grade. The average age of the female group was 14.9 years old. The ethnicity of the female group consisted of 36.2% White, 1.4% Black/African Americans, 1.4% Hispanic/Latino, 53.6% Asian, 1.4% American Indian/Alaska Native, 2.9% Bi-racial, 1.4% Multi-racial, and 1.4% Other. Table 2 provides the female group sample population demographics observed at the robotics competition.

Table 3

Male Group Sample Population Demographics

		N	Percentage
	Total Females	125	
Grade level	Seventh grade	5	4.0%
	Eighth grade	12	9.6%
	Ninth grade	33	26.4%
	10th grade	24	19.2%
	11th grade	32	25.6%
	12th grade	19	15.2%
Age	Average Age	15.4	
Ethnicity			
	White		47.2%
	Black		0.0%
	Hispanic/Latino		0.0%
	Asian		48.0%
	American Indian/Alaskan Native		0.8%
	Biracial		0.8%
	Multiracial		2.4%
	Other		0.8%

The male group consisted of 125 male students. The grade assignments for the male group consisted of five students from the seventh grade, 12 students from the eighth grade, 33 students from the ninth grade, 24 students from the 10^{th} grade, 32 students from the 11^{th} grade, and 19 students from the 12^{th} grade. The average age of the male group was 15.4 years old. The ethnicity of the male group consisted of 47.2% White, 0.0% Black/African Americans, 0.0% Hispanic/Latino, 48.0% Asian, 0.8% American Indian/Alaska Native, 0.8% Bi-racial, 2.4% Multi-racial, and 0.8% Other. Table 3 provides the male sample population demographics observed at the robotics competition.

Instrumentation

The instrument used in the research study was the Student's Attitude towards Robotics Competitions (SATRC) survey, a modified version of the Student's Attitude towards Science Fairs Survey or SATSFS (Michael & Huddleston, 2014) customized for use at the southeastern state robotics competition (see Appendix A for survey instrument). The researcher obtained permission to use and alter the survey instrument for use at the robotics competition from the survey developers. The only alterations to the instrument itself were to replace the phrase "science fairs" from the original science fair survey to "robotics competitions" in the survey instrument that was used in this research study. The researcher also altered the demographic information from the original survey to meet the information surveying requirements that is needed for this research study. The SATRC instrument demographic section acquired student information regarding grade level, age, race/ethnicity, and a few questions regarding each participant's robotics team make-up with regard to team size, gender statistics, requirements for robotics participation, and quantity of robotics competition participation. The purpose of the original instrument was to measure student's attitudes towards science fairs; this was accomplished by combining two sub-scales, enjoyment (intrinsic value) and usefulness (utility value).

The unpublished instrument was developed by Michael (2005) and was derived from the meta-analysis of literature produced by Osborne et al., (2003) that stemmed over a 20-year period. The original instrument contained 45 questions and addressed nine domains (Huddleston, 2014; Westbury, 2016). The nine domains that were addressed in the instrument were anxiety, value, efficacy, motivation, enjoyment, achievement, social influences-parents, social influences-teachers, and social influences-friends. Huddleston (2014) conduced factor-analysis on the original 45 question instrument inspired by Osborne et al. (2003) and derived the two present sub-scales used to measure student attitude, enjoyment, and usefulness. The 45-question instrument that was modified by Huddleston (2014) was based on a four-point Likert scale that ranged from strongly agree to strongly disagree. The instrument was reduced to only 10 questions that measured enjoyment and usefulness (Huddleston, 2014; Westbury, 2016). The shorter version of the instrument, used by Westbury (2016), was based on a five-point Likert scale that ranged from strongly agree to strongly disagree, but incorporated the neutral response. Responses were as follows: strongly agree = 5, agree = 4, neutral = 3, disagree = 2, and strongly disagree = 1. The instrument was reported by previous researchers to take approximately 10 minutes to administer. The instrument was used in two previous studies (Huddleston, 2014; Westbury, 2016). The score on the instrument ranges from 10-50 points; a score of 10 represents low enjoyment and usefulness and a score of 50 represents maximum enjoyment and usefulness. The instrument is a valid and reliable instrument in measuring student attitudes based on enjoyment and usefulness. The Cronbach's alpha value was .94 among the combined sub-scales; both enjoyment and usefulness individually ranged from .89 to .90 (Huddleston, 2014; Westbury, 2016). Permission to use the instrument was granted to the researcher (see Appendix B for permission to use a modified version of the Students Attitudes towards Science Fairs survey that can used at a robotics competition.)

Procedures

Permissions

The researcher gained approval from *FIRST* Chesapeake to administer a survey called *Student's Attitude towards Robotics Competitions* (SATRC) at a 2018 southeastern robotics competition (see Appendix F for permission from FIRST Chesapeake to administer the surveying instrument at the robotics competition). Prior to data collection, the following approvals were pursued and obtained: Liberty University Institutional Review Board (IRB), necessary superintendents for public school teams, and/or robotics team head coaches whose teams identify themselves as neighborhood/community teams (i.e. not representing a public school). See Appendix C for Liberty IRB approval, Appendix D and E for public school superintendents' permission, and Appendix J and K for neighborhood/community team permission from coaches for those that participate in the robotics survey. Once all approvals were granted from *FIRST* Chesapeake, Liberty University IRB, public school superintendents, and neighborhood/community teams, the researcher worked with the robotics competition organization by contacting the Director of Programs (DOP) of *FIRST* Chesapeake two weeks prior (middle of January 2018) to discuss details regarding administering the survey at the first robotics competition (see Appendix F for permission from *FIRST* Chesapeake).

Pre-Competition Preparation

The researcher copied paper-pencil surveys (500 copies), consent forms (500 copies), and coaches' direction sheets (55 copies) prior to traveling to the robotics competition site. Also, 55 bundles of pens were created containing 10 pens per bundle for average size robotics teams. There were also extra materials (i.e. paper-pencil surveys, consent forms, coaches' direction sheets, and pens) brought for larger student teams and the possibly of misplaced items during the competition. The researcher traveled to the location of the robotics competition one day prior to the competition to meet with the Director of Programs (DOP). The researcher acquired the team participants' lists from the DOP. Robotics team packets were created for each participating robotics team by the researcher. The packets contained the required components and materials to complete the paper-pencil survey for each team. Head robotics coaches were asked by the researcher to administer the paper-pencil surveys to their team members after their teams first qualifying match during the competition. The researcher provided the head coach of each participating team with a large 11x14 manila envelope with their team number written on the front of the envelope. The researcher included in each packet the directions for the coach to administer the survey to their team members (see Appendix I for coaches' directions), a letter to student participants explaining the research study (see Appendix G), an assent form (see Appendix H) for each team participant to read explaining survey information and procedures, a paper-pencil survey (see Appendix A) for each team member to complete, and the needed number of pens for each student to complete the survey. The consent form was attached to the front of the paper-pencil survey with a paper clip. The robotics team packets were sorted by competing divisions that correlated with the team participant's lists (as acquired earlier by the DOP).

Survey Administration at Robotics Competitions

During the morning of the robotics competition, the researcher arrived at the competition location a few hours prior to the event start time to get organized for survey administration.

After opening ceremonies and when all robotics students had participated in at least one qualifying match, the researcher visited each team in their designated pit area during a time that did not conflict with their judging or match schedule times. The researcher gave each robotics team head coach a robotics team packet with their team number on the front. The head coaches were informed about the purpose for the study, the need for completed surveys at the robotics competition, an explanation of the steps for completing the survey (see Appendix I for coaches' directions), the approximate time to take the survey, and an explanation of the contents in the robotics team packet. The researcher also informed head coaches that upon completion of the surveys by team participants, participants could keep the pens provided by the researcher. It was also explained that teams were eligible to enter a drawing for a chance to win a $200.00 Visa gift card after completing the survey. The researcher explained to the coach that once they have administered the survey to their team, the researcher would revisit each team at their designated pit area within the next 35-40 minutes of the first visit to collect the completed surveys. During that time, the researcher gave the coach one raffle ticket for each completed survey returned by their team members and asked them to print their team number on the back of each ticket. The coach gave the tickets with team numbers to the researcher. The researcher placed each ticket in a plastic bucket with a lid. Once the surveys had been collected by the researcher and all raffle tickets had been placed in the bucket, the bucket was agitated to mix the tickets. One ticket was drawn from the plastic bucket by the Director of Programs (DOP) and the winner of the gift card was announced at closing ceremonies. Once all data was collected from the competition, all surveys were coded (i.e. each survey was assigned a number) and later entered into IBM SPSS for data analysis.

Data Analysis

A one-way multivariate analysis of variance (MANOVA) was used to determine if differences exist between male and female students' attitudes toward robotics competitions. A MANOVA was utilized for this research study because each participant "will have a score on two or more dependent variables" (Gall et al., 2007, p. 321). Each research participant was scored on student attitudes (dependent variable) that was measured by the combination of two specific attitudinal components, enjoyment (intrinsic value) and usefulness (utility value) as measured on the Student's Attitude towards Robotics Competitions (SATRC) instrument.

There are several factors that must be considered when conducting a MANOVA. First, the data was screened to assess for outliers and inconsistencies within the data by means of box and whisker plots. The observations of all variables were independent of one another and random sampling was performed. According to Warner (2013) and Green and Salkind (2011), there are several key assumptions in conducting a MANOVA. Scatterplots were used to illustrate a normal multivariate distribution of the data. The Kolmorgorov-Smirnov test was utilized to validate the assumption of normality; this test is selected for samples with greater than 50 participants (Warner, 2013). In order to test the assumption of homogeneity of variance-covariance, the Levene's test was utilized in this research study. Lastly, the researcher analyzed the Pearson *r* to test for the assumption on multicollinearity as recommended by Warner (2013). Once all assumptions were met, the MANOVA was conducted. All data was tested and considered significant at the 95% confidence level for all statistical tests. Results were reported using Wilks's lambda (Green & Salkind, 2013), and effect size was measured using partial eta squared.

CHAPTER FOUR: FINDINGS

Overview

This chapter discusses the data findings from the study as revealed from the administration of the Student's Attitude towards Robotics Competitions (SATRC) instrument at a southeastern state robotics competition. The researcher reports and discusses all descriptive statistics for all variables in the research study (i.e. statistics from independent and dependent variables, population and sample statistics, etc.). This chapter discusses statistical procedures used in the study and data screening methods and assumption tests results. All inferential statistics are reported as related to the hypothesis for all variables (reporting alpha level and effect size), and the research study null hypothesis is evaluated.

Research Question

RQ1: Is there a difference in overall attitudes towards robotics competitions between male and female students participating in a southeastern state robotics competition?

Null Hypothesis

$H_0$1: There is no significant difference in the overall attitudes towards robotics competitions, usefulness of robotics competitions, and enjoyment of robotics competitions between male and female students participating in a southeastern state robotics competition.

Descriptive Statistics

A one-way multivariate analysis of variance (MANOVA) was used to evaluate if differences exist between male and female students' attitudes toward a southeastern robotics competition. A causal comparative research design was utilized in this study to determine if there is a statistically significant difference in overall attitudes as measured through the lens of usefulness (utility value) and enjoyment (intrinsic value) between male and female students participating in robotics competitions. A convenience sample of public school students (*N* = 194) were selected at the robotics competition. Each participant was administered the Student's Attitude towards Robotics Competitions (SATRC) survey instrument. Data collected for enjoyment, value (usefulness), and total (overall attitude) towards robotics can be found in Table 4.

Table 4

Descriptive Statistics for Enjoyment, Value, and Total by Gender

	Gender	*M*	*SD*	*N*
Enjoyment	Female	23.59	2.03	69.00
	Male	23.47	2.26	125.00
	Total	23.52	2.17	194.00
Value	Female	21.48	3.13	69.00
	Male	21.48	3.13	125.00
	Total	21.48	3.12	194.00
Total	Female	45.07	4.54	69.00
	Male	44.95	4.77	125.00
	Total	44.99	4.68	194.00

The enjoyment domain overall (*M* = 23.52, *SD* = 2.17) was marginally higher in females (*M* = 23.59, *SD* = 2.03) than in males (*M* = 23.47, *SD* = 2.26). The value (or usefulness) domain collectively (*M* = 21.48, *SD* = 3.12) was numerically identical among males (*M* = 21.48, *SD* = 3.13) and females (*M* = 21.48, *SD* = 3.13). The overall attitude among females (*M* = 45.07, *SD* = 4.55) was higher than males (*M* = 44.95, *SD* = 4.77). Descriptive statistics was also performed by comparing means of enjoyment, value (usefulness), and total (overall attitude) among grade levels and can be found in Table 5.

Table 5

Descriptive Statistics for Enjoyment, Value, and Total by Grade Level

	Grade level	*M*	*SD*	*N*
Enjoyment	7th	24.07	2.46	14.00
	8th	23.53	1.78	19.00
	9th	23.51	2.22	53.00
	10th	23.24	2.08	41.00
	11th	23.24	2.40	42.00
	12th	23.80	2.06	25.00
Value	7th	23.07	1.73	14.00
	8th	22.26	2.75	19.00
	9th	21.00	3.37	53.00
	10th	21.24	3.08	41.00
	11th	21.02	3.20	42.00
	12th	22.16	3.09	25.00
Total	7th	47.14	3.72	14.00
	8th	45.79	4.01	19.00
	9th	44.51	5.15	53.00
	10th	44.49	4.26	41.00
	11th	44.45	5.04	42.00
	12th	45.96	4.43	25.00

The value for enjoyment was found to be greatest among seventh grade (*M* = 24.07, *SD* = 2.46) students and lowest among 10th grade (*M* = 23.24, *SD* = 2.08) students. The value domain was also found to be greatest among seventh grade (*M* = 23.07, *SD* = 1.73) students while the lowest was among ninth grade (*M* = 21.00, *SD* = 3.37) students. Overall attitude was observed to be highest in seventh grade (*M* = 47.14, *SD* = 3.72) students while the lowest was found among 11th grade (*M* = 44.45, *SD* = 5.04) students. Most student participants within this study were from ninth grade (*n* = 53), the second largest group from 11th grade (*n* = 42), and the third largest group from 10th grade (*n* = 41). Data was also reported on enjoyment, value, and total (overall attitude) by race and can be found in Table 6.

Table 6

Descriptive Statistics for Enjoyment, Value, and Total by Race

	Ethnicity	*M*	*SD*	*N*
Enjoyment	White	23.38	2.34	84.00
	Black	23.00	0.00	1.00
	Hispanic/Latino	18.00	0.00	1.00
	Asian	23.58	2.06	97.00
	American Indian/Alaskan Native	24.00	1.41	2.00
	Bi-racial	24.67	0.58	3.00
	Multi-racial	24.50	1.00	2.00
	Other	25.00	0.00	2.00
	Total	23.52	2.17	194.00
Value	White	21.45	3.28	84.00
	Black	19.00	0.00	1.00
	Hispanic/Latino	20.00	0.00	1.00
	Asian	21.65	3.01	97.00
	American Indian/Alaskan Native	23.00	2.83	2.00
	Bi-racial	18.33	0.58	3.00
	Multi-racial	20.00	3.46	2.00
	Other	22.50	3.54	2.00
	Total	21.48	3.12	194.00
Total	White	44.83	5.23	84.00
	Black	42.00	0.00	1.00
	Hispanic/Latino	38.00	0.00	1.00
	Asian	45.23	4.31	97.00
	American Indian/Alaskan Native	47.00	4.24	2.00
	Bi-racial	43.00	0.00	3.00
	Multi-racial	47.50	3.79	2.00
	Other	47.50	3.54	2.00
	Total	44.99	4.68	194.00

Individuals that identified themselves as Bi-racial (*M* = 24.67, *SD* = 0.58) were identified to have the highest mean for enjoyment score whereas Hispanic (*M* = 18.00, *SD* = 0.00) individuals were observed to lowest mean. The value domain was also found to be greatest among those who classify themselves as Other (*M* = 22.50, *SD* = 3.54) while the lowest was among Bi-racial (*M* = 18.33, *SD* = 0.58) individuals. Overall attitude was observed to be highest in those who identified their race as Other (*M* = 47.50, *SD* = 3.54) while the lowest was found among Hispanic (*M* = 38.00, *SD* = 0.00) individuals. The majority of student participants within this research study identified themselves as Asian (*n* = 97), and the second largest group reported themselves as White (*n* = 84). Descriptive statistics was also reported regarding enjoyment, value, and total (overall attitude) by number of robotics competitions individuals have participated within the robotics season. Data on enjoyment, value, and total (overall attitude) by number of robotics competitions can be found in Table 7.

Table 7

Descriptive Statistics for Enjoyment, Value, and Total by No. of Competitions

	Number of Competitions	*M*	*SD*	*N*
Enjoyment	1	22.17	3.13	6.00
	2	23.78	1.96	60.00
	3	23.50	2.19	112.00
	4	23.50	1.61	14.00
	10	16.00	0.00	1.00
	18	25.00	1.00	0.00
	Total	23.52	2.17	194.00
Value	1	17.67	5.13	6.00
	2	21.78	3.12	60.00
	3	21.57	3.03	112.00
	4	20.21	2.78	14.00
	10	20.00	0.00	1.00
	18	23.00	1.00	0.00
	Total	21.48	3.12	194.00
Total	1	41.83	45.57	6.00
	2	45.57	4.61	60.00
	3	45.07	4.60	112.00
	4	43.71	3.50	14.00
	10	36.00	0.00	1.00
	18	48.00	1.00	0.00
	Total	44.99	4.68	194.00

The data documenting the total number of robotics competitions that students participated within the robotics season revealed the highest values for enjoyment (*n* = 1, *M* = 25.00, *SD* = 0.00) were students reported they participated in 18 competitions, the second highest for enjoyment (*n* = 60, *M* = 23.78, *SD* = 1.96) were students that reported they participated in two competitions, and third highest (*n* = 112, *M* = 23.50, *SD* = 2.19) were students that reported they participated in three competitions. The highest value for usefulness (*n* = 1, *M* = 23.00, *SD* = 0.00) occurred with students that participated in 18 robotics competitions, the second highest for usefulness (*n* =

60, *M* = 21.78, *SD* = 3.12) was students that reported they participated in two competitions, and third highest (*n* = 112, *M* = 21.57, *SD* = 3.03) were students that reported they participated in three competitions. Overall attitude was observed to be highest in students that participated in 18 (*n* = 1, *M* = 48.00, *SD* = 0.00) robotics competitions, second highest were students that participated in two (*n* = 60, *M* = 45.57, *SD* = 4.61) robotics competitions, and the third highest were students that participated in three (*n* = 112, *M* = 45.07, *SD* = 4.60) robotics competitions. Overall, enjoyment and usefulness values tend to increase as students participate in more robotics competitions but tend to differentiate beyond students participating in more than two robotics competitions.

Results

Data Screening

Data screening was conducted by the researcher on each dependent variable (i.e. enjoyment, usefulness, and overall total attitude) to assess for data discrepancies and extreme outliers. There were four surveys removed from the total number of surveys collected due to student participants' incomplete survey responses. The sample used in this research study was 194 public-school students. Student #180 appeared to be an extreme score (*z*-score = -2.98). The raw score was converted to a standard *z*-score. According to Warner (2013), this score fell between acceptable tolerances that were between -3.30 to +3.30 and was determined not to be an outlier. Outliers were analyzed using box and whisker plots for each dependent variable (see Figures 1, 2, and 3).

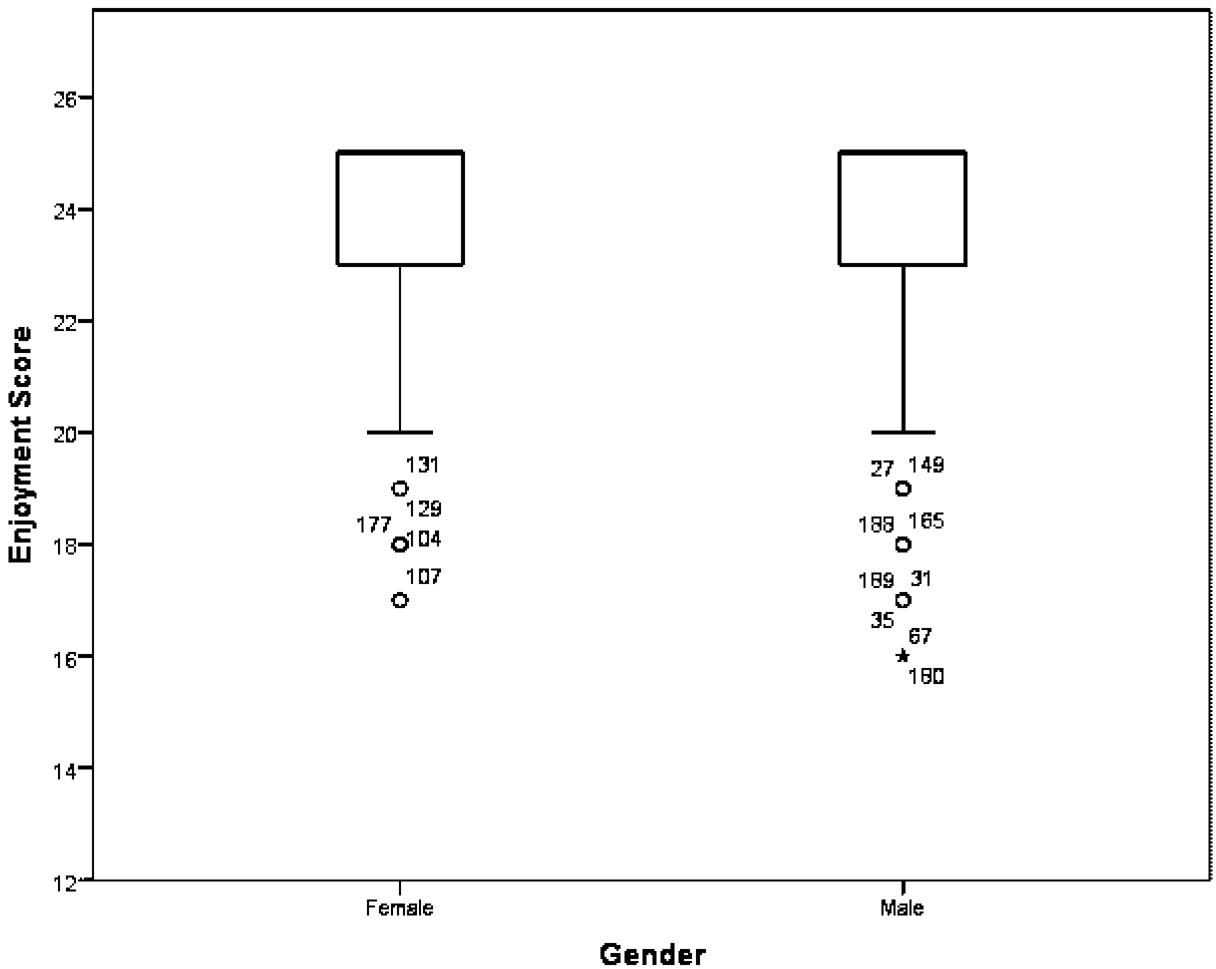

Figure 1. Box and whisker plot for enjoyment by gender.

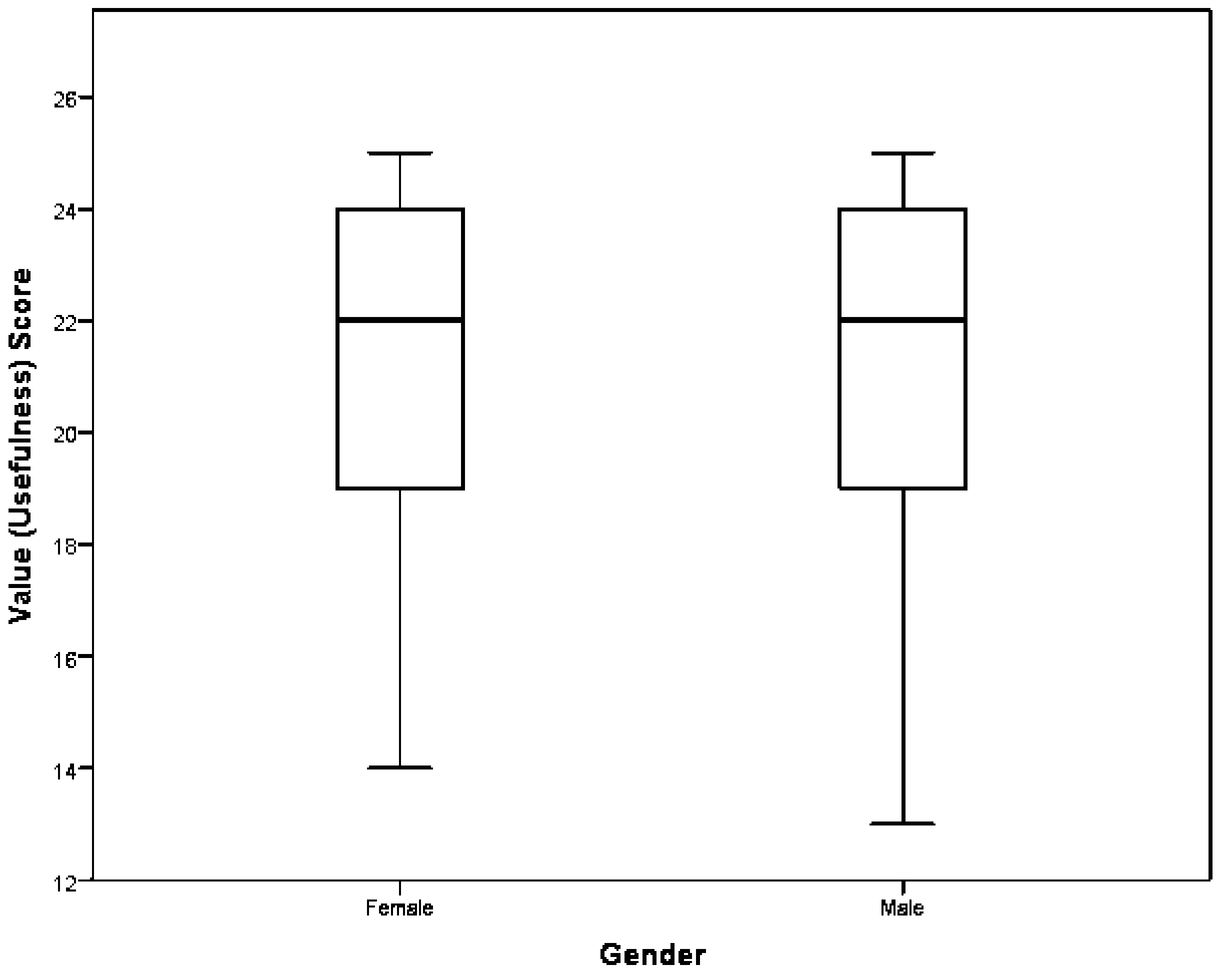

Figure 2. Box and whisker plot for value (usefulness) by gender.

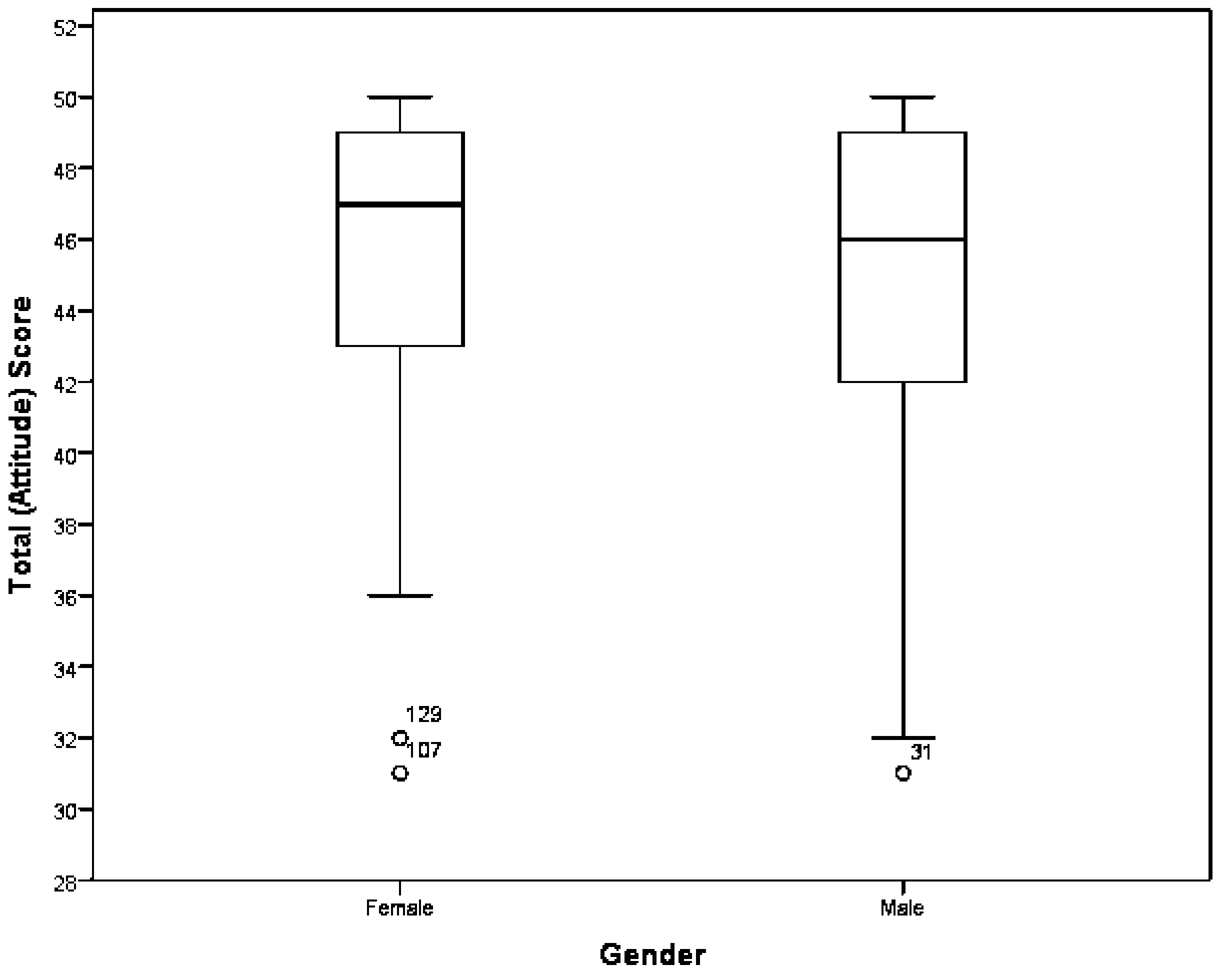

Figure 3. Box and whisker plot for total (attitude).

Assumptions

This research study utilized a one-way multivariate analysis of variance (MANOVA) to determine if differences exist between male and female students' attitudes toward robotics competitions. Scatterplots were used to illustrate a normal multivariate distribution of the data (see Figures 4, 5, and 6 for scatterplots of enjoyment, value, and total attitude).

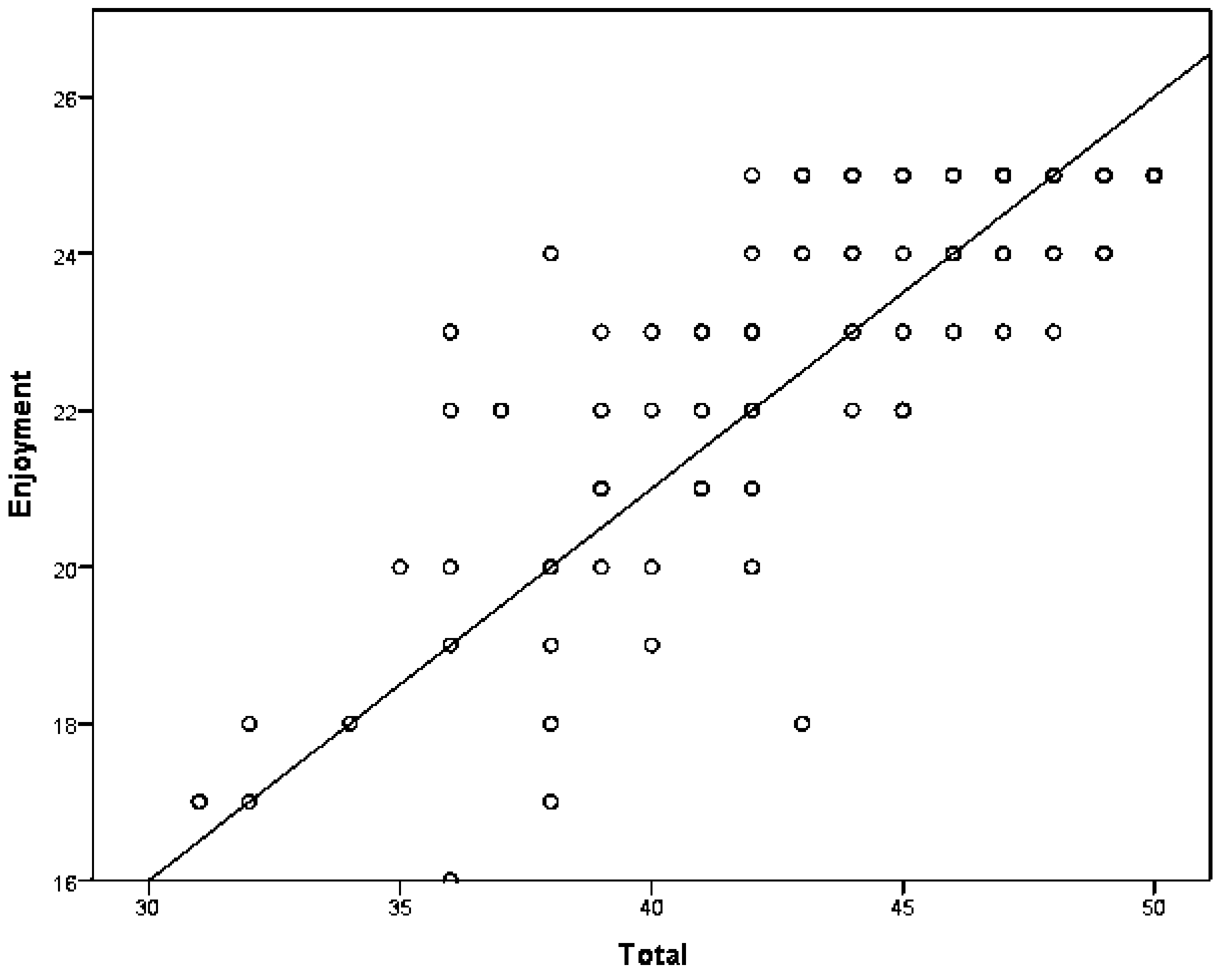

Figure 4. Scatterplot for enjoyment of robotics competition.

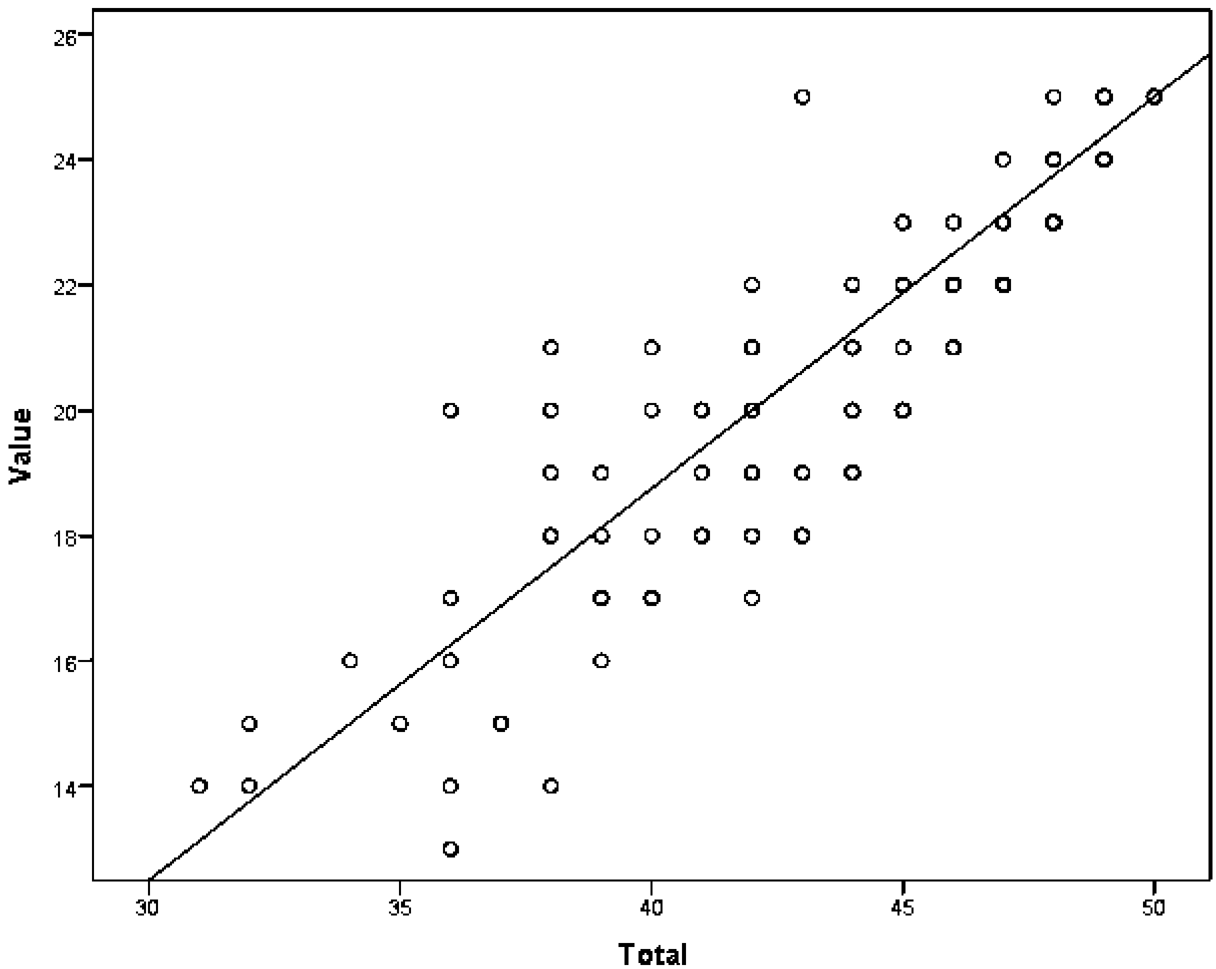

Figure 5. Scatterplot for value (usefulness) of robotics competition.

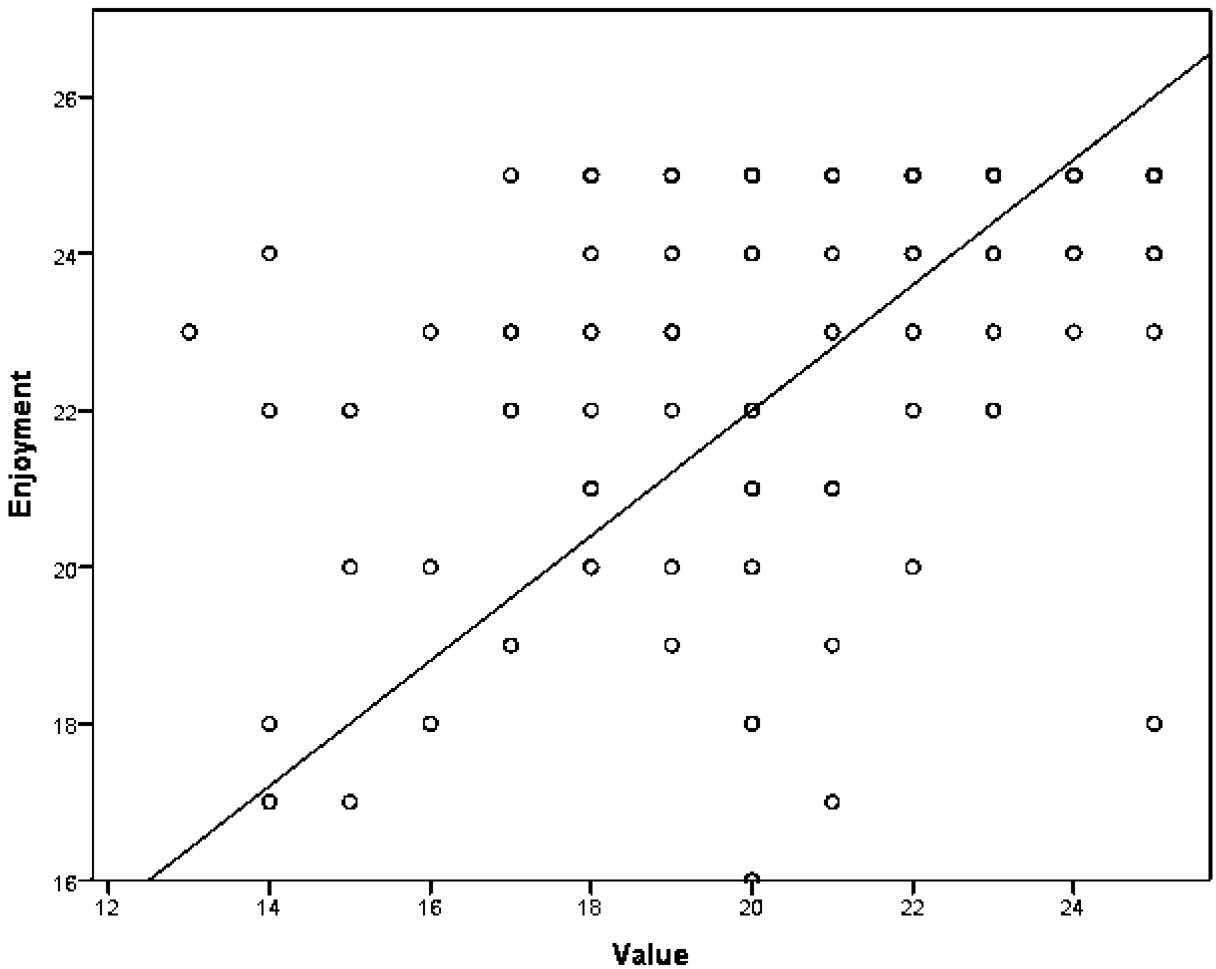

Figure 6. Scatterplot for value vs. enjoyment of robotics competition.

All scatterplots for enjoyment, value, and total attitude showed a normal distribution; thus, the assumption for normal multivariate distribution was tenable. The Kolmogorov-Smirnov test was used to evaluate the assumption of normality (see Table 8 for the Test of Normality).

Table 8

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Gender	Statistic	df	Sig.	Statistic	df	Sig.
Enjoyment	Female	.277	69	.000	.726	69	.000
	Male	.279	125	.000	.721	125	.000
Value	Female	.175	69	.000	.897	69	.000
	Male	.130	125	.000	.910	125	.000
Total	Female	.172	69	.000	.892	69	.000
	Male	.162	125	.000	.894	125	.000

Note. a = Lilliefors Significance Correction

The assumption of normality was not tenable among male and female sub-levels for the enjoyment, value, and total group ($p < .001$ for all groups and subgroups). However, Warner (2013) stated that an ANOVA is considered robust enough to withstand a violation of the normality assumption. The assumption of homogeneity of variance was tested by analyzing the Levene’s test (see Table 9).

Table 9

Levene’s Test Results

	F	df1	df2	Sig.
Enjoyment	.918	1	192	.339
Value	.007	1	192	.935
Total	.771	1	192	.381

Notes. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.[a] a. Design: Intercept + gender

The assumption for homogeneity of variance was tenable for enjoyment (p = .339), value (p = .935), and total (p = .381). The researcher also analyzed the Pearson r value to test for the assumption on multicollinearity. See Table 10 for Pearson r value analysis.

Table 10

Correlations – Pearson r value

		Enjoyment	Value	Total
Enjoyment	Pearson Correlation	1	.547**	.830**
	Sig. (2-tailed)		.000	.000
	N	194	194	194
Value	Pearson Correlation	.547**	1	.921**
	Sig. (2-tailed)	.000		.000
	N	194	194	194
Total	Pearson Correlation	.830**	.921**	1
	Sig. (2-tailed)	.000	.000	
	N	194	194	194

Note. **. Correlation is significant at the 0.01 level (2-tailed).

The value for enjoyment and total revealed a large level of collinearity (r = .830). It was also observed that the value for value and total revealed a large level of collinearity (r = .921). These data findings were consistent due to the value for total (attitude) being derived from adding the enjoyment and value (usefulness) subscales together to get a total value for attitude. It was also found that collinearity (r = .547) existed between enjoyment and value. Thus, the assumption of multicollinearity was maintained.

Null Hypothesis

This research study utilized a one-way multivariate analysis of variance (MANOVA) to determine if differences exist between male and female public-school students' attitudes towards robotics competitions. The MANOVA yielded that there are no significant differences found at the 95% confidence level among the gender of students and their enjoyment, value (usefulness), and total (overall attitude) values, Wilks's $\Lambda = 1.00$, $F(2, 191) = 0.10$, $p > .05$, partial $\eta^2 = 0.001$. The effect size was small. Thus, the researcher failed to reject the null hypothesis signifying there was no significant difference in the overall attitudes towards robotics competitions, usefulness of robotics competitions, and enjoyment of robotics competitions between male and female students participating in a southeastern state robotics competition. Because the null hypothesis was not rejected, no post hoc analysis was required.

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter discusses the results obtained from the present research study by re-examining the purpose statement and outlining a brief synopsis of the entire study to this point. The findings of this study are compared to results obtained by other researchers that conducted similar research investigations. Implications that resulted from the completion of this research study are thoughtfully reviewed. The researcher identifies limiting factors as it pertains to this quantitative investigation and discusses recommendations for future research based on the study findings.

Discussion

The purpose of this quantitative research study was to determine if there was a statistically significant difference in the overall attitudes, as measured through the sub-scales of usefulness (utility value) and enjoyment (intrinsic value), between male and female public-school students participating in a southeastern state robotics competition. The population investigated was public school students from grades seven through 12 that participated in a southeastern state robotics competition. The data was collected during the spring semester of the 2017-2018 school year in February. The appropriate permissions, consents, and approvals were acquired prior to survey administration.

The researcher administered the Student's Attitude towards Robotics Competitions (SATRC) survey at a southeastern state robotics competition. During the robotics competition, there were 198 student surveys collected from public school students; four surveys were discarded, resulting in a sample population of 194 public school students. Among the sample population, there were one-hundred and 25 males and 69 females. All data collected at the robotics competition was coded and prepared for data analysis. The researcher conducted a one-way multivariate analysis of variance (MANOVA) to investigate if disparities exist between male and female public-school students' attitudes towards robotics competitions. Data was screened for outliers and data discrepancies (as mentioned earlier), and all assumptions for MANOVA were tenable. The independent variable was biological sex (i.e. male and female) and the dependent variables were overall attitudes (i.e. total), usefulness (utility value), and enjoyment (intrinsic value). The research question postulated was, "is there a difference in overall attitudes towards robotics competitions, between male and female students participating in a southeastern state robotics competition?" The results of the MANOVA validated that there was no significant difference among the means between the independent and dependent variables. Thus, the researcher failed to reject the null hypothesis in this quantitative research study and, therefore, confirmed there is no statistical difference between the overall attitudes of public school students (as measured by usefulness and enjoyment) between males and females at a southeastern robotics competition.

The results of this research study as compared to similar studies seeking to investigate student attitudes towards STEM related competitions, such as the studies conducted by Huddleston (2014) and Westbury (2016), have similarities and differences. Huddleston's (2014) results are found to be in stark contrast when compared to the results of the present study. For example, Huddleston's (2014) study focused on ascertaining student attitudes at science fairs by refining and administering the Student's Attitude towards Science Fairs Survey (SATSFS) to seventh and eighth grade middle school students (N = 110) from the inner city. Huddleston (2014) concluded in her study that "a significant difference between males (M = 23.0, SD = 7.06) and females (M = 26.2, SD = 7.38) was found: $t(98) = 2.04$, $p = .04$" and specifically she stated that "overall, females had a more positive attitude towards science fairs than males" (p. 63). This is totally opposite to the results of the present study that found there to be no significant differences in the overall attitudes between male and female public-school students towards robotics competitions (i.e. a type of STEM competition like science fairs) as measured by usefulness and enjoyment. However, when compared means of enjoyment, usefulness, and overall attitude were analyzed in present study, the enjoyment and total (overall attitude) values revealed similarity to Huddleston's (2014) study. In fact, the present study revealed that females had slightly higher enjoyment and overall attitude values towards robotics competitions (i.e. a type of STEM competition comparative to science fairs) as compared to males. This finding did correlate with Huddleston's (2014) statement that "females had a more positive attitude towards science fairs than males" (p. 63).

Another study that investigated science fairs (or type of STEM competition) was conducted by Westbury (2016). When compared to the Westbury (2016) study, the present study investigating student's attitudes towards robotics competitions revealed several direct parallels to the findings revealed by Westbury (2016). The present study was a replication study of Westbury's (2016) study but chose a different student population and type of competitive STEM competition. Westbury's (2016) research study focused on the attitudes of male and female Christian private school students (N = 146) in grades five through eight towards science fairs while the present study concentrated on student attitudes of public school students (between males and females) towards robotics competitions in grades seven through 12.

In analyzing the compared means of the dependent variables (i.e. enjoyment, usefulness, and overall attitude) between the present study and Westbury's (2016) study, both studies compared mean values show agreement regarding female values for enjoyment and overall attitude. This present study paralleled Westbury's (2016) findings that female participants' enjoyment and overall attitude mean values appear to be higher than males. However, the mean values between males and females for usefulness did not agree among the two studies. For example, Westbury (2016, p. 66-67) discovered the usefulness mean value to be lower in females (M = 14.73, SD = 4.60) than males (M = 15.04, SD = 5.40) opposed to the present study results that revealed the mean values for usefulness to be identical between females and males (M = 21.48, SD = 3.13). Although the present study and Westbury's (2016) study analyzed different grade level intervals, a common parallel was identified. In both studies, the means for enjoyment and overall attitude are higher in students from lower grade levels. As mentioned earlier, Westbury (2016) investigated students in grades five through eight while the present study focused on students in grades seven through 12. Enjoyment and overall attitude mean values were observed to be highest in fifth grade students in Westbury's (2016, p. 67) study while they were revealed to be the highest in seventh grade students in the present study. Thus, the highest mean values were observed in students from the lowest grade levels studied in each research study. Lastly, when comparing the null hypotheses from both research studies, the null hypothesis failed to be rejected in both the present study and Westbury's (2016) study. According to Westbury's (2016), the MANOVA test results for her research study were "not significant at an alpha level of .05, where $F(2, 143) = 2.52$, $p = .08$, partial $\eta^2 = 0.034$" (p. 81). The present studies MANOVA statistical test results were Wilks's $\Lambda = 1.00$, $F(2, 191) = 0.10$, $p > .05$, partial $\eta^2 = 0.001$. Both studies agreed that there were no significant differences in the overall attitudes towards the STEM competition (being investigated in each study as mentioned previously) as measured by usefulness and enjoyment values between male and female students participating in a specific type of STEM competition.

Another notable parallel that this research study established is related to the proportionality between enjoyment and the usefulness of a task. This study reaffirmed and supported the ideology supported by Tyler-Wood et al. (2012) that when an individual finds enjoyment within a task or event, an overall positive attitude is fostered by that individual. For example, as mentioned earlier, when comparing mean values of enjoyment and overall attitude, individuals with higher enjoyment scores also had higher overall positive attitudes regarding the event or task that they participated; in this study it was the female group. Similarly, the data in this present study also supported the perspectives of Ali et al. (2013) by the general premise that individuals who find something useful tend to manifest more positive attitudes.

The data in this study also supported the literature (Beede et al., 2011; Bergeron & Gordon, 2017; Gayles & Ampaw, 2014; Heilbronner, 2013; Landivar, 2013a, 2013b; MacPhee et al., 2013; National Science Foundation, 2017; Simon et al., 2017; Yonghong, 2015) of the known gender disparity still apparent in STEM. For example, the convenience sample (N = 194) noted in this study demonstrated that disparity due to the proportion of males (n = 125) to females (n = 69) resulting in an approximate 2:1 disproportionality that directly supported Landivar’s (2013a) report on gender trend statistical information within STEM. Also, this current study supported the ideology of Archer et al. (2013) that established the viewpoint that males tend to be more attracted to fields within science than do females.

Implications

Investigating the attitudes of students towards science and engineering competitions (such as robotics competitions) is crucial to research so future needs can be met within STEM. The competitions ignite positive attitudes within individuals towards the STEM workforce (Ali et al., 2013; Alsup, 2015; Najafti et al., 2012). These research investigations, like the current study, helped identify areas of improvement at these competitions. Once these areas of improvement are identified and addressed, this will result in attracting more skilled men and women to the STEM field and facilitate optimized recruiting to fulfill future employment needs in the STEM workforce.

Very little research has been conducted within the area of assessing attitudes of students towards science competitions. This research study was developed and ultimately is an extension of former studies conducted by Huddleston (2014) and Westbury (2016) investigating the attitudes of male and female students (of different school types) towards science fairs. This study aspired to replicate Westbury's (2016) study but expand the study to a different type of STEM competition (i.e. from science fair to robotics competition) and different student population (i.e. from Christian private school students to public school students). It is important to gain student attitude perspectives at diverse types of science and engineering competitions so untapped potential can be discovered among skilled men and women from various academic backgrounds. As a result, this research study positively added to the limited body of knowledge addressing student attitudes towards STEM competitions.

Limitations

This research study only focused on public school students from one southeastern state robotics competition and one specific type of robotics competition that is recognized by For Inspiration and Recognition of Science and Technology (*FIRST*). Thus, the results of this research study can only be relative to the specific population being studied. These results cannot be used as universal statistics to explain results of other states or student attitudes towards other types of robotics and/or science and engineering competitions. Among the different demographic variables collected, there were not uniform participation observed among gender in the convenience sample (N = 194). As mentioned previously, the sample population consisted of 125 male and 69 female public-school students, which is approximately a 2:1 ratio of males to females. This statistic directly correlates with the information in an American Community Survey Report produced by Landivar (2013a). Thus, this research study should not be overly generalized regarding female attitudes towards STEM due to their underrepresentation in this study. Another limitation of this research study resides around ethnicity. Data collected on ethnicity resulted in half the sample population at the robotics competition identifying themselves as being Asian with approximately the other half being White. As a result, the lack of representation among other ethnicities such as African Americans and Hispanics in this study must be considered when making inferences regarding students' attitudes towards robotics competitions as compared across all ethnicities.

Recommendations for Future Research

It is highly imperative that future studies encompassing this research topic be conducted to further gain much needed insight regarding attitudes of future STEM laborers towards science and engineering competitions pertaining to robotics. There are so few research studies exploring differences among student attitudes towards STEM, resulting in the need for more studies to be conducted. One area of future research needs to further investigate the continued reasons for gender disparity still present within the STEM workforce. In analyzing the plethora of literature, many scholars postulate as to the reasons for the apparent gender disparity. However, further research needs to focus on why females are still underrepresented in these scientific competitions such as robotics competitions and in the workforce. More studies should be investigated that focus on the female gender that assess reasons for disparity.

A second area of future study should focus on the relationship between parental occupation influence and their children's desired future occupation. For example, another question item should be added to the demographic section of the survey instrument used in this research study that asks the student participant if their parents are currently or have been employed in a STEM-related occupation. Thus, student responses can be compared to their current attitudes towards the STEM field as an influencing factor for their future career selection.

Thirdly, there should be more research studies conducted ascertaining public-school students' attitudes towards other types and/or levels of robotics competitions such as *FIRST*, Eurobot, RoboRave, and BEST Robotics. More research is greatly needed not only at the primary, middle, and secondary education levels (i.e. among both public and private school models), but also student attitudes towards these robotics competitions should also be assessed at the post-secondary level. Investigation at this educational level will allow researchers to analyze and postulate potential future trends in the STEM workforce.

Another area that could also be explored for future research is the variable of ethnicity. Whites were predominantly represented in the former research studies conducted by Huddleston (2014) and Westbury (2016). This research study found most of the sample population to be Asian (50.0%) and the next highest percentage to be White (43.3%), while African Americans and Hispanics were minimally represented. This is consistent with the statistical information compiled by Landivar (2013a) that emphasized that "Blacks and Hispanics have been consistently underrepresented in STEM employment" (p. 2). Follow-up interviews in future research studies are greatly recommended for students from minorities to ascertain what factors/aspects primarily attract them to participate in these science and engineering competitions. Future studies focusing on the disparity of these ethnic backgrounds and their attitudes towards participating in these types of scientific competitions is greatly warranted.

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APPENDIX A: Student Robotics Competition Attitude Survey

Student Robotics Competition Attitude Survey

This two-part survey is designed to assess your thoughts about robotics competitions. Your participation is voluntary and your answers will remain anonymous. If you have any questions about the survey, please contact Jesse E. Neece at jneece@liberty.edu or Kurt Y. Michael at kmichael9@liberty.edu.

Part I: Demographic Information

Grade Level: *(mark "X" in the box)*	☐ 7th ☐ 8th ☐ 9th ☐ 10th ☐ 11th ☐ 12th
School Type: *(mark "X" in the box)*	☐ Public ☐ Private ☐ Home School
Age in years: *(place answer in the box)*	☐
Gender: *(mark "X" in the box)*	☐ Female ☐ Male
Race: *(mark "X" in the box)*	☐ White ☐ Asian ☐ Black or African American ☐ Bi-racial ☐ Hispanic or Latino ☐ Multi-racial ☐ Asian ☐ Other ☐ American Indian or Alaska Native ☐ Native Hawaiian or other Pacific Islander
How many robotics competitions have you participated this season, including this one? *(place answer in the box)*	☐
Were you required to participate in this robotics competition? *(mark "X" in the box)*	☐ No ☐ Yes
How many total students are on your robotics team? *(place answer in the box)*	☐
How many female and male students are on your robotics team? *(place answers in the appropriate box)*	☐ # of Females ☐ # of Males

(OVER)

Part II: Student's Attitudes Towards Robotics Competitions Survey

STUDENT'S ATTITUDE TOWARDS ROBOTICS COMPETITIONS Developed by Kurt Y. Michael and Claudia A. Huddleston ©2014 ©Used with permission from Dr. Kurt Y. Michael, Ph.D. (Use only by permission of the authors)					
Student Robotics Competition Attitude Instructions: Please rate how strongly you agree or disagree with each of the following statements by marking the appropriate box with an "X".	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1.) I enjoyed competing in the robotics competition.	☐	☐	☐	☐	☐
2.) I will use what I learned from the robotics competition in everyday life.	☐	☐	☐	☐	☐
3.) The robotics competition was an awful experience.	☐	☐	☐	☐	☐
4.) I believe that the robotics competition will help me better succeed in other science classes.	☐	☐	☐	☐	☐
5.) I believe that the robotics competition was a valuable experience.	☐	☐	☐	☐	☐
6.) The robotics competition was exciting.	☐	☐	☐	☐	☐
7.) I believe that the robotics competition has helped prepare me for a future career in science.	☐	☐	☐	☐	☐
8.) The robotics competition was boring.	☐	☐	☐	☐	☐
9.) I believe that the robotics competition has influenced me to take more science courses.	☐	☐	☐	☐	☐
10.) The robotics competition was fun.	☐	☐	☐	☐	☐
END OF SURVEY Thank you for being part of this research.					

APPENDIX B: Instrument Request, Permission, and Approval for Use

October 20, 2017

Dr. Kurt Michael
Liberty University
DeMoss 1165G
1971 University Blvd.
Lynchburg, Virginia 24515

Dear Dr. Michael:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The title of my research project is "Differences in Attitudes towards Robotics Competitions of Male and Female Students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition" and the purpose of my research is to investigate if there will be a difference in attitudes between male and female students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition.

I am writing to request your permission to use and modify your instrument entitled *Student's Attitude towards Science Fairs Survey* (SATSFS) so it can be used to assess student attitudes at a robotics competition. I would be conducting my study during the 2017-2018 school year, spring semester.

I plan to administer a survey, entitled "Student Robotics Competition Attitude Survey", to students from school divisions that participate in the 2018 Virginia *FIRST* Tech Challenge (FTC) State Championship, sponsored by ECPI University, on February 24, 2018 in Richmond, Virginia.

Participants will be asked to complete the survey at a robotics competition. Thank you for considering my request. If you choose to grant permission, please provide a signed statement indicating your approval or you can respond by email to jneece@liberty.edu.

Sincerely,

Jesse E. Neece
Doctoral Candidate
Liberty University

RE: Permission to Use and Modify Survey

MY Michael, Kurt Y (School of Education)
Fri 10/20/2017 1:31 PM
To: Neece, Jesse

Inbox

Hello Jesse Neece,

I grant you permission to use, modify, and print the instrument *Student's Attitude Towards Science Fairs* for your study.

Sincerely,
Kurt Y. Michael, PhD
Professor
School of Education

(434) 592-3760

LIBERTY UNIVERSITY

Liberty University | Training Champions for Christ since 1971

August 13, 2018

Dr. Kurt Michael
Liberty University
DeMoss 1165G
1971 University Blvd.
Lynchburg, Virginia 24515

Dear Dr. Michael:

As a graduate student in the School of Education at Liberty University, I conducted research as part of the requirements for a doctorate degree. The title of my research project is "Attitudinal Differences towards Robotics Competitions of Male and Female Students Participating in a Southeastern State Robotics Competition" and the purpose of my study was to investigate if there was a difference in attitudes between male and female students participating in a southeastern state robotics competition.

I am writing to request your permission to reproduce and publish the survey in my dissertation (see Appendix A) that was used in this research study entitled *Student Robotics Competition Attitude Survey*.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement indicating your approval or you can respond by email to jneece@liberty.edu.

Sincerely,

Jesse E. Neece
Doctoral Candidate
Liberty University

RE: permission to reproduce and publish survey

Michael, Kurt Y (School of Education)
Tue 8/14/2018 9:36 PM
To: Neece, Jesse

Reply all

Inbox

Hello Jesse Neece,

Per your request, I grant you permission to reproduce and publish the *Student Robotics Competition Attitude Survey* to be used in Appendix A of your dissertation entitled "Attitudinal Differences towards Robotics Competitions of Male and Female Students Participating in a Southeastern State Robotics Competition."

Sincerely,
Dr. Kurt Michael

APPENDIX C: IRB Approval Letter

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

February 12, 2018

Jesse E. Neece
IRB Approval 3160.021218: Attitudinal Differences towards Robotics Competitions of Male and Female Students Participating in a Southeastern Robotics Competition

Dear Jesse E. Neece,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
The Graduate School

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UNIVERSITY.
Liberty University | Training Champions for Christ since 1971

APPENDIX D: Permission Request Letter for Superintendents

[Date]

[Name of Superintendent]
Division Superintendent
[School Division Name]
[Address]
[City, State, Zip]

Dear [Name of Superintendent]:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The title of my research project is "Differences in Attitudes towards Robotics Competitions of Male and Female Students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition" and the purpose of my research is to investigate if there will be a difference in attitudes between male and female students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition.

I am writing to request your permission to administer a survey, entitled "Student Robotics Competition Attitude Survey", to students from your school division that participate in the 2018 Virginia *FIRST* Tech Challenge (FTC) State Championship, sponsored by ECPI University, on February 24, 2018 in Richmond, Virginia.

Participants will be asked to complete the attached survey at the robotics competition identified in the above paragraph. Participants will be presented with informed consent information prior to completing the survey. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission for your students to participate in the survey, please provide a signed statement indicating your approval (see attached signature page – print, sign, scan, return) or you can respond by email to jneece@liberty.edu.

Sincerely,

Jesse E. Neece
Doctoral Candidate
Liberty University

APPENDIX E: Permission Letter from Superintendents

[Date]

Jesse E. Neece
Doctoral Candidate – Liberty University

Dear Mr. Jesse Neece:

After careful review of your research proposal entitled "Differences in Attitudes towards Robotics Competitions of Male and Female Students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition", I hereby grant you permission to administer the survey, entitled "Student Robotics Competition Attitude Survey", to students from **[Division Name]** that participate in the 2018 Virginia *FIRST* Tech Challenge (FTC) State Championship, sponsored by ECPI University, on February 24, 2018 in Richmond, Virginia.

Check the following boxes, as applicable:

☐ Data will be provided to the researcher stripped of any identifying information.

☐ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

____
Division Superintendent/Designee Name (Print)

____ ____________________
Division Superintendent/Designee Signature Date
Division Name

APPENDIX F: Permission Letters for Robotics Competition

FIRST CHESAPEAKE
DISTRICT OF COLUMBIA · MARYLAND · VIRGINIA

8177 Mechanicsville Turnpike
Mechanicsville, VA 23111
(804) 572-8454
contactus@firstchesapeake.org
www.firstchesapeake.org

July 13, 2017

Jesse E. Neece

RE: Survey Administration Permission at 2018 Virginia FTC State Championship Competition

Dear Mr. Neece,

You have been granted permission to administer your survey, entitled "Student Robotics Competition Attitude Survey", at the Virginia *FIRST* Tech Challenge (FTC) State Championship Sponsored by ECPI University (February 3rd, 2018) for use in your doctoral dissertation at Liberty University. Please note that, per instructions from *FIRST* Headquarters and within the varying guidelines of the Commonwealth's local school districts, this survey will only be distributed to community-based teams. Any surveys presented to public school teams must be approved in writing by each school district prior to the event.

The timing of this survey and its contents, as well as any additional activities, will be approved at least 14 days prior to the event by the *FIRST* Chesapeake Director of Programs. It is understood by all parties that the survey must be administered in the least disruptive manner during the competition. If the event is cited in your work, it must be referred as **FTC State Championship Sponsored by ECPI University**. *FIRST* Chesapeake reserves the right to withdraw this permission at any time if proper protocol is not observed.

Sincerely,

Leighann Scott Boland
Executive Director/Director of Development
FIRST Chesapeake dba Virginia *FIRST*
lboland@firstchesapeake.org
804.514.7712

FIRST CHESAPEAKE
DISTRICT OF COLUMBIA · MARYLAND · VIRGINIA

8161 Mechanicsville Turnpike
Suite I
Mechanicsville, VA 23111

(804) 572-8454 contactus@firstchesapeake.org
www.firstchesapeake.org

February 7th, 2018

Jesse E. Neece

RE: Survey Administration Permission at 2018 Virginia FTC State Championship Competition

Dear Mr. Neece,

As originally stated in my letter to you of July 13th, you have been granted permission to administer your survey, entitled "Student Robotics Competition Attitude Survey", at the Virginia *FIRST* Tech Challenge (FTC) State Championship Sponsored by ECPI University for use in your doctoral dissertation at Liberty University. Note: The event date has been changed from February 3rd to February 24th, 2018.

Please recognize that, per instructions from *FIRST* Headquarters and within the varying guidelines of the Commonwealth's local school districts, this survey will only be distributed to community-based teams. Any surveys presented to public school teams must be approved in writing by each school district prior to the event. The timing of this survey and its contents, as well as any additional activities, will be approved at least 14 days prior to the event by Kristin Clemons, *FIRST* Chesapeake Director of Programs.

It is understood by all parties that the survey must be administered in the least disruptive manner during the competition. If the event is cited in your work, it must be referred as FTC State Championship Sponsored by ECPI University. *FIRST* Chesapeake reserves the right to withdraw this permission at any time if proper protocol is not observed.

Sincerely,

Leighann Scott Boland
Executive Director
FIRST Chesapeake dba Virginia*FIRST*
lboland@firstchesapeake.org
804.514.7712

APPENDIX G: Student Recruitment Letter

February 24, 2018

Dear Student:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The tentative title of my research project is "Differences in Attitudes towards Robotics Competitions of Male and Female Students Participating in the Virginia *FIRST* Tech Challenge State Robotics Competition" and the purpose of my research is to investigate if there will be a difference in attitudes between male and female students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition. I am writing to invite you to participate in my study.

You are being asked to be in this research study because you are a male or female student between the ages of 14-18 years old and you attend a public school that participates in a southeastern state robotics competition. If you are willing to participate, you will be asked to complete a short survey. The survey will take approximately 10 minutes to complete. Your participation will be completely anonymous, and no personal, identifying information will be collected.

An assent form is included. The assent form contains additional information about my research, but you do not need to sign and return it. Please read the assent form before beginning the survey.

The robotics teams that participate in the research study will be entered in a raffle and have an opportunity to win one $200.00 Visa Gift Card for the team. Thank you for considering my request.

Sincerely,

Jesse E. Neece
Doctoral Candidate
Liberty University

APPENDIX H: Assent Form

ASSENT OF CHILD TO PARTICIPATE IN A RESEARCH STUDY

What is the name of the study and who is doing the study?
Jesse E. Neece, a doctoral candidate at Liberty University, is conducting this study. The study is called "Differences in Attitudes towards Robotics Competitions of Male and Female Students Participating in the Virginia *FIRST* Tech Challenge State Robotics Competition."

Why are we doing this study?
We are interested in studying if there will be a difference in attitudes between male and female students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition.

Why are we asking you to be in this study?
You are being asked to be in this research study because you are a male or female student between the ages of 14-18 years old and you attend a public school that participates in a southeastern state robotics competition.

If you agree, what will happen?
If you are in this study, you will be asked to complete a short survey that is completely anonymous.

Do you have to be in this study?
No, you do not have to be in this study. If you want to be in this study, then complete the survey. If you don't want to, it's OK to say no. The researcher will not be angry. You can say yes now and change your mind before you turn in the survey. It's up to you.

Do you have any questions?
You can ask questions any time. You can ask now. You can ask later. You can talk to the researcher. If you do not understand something, please ask the researcher to explain it to you again.

Researcher:
Jesse E. Neece
Doctoral Candidate
Liberty University
jneece@liberty.edu

Faculty Advisor:
Dr. Kurt Michael
Professor of Education
Liberty University
kmichael9@liberty.edu

APPENDIX I: Directions for Robotics Coaches

STUDENT ROBOTICS COMPETITION ATTITUDE SURVEY
Survey Administration Directions for Robotics Team Coaches

Directions: Please complete the following steps to successfully administer the Student Robotics Competition Attitude Survey.

1. **Please give each student on your team the assent form and ask them to read it carefully (front and back).**

   If students should have any questions about the research study, please tell them they can ask the researcher when he/she revisits the teams pit area to collect surveys.

   Paper-clipped to the assent form is the Student Robotics Competition Attitude Survey instrument. If students want to participate in the research study, please give out the free pens provided by the researcher and continue to the next step.

2. **Please instruct each student on your team who wants to participate to complete the Student Robotics Competition Attitude Survey instrument (front and back) that is paper-clipped to the assent form. The survey should take approximately ten (10) minutes to complete.**

3. **Collect all completed surveys from students and place them back in the large 11x14 manila envelope with your team number written on the front.**

   The researcher will revisit your team, at your designated pit area within the next 35-40 minutes to collect the completed surveys. Robotics teams will be eligible to participate in a team raffle for a chance to win a $200.00 Visa Gift Card.

4. **Give the completed surveys to the researcher.**

   The researcher will give the coach one raffle ticket for each completed survey returned by their team members. Please print your team number on the back of each ticket given to you by the researcher. Place give the tickets to the researcher.

   The researcher will put the tickets in a plastic bucket with a lid. Once the surveys have been collected by the researcher and all raffle tickets have been placed in the bucket from the competition, the bucket will be agitated to mix the tickets. One ticket will be drawn from the plastic bucket and the winner of the gift card will be announced at closing ceremonies.

THANK YOU VERY MUCH FOR PARTICIPATING IN THIS RESEARCH STUDY

APPENDIX J: Permission Request for Coaches of Neighborhood/Community Teams

February 8, 2018

Dear Coach:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctorate degree. The tentative title of my research project is "Differences in Attitudes towards Robotics Competitions of Male and Female Students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition" and the purpose of my research is to investigate if there will be a difference in attitudes between male and female students participating in the Virginia *FIRST* Tech Challenge State Robotics Competition.

I am writing to request your permission to administer a survey, entitled "Student Robotics Competition Attitude Survey", to students from your robotics team that participate in the 2018 Virginia *FIRST* Tech Challenge (FTC) State Championship, sponsored by ECPI University, on February 24, 2018 in Richmond, Virginia.

Participants will be asked to complete the attached survey at the robotics competition identified in the above paragraph. Participants will be presented with informed consent information prior to completing the survey. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission for your students to participate in the survey, please provide a signed statement indicating your approval (see attached signature page – print, sign, scan, return) or you can respond by email to jneece@liberty.edu.

Sincerely,

Jesse E. Neece
Doctoral Candidate
Liberty University

APPENDIX K: Permission from Coaches for Neighborhood/Community Teams

February 8, 2018

Jesse E. Neece
Doctoral Candidate – Liberty University

Dear Mr. Jesse Neece:

After careful review of your research proposal tentatively entitled "Differences in Attitudes towards Robotics Competitions of Male and Female Students Participating in the Virginia *FIRST* Tech Challenge State Robotics Competition," I hereby grant you permission to administer the survey, entitled "Student Robotics Competition Attitude Survey," to students from ____ **(Team Number and Name)** that participate in the 2018 Virginia *FIRST* Tech Challenge (FTC) State Championship, sponsored by ECPI University, on February 24, 2018, in Richmond, Virginia.

Check the following boxes, as applicable:

☐ Data will be provided to the researcher stripped of any identifying information.

☐ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

____
Robotics Team Head Coach Name (Print)

____ ____________________
Robotics Team Head Coach Signature Date