LOCUS OF CONTROL, ATTITUDES TOWARD MATHEMATICS, AND MATHEMATICS PERFORMANCE OF UNDERGRADUATE STUDENTS AT A RURAL STATE UNIVERSITY

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This dissertation is dedicated to my wife Melissa,
my daughter Ava, and my son Casey for their love,
understanding, and support of my countless hours
dedicated to earning my doctoral degree.

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ABSTRACT

LOCUS OF CONTROL, MATHEMATICS ATTITUDES, AND MATHEMATICS PERFORMANCE OF UNDERGRADUATE STUDENTS AT A RURAL STATE UNIVERSITY

by Cale Thomas Polkinghorne

A skills gap exists between unemployed workers and jobs available for skilled technical labor. One reason for the lack of skilled technical workers is the decrease in the number of high school graduates who attend Career and Technical Education (CTE) programs (Gaunt, 2006). Mathematics is becoming increasingly important for careers that once did not require the use of mathematics (Castelano, 2003). Along with mathematics being increasingly important in CTE programs, fewer students are enrolling in CTE programs. The emphasis on four-year academic institutions has limited the amount of students enrolled in CTE programs (Arnold, 2012; Boodhoo, 2012; Levesque & Hudson, 2003). Students who are interested in CTE programs generally have low mathematics performance (Arnold 2012; Boodhoo, 2012; Levesque & Hudson, 2003). According to the U.S. Secretary of Education Arne Duncan, mathematics scores for Grade 4 have not increased from 2007-2009, and Grade 8 only increased slightly by two-points from 2007-2009. Mr. Duncan issued the following statement, "Today's results are evidence that we must better equip our schools to improve the knowledge and skills of America's students in mathematics" (U.S. Department of Education, 2009, p.1). The 2012 Department of Education Program for International Students Assessment (PISA) results suggest that in the U.S., 26% of 15-year-olds are performing below average in mathematics and only 9% are performing at a high level (U.S. Department of Education, 2013, p. 1). Also, the U.S. was lower performing in mathematics than 29 and higher than 26 other developed countries educational systems. The best way to increase the supply of highly skilled manufacturing employees is to understand the mathematics attainment problem in relation to these students. Research on CTE often relates to identifying how CTE impacts students. This research project examines on how students impact CTE, specifically mathematics within CTE.

This research used a non-experimental, cross-sectional, predictive research design to identify predictors for students' field of study choice and performance in mathematics. The predictor variables used in the study were field of study, locus of control, and five mathematics attitudes variables, which are attitudes toward success in mathematics, parents' attitudes, teachers' attitudes, math related affect, and usefulness of mathematics. The research examined the extent that locus of control and mathematics attitudes predicted field of study and performance in mathematics. Students with a lower attitude toward success in mathematics were more likely to enroll in a technical CTE associates program than students enrolled in all other degrees. Teachers' attitudes, mathematics related affect, and low mathematics preparation were found to have a significant negative relationship with mathematics performance. The implications suggest that the delivery for teaching mathematics should be changed to help students perceptions of the usefulness of mathematics, increase mathematics related affect, and increase students' perceptions on teachers' attitudes.

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INTRODUCTION

In 2008, more than two million manufacturing employees lost their jobs due to the national recession. Since the recession, only 500,000 low-skill manufacturing jobs have been created (Boodoo, 2012). According to the Bureau of Labor Statistics the unemployment rate in October of 2012 was 7.9 %; however, despite the unemployment figures, thousands of skilled jobs are posted throughout U.S. manufacturing who are in need of workers within computer numerical control and other technology related fields (Arnold, 2012). The gap between unemployed workers and the need for skilled manufacturing workers poses the question, how can the U.S. train unemployed workers to fill skilled U.S. manufacturing positions? The owner of Merrill Tool, located in Merrill Michigan, attended a career fair at a Michigan university where he stated, “If a college could provide me with 20 students who are graduating with a computer numerical control (CNC) related degree, I would charter a plane and fly them to Merrill for an interview and a tour of our facility.”

One reason for the lack of CNC workers within industry is the decrease in the number of high school graduates that attend career and technical education (CTE) programs (Gaunt, 2006). High school curriculum changes across the US such as the Michigan Merit Curriculum have been placing an emphasis on four-year college bound students (Michigan Department of Education, 2012). The emphasis on four-year academic institutions has limited the amount of students enrolled in CTE programs. The students who remain interested in CTE programs including CNC technology often are students with low mathematics performance (Arnold, 2012; Boodhoo, 2012; Levesque & Hudson, 2003).

Companies have started training students in-house due to the lack of students graduating from CTE programs. These manufacturers face difficulties with CTE training programs because of low mathematic abilities of their employees (Arnold, 2012). Thus, companies are providing high support for CTE programs at post-secondary institutions, which have the ability to remediate mathematics skills. However, attracting students who are interested in technology positions and have the mathematical abilities to complete the course work remains a huge problem (Arnold, 2012). The best way to increase the supply of these highly skilled manufacturing employees is to understand the mathematics attainment problem in relation to these students. So this research must first identify predictors related to mathematics performance. Understanding these predictors, especially among CTE students would help develop policies to the problem.

The Problem of Weak Mathematics Performance in Career and Technical Education

Mathematics is becoming increasingly important for careers that once did not require the use of mathematics (Castelano, 2003). Many of the machines used in the past were one-step machines that required workers to press a button to complete one operation and then pass the part on to the next person who would complete the next process. What workers used to complete manually step by step, workers now use computer programming to complete a task in one operation. The switch from a manual, hands-on approach to a computerized mathematics based approach creates a skills gap in the workplace. The improvement in technology requires students to be able to complete tasks such as precision measuring for quality control and using trigonometry to program CNC machines. The accelerated technology used in manufacturing and the higher mathematics skills needed to use advanced technology will create problems because our labor force and high school graduates did not increase its mathematics performance at the same accelerated rate as the technologies changed. According to the U.S. Secretary of Education Arne Duncan, mathematics scores for Grade 4 have not increased from 2007-2009, and Grade 8 only increased slightly by two-points from 2007-2009. Mr. Duncan issued the following statement “Today’s results are evidence that we must better equip our schools to improve the knowledge and skills of America’s students in mathematics” (U.S. Department of Education, 2009, p. 1). The 2012 Department of Education Program for International Students Assessment (PISA) results suggest that in the U.S., 26% of 15-year-olds are performing below average in mathematics and only 9% are performing at a high level (U.S. Department of Education, 2013). When compared to other countries educational systems, the U.S. is not a leader in mathematics education. In 2012 was lower performing in mathematics than 29 and higher performing than 26 other developed countries educational systems (U.S. Department of Education, 2013). The problem of weak mathematics performance in CTE has drastic effects on CTE programs and is emphasized in the following section.

Effect on Career and Technical Education

Statistically, students with a lower high school grade point average (GPA) are more likely to attend a two-year career and technical education programs compared to students with a higher high school GPA (Levesque & Hudson, 2003). Students with a higher GPA are more likely to attend a four-year post-secondary institution. The increased mathematics requirements for two year CTE programs are preventing students from enrolling or are not completing the program because students are not able to complete the mathematics requirements (Arnold, 2012). The lack of students in CTE programs is creating a problem by reducing the amount of support programs are receiving and in many instances, causing programs to be eliminated. The elimination of programs is generating a strain on manufacturing companies that need CTE graduates to operate or program machinery. The lack of skilled workers is causing companies to reject contracts for product manufacturing because the limited amount of skilled labor is preventing them from expansion. The outcome of preventing U.S. manufacturing from expanding has drastic effects on society.

Effects on Society

The purpose of manufacturing is to produce products for consumers. Products such as automobiles, medical devices, furniture, electronics, and just about anything else a person uses throughout the day are purchased through the retail market. Prices for the items are dependent on manufacturing costs. If the supply of a product is limited and the demand of a product is high, the consumer will pay a higher price. Manufacturers with a limited work force are able to create fewer products than a company with a substantial work force. The limited work force will create a limited supply, thus consumer prices will rise. The cost of a limited skilled work force is distributed throughout consumer base for products purchased in the retail market. Limited skilled labor within the U.S. will increase the cost to hire skilled labor. Manufacturers must pay more for skilled labor to attract workers to their companies. A tooling research and development company in Houghton Michigan explained that their company is hiring engineers to work as CNC machinists for a starting salary of $45,000 to $55,000. For manufacturers to make a profit on their product, the higher cost of wages is passed onto the consumer through higher prices of manufactured goods. Existing research on CTE is minimal and a strong need for current research on post-secondary CTE (Boodoo, 2012; Castellano, 2003).

The Problem with Existing Literature

Career and Technical Education (CTE) reform efforts are under researched and few scholarly attempts have been made to link CTE to research on academic components of U.S. schooling (Castellano, 2003). Project based learning is often modeled within CTE courses and many research studies have been conducted suggesting the positive effects of teaching mathematics using project based learning within a CTE courses (Gentry, Mann, & Peters, 2007). Many studies focus on the liking of hands on learning compared to traditional learning. Other areas that CTE is commonly researched include truancy, the need for CTE, and academic performance of CTE students (Alfeld, Pearson & Stone, 2008; Archambault, Fallu, Janosz, & Pagani, 2008; Bae, Gray & Yeager, 2007; Castellano, Stone & Stringfield, 2003; Chad, & Drage, 2006). Research on CTE often relates to identifying how CTE impacts students. This research project examines on how students impact CTE, specifically mathematics within CTE. To improve CTE, predictors that affect mathematics performance must be identified to find a solution to CTE students' low mathematics performance. This research focuses primarily on two potential predictors for mathematics performance, namely locus of control and attitudes toward mathematics.

To increase students' mathematical skills, research must be conducted to identify predictors related to mathematics performance. Once predictors are identified, solutions to the problem can be developed. The first variable used is locus of control. Locus of control is a person's perception on the type of control he or she possesses. Understanding a students' perception of control is important to understand when attempting to improve performance. When a student has the perception of internal control, the student will take personal responsibility for success and failure. When a student is successful and takes credit for the success, a positive attitude toward the success will follow (Rotter, 1966). When a student fails and blames the failure on an external factor, the student will not make the link between lack of effort and failure or between effort and success. When students feel they have no control over outcomes, it is difficult to improve performance. If a significant relationship is identified between CTE students perception of control and mathematics performance, an intervention could be developed to improve the perceptions of control, which could in turn improve mathematics performance.

Much of the educational research using the locus of control scale involves general academic performance and attendance (Crede et al., 2010; Edwards & Waters, 1981). Locus of control does not predict students' attitudes toward mathematics (Akinsola & Ifamuyiwa, 2008). Those who possess an internal locus of control do not have a significantly different attitude toward mathematics than those who possess an external locus of control (Akinsola & Ifamuyiwa, 2008). Tella, Tella, & Adeniyi (2009) researched locus of control to see what extent locus of control had on academic achievement of young secondary students in Nigeria. The participants' locus of control significantly predicts academic achievement. With a similar methodology, Rahimi, Sharagard, and Yazdanaphah (2010) used locus of control and age as predictor variables for academic achievement among Iranian English language learners. Students with an internal locus of control had a higher academic achievement than students with an external locus of control. Hadsell (2010) used the Rotter (1966) locus of control scale to measure the extent that locus of control predicts economics performance. The results indicate that locus of control was not significant in determining economic performance; however, locus of control was significant in predicting interest and enjoyment in the subject. Joo, Lim, and Kim (2013) had results similar to Hadsell (2010), indicating that locus of control had no significance for achievement of online learning; however, students with an internal locus of control had greater learner satisfaction.

Although several studies had found a significant relationship between locus of control and academic performance, Daniels and Stevens (1976) suggested that locus of control is one measure to predict academic performance; however, locus of control alone will not predict performance. Edwards (1981) concluded that to link locus of control to academic performance, locus of control must have a significant relationship with another variable that is a known variable in predicting academic performance. Edwards (1981) study uses attitudes toward mathematics along with locus of control to predict mathematics performance

Several factors exist in a students' attitude toward mathematics. Internal factors such as perceived usefulness of mathematics, attitude toward success in mathematics, and personal feeling toward mathematics. External factors are perceptions of teachers' attitudes, perceptions of parents' attitudes, and perceptions of mathematics and gender. Both internal and external factors determine a students' general attitude toward learning mathematics. As students' general attitude toward learning mathematics increases, performance increases (Ma & Kisher, 1997). If a significant relationship could be identified between CTE students' attitude toward mathematics and mathematics performance, an intervention could be developed to improve the students' attitude toward mathematics, which could in turn improve mathematics performance.

Mathematics attitude measurement scales had been developed and used for many purposes, such as predicting mathematics performance, finding relationships between enjoyment and mathematics performance, and measuring perceptions on mathematics value. Dutton (1954) developed one of the earliest mathematics attitudes scale measuring elementary students feelings toward arithmetic. Dutton (1954) suggested that feelings toward mathematics are developed in all grades, attitudes of elementary students' feelings are important for progress in mathematics, and teachers' ability to make mathematics practical are important for positive feeling toward mathematics. Aiken and Dreger (1961) used the scale to determine the relationship between mathematics attitudes and mathematics performance. Positive mathematics attitudes correlated with high mathematics performance.

Ma and Kisher (1997) found inconsistencies in the research findings of mathematics attitudes predicting mathematics achievement. A meta-analysis of studies containing mathematics attitudes as a predictor for mathematics achievement was conducted summarizing the findings of 113 studies. The results of the meta-analysis indicated that attitudes toward mathematics had a significant effect on achievement in mathematics the higher the positive attitude the higher the achievement.

Both locus of control and attitudes had been used to predict academic performance in diverse areas. This study is interested in only mathematics performance. Currently, a shortage exists of students choosing science, technology, engineering, and mathematics (STEM) related areas. Students who perceive an external control or had a negative attitude in mathematics are less likely to take additional courses in the subject beyond the academic program requirements or choose a field of study that involves math. Some students are graduating from high school with high mathematics preparation by taking a higher-level mathematics than required such as pre-calculus or calculus, while other students had average to low mathematics preparation by taking the minimum mathematics requirements to graduate from high school. The amount of mathematics preparation and chosen field of study could serve as a predictor for mathematics performance in a university mathematics course. The identification of predictors for weak mathematics performance would also help all STEM areas. If CTE students are found to have a significantly lower attitude toward mathematics or are significantly closer to an external control than general academic students, policy can be set to help CTE students' perception of control and mathematics attitudes. Evidence on locus of control, mathematics attitudes, field of study, and mathematics preparation as predictors for mathematics performance might help CTE educators educate students for technical employment.

The Purpose of the Study

The purpose of this study is to address the extent that locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics. The study also addresses the extent that locus of control and mathematics attitudes predicts field of study. The following research questions guide the study.

Research question 1: To what extent does locus of control and mathematics attitudes predict field of study?

Research question 2: To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics?

Conceptual Framework

For this study, several concepts had been used to identify predictors for mathematics performance. The conceptual framework for this study uses the Rotter (1966) locus of control scale and the Mulhern and Rae (1998) shortened version of the Fennema-Sherman mathematics attitudes scale (FSMAS-SV). Many studies had adapted the locus of control and mathematics attitudes scales for specific academic subjects; however, CTE has not been the focus nor has a study used both the mathematics attitudes scale and the locus of control scale within the same study.

The foundation for the locus of control scale was built off of the Rotter (1954) social learning theory. The purpose of the social learning theory was to study a person's personality as relates to the environment. Rotter (1954) suggests that a person cannot have a personality independent of their environment. Also, that a person's personality is not completely driven by the environment. To understand personality, the individuals' history, such as experiences and family life must be examined along with the current environment. Rotter (1954) looked at behavior and personality as a changeable. If a person has a change in environment and begins to think differently because of the environment, behavior will change. Social learning theory was developed as a model to predict behavior. The social learning theory was the beginning of looking at both internal and external factors for predicting an outcome.

Although the social learning theory was the foundation for locus of control, social learning theory also encompasses the attitudes toward mathematics of this study. Social learning theory was the start of looking at internal and external control in understanding students' choices and success. Both the locus of control scale and the FSMAS-SV contain internal and external control components. The purpose of the locus of control scale is to determine the type of control the students' possess on a continuum from internal to external. The purpose of the FSMAS-SV is to collect data to determine the attitude a student has toward mathematics. Although the purpose for each scale is different, the interesting piece of the FSMAS-SV is two of the constructs collect data on external factors of students' attitudes and three of the constructs collect data on internal factors of students' attitudes. Each scale has a control component that helps identify whether a link exists between students' perceptions of control and attitudes toward mathematics.

The two constructs of the mathematics attitudes scale that represent external control are teachers' attitudes and parents' attitudes'. Examining students' perceptions of control directly relates to social learning theory, which was the beginning of measuring perceptions of control. Prior to the internal and external locus of control scale, the social learning theory examined the internal and external factors for predicting an outcome. Social learning theory is the link between locus of control and measuring students' attitudes toward mathematics using perceptions of control constructs. Although social learning theory is not a major component of this research, the social learning theory will be discussed in chapter two to help understand the history of researching control and the locus of control scale. This section provides details of both the locus of control and mathematics attitudes concepts used in this research.

Locus of Control

Locus of control is a person's perception on the type of control he or she possesses, but locus of control is not in the conscious awareness for the individual. Rotter (1975) suggests the scale from internal to external are two ends of a continuum not an either/or classification. The Rotter (1966) 29-item locus of control scale was used to collect data on the participants perceived control. The 29-item locus of control scale has two statements for each item. Participants were asked to choose the statement that most applies to their beliefs. Of the 29 items, six filler items were not scored. The filler items are added to the scale to make the purpose of the test somewhat ambiguous (Rotter, 1966). The remaining 23 items were scored from the participant's statement choice. The participants received one point for each question that applied toward internal locus of control. The higher the score, the further the participant is from having a high external locus of control and the closer to having a high internal locus of control.

A person with high internal locus of control is called an internal. Internals believe success comes from within and, “their actions can change outcomes and look inward both for motivation and perseverance” (Alexander, 2005). Along with taking responsibility for success, internals will also take responsibility for low academic achievement. Students are encouraged to look at themselves for drive and motivation. Students who possess an internal locus of control had a greater probability of receiving above average grade reports compared to students who had an external locus of control, which makes possessing an internal locus of control desirable (Grimes, 2004). Students with an internal locus of control are excited when doing well and disappointed when doing poorly.

Persons with high external locus of control might say an external source was to blame for their fate. For example, students may blame a teacher for low academic success or will credit luck for high academic success (Bursik, 2006). Students with a high external locus of control often feel more anxiety and frustration in the classroom (Grimes, 2004). Externals often feel helpless and their actions had little to do with their progress. If something good happens, luck is responsible. If something bad happens, the teacher or authority figure did not like them (Alexander, 2005). Students with an external locus of control commonly had very little emotion with good or bad outcomes (Alexander, 2005).

Students who perceive an external control in mathematics are less likely to take additional courses in the subject beyond the academic program requirements or choose a field of study that involves math. Some students are graduating from high school with high mathematics preparation by taking a higher level mathematics than required such as pre-calculus or calculus, while other students had average to low mathematics preparation by taking the minimum mathematics requirements to graduate from high school. Possessing an external locus of control could deter students from taking courses related to mathematics while at the same time deterring a student from entering a field of study related to mathematics. The limited mathematics preparation could serve as a predictor for mathematics performance in a university mathematics course. Also, the type of control a student possesses could serve as a predictor for a students' chosen field of study. Along with locus of control, mathematics attitudes were used to examine predictors for mathematics performance.

Attitudes Toward Mathematics

Mathematics attitude measurement scales had been developed and used for many purposes throughout history such as predicting mathematics performance, finding relationships between enjoyment and mathematics performance, and measuring perceptions on mathematics value. Several factors exist in a students' attitude toward mathematics. Internal factors such as perceived usefulness of mathematics, attitude toward success in mathematics, and personal feeling toward mathematics. External factors are perceptions of teachers' attitudes, perceptions of parents' attitudes, and perceptions of mathematics and gender. Both internal and external factors determine a students' general attitude toward learning mathematics. Similar to locus of control, the FSMAS-SV has the internal and external social learning foundation. The internal and external components of mathematics attitudes and internal and external locus of control scale should be analyzed to observe the relationship between students' locus of control and the internal/external attitudes toward math. Much like students with an internal locus of control, as students' general attitude toward learning mathematics increases, performance increases (Ma & Kisher, 1997).

The Fennema-Sherman mathematics attitude scale (FSMAS) is considered the most prominent scale for measuring effect of mathematics attitudes (Hyde, 1990). The original

FSMAS was designed to collect data using nine scales, each containing 12 items. Mulhern and Rae (1998) supported the content of FSMAS, but criticized the time taken to complete, suggesting that participants lose interest toward the end of the scale, which sacrifices validity. Mulhern and Rae (1998) developed a shortened version of the Fennema-Sherman Mathematics Attitudes Scale (FSMAS-SV). Several constructs of the FSMAS were combined to make a total of six constructs which are attitude toward success in mathematics, parents' attitudes, mathematics as a male domain, teachers' attitudes, mathematics related affect, and usefulness in mathematics. Like the FSMAS each construct is made up of positive and negative related statements. A response corresponding to a positive response scores a five and the negative response scores a one. The cumulative response score determines students' attitude toward mathematics from a range of positive to negative. A low score represents a negative attitude and a high score represents a positive attitude

Students' who possess a negative attitude toward mathematics are less likely to take additional courses in the subject beyond the academic program requirements or choose a field of study that involves math. Having a negative attitude toward mathematics could deter students from taking courses related to math, which in turn deters students from entering a field of study related to mathematics. The limited mathematics preparation could serve as a predictor for mathematics performance in a university mathematics course. Also, student attitudes could serve as a predictor for students chosen field of study.

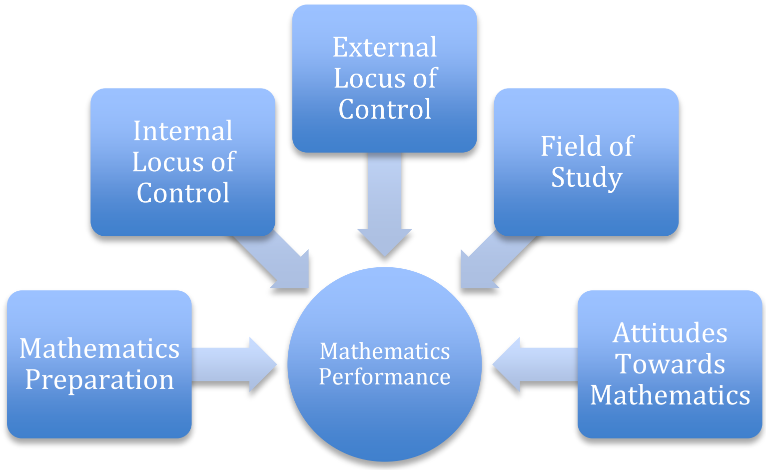

Figure 1. Conceptual Framework

Definitions of Key Terms

The following definitions are used in the research:

Attitude toward success in mathematics is defines as the level students' anticipate their positive or negative success in mathematics (Fennema & Sherman, 1976).

Career and technical education came about when vocational programs were forced to change their focus to highly technical education which changed the name vocational education to Career and Technical Education (CTE) and concentrated on areas such as: computerized diagnostic repair, computer numerical control machines, and modern medical equipment (Castelano, 2003). This research project concentrates on mathematics related technical fields often found in manufacturing such as computer numerical control programmers, electronics technicians, or other related technical field.

Experiential Learning is the process of learning through direct experiences in a subject area.

Locus of control is a person's perception on the type of control he or she possesses, but locus of control is not in the conscious awareness for the individual. People fall along a continuum from completely internal to completely external (Rotter, 1966).

Mathematics attitude is defined as a person's attitude toward learning mathematics. Mathematics attitudes range continuous from positive to negative (Mulhern & Rae, 1998).

Mathematics performance is defined as the continuous score earned within mathematics or mathematics related course.

Mathematics related affect is defined as positive or negative feelings students have when exposed to mathematics (Mulhern, & Rae, 1998)

Parents' attitude is defined as the level students' perceive their parents' attitudes towards learning mathematics (Fennema & Sherman, 1976).

Student engagement is defined as students' level of commitment to education not only for grades, but also for seeking understanding of a subject.

Teachers' attitude is the measurement of students' perceptions of teachers' attitudes toward learning. Teachers' attitude includes the teachers' interest, encouragement and confidence in the students' ability (Fennema & Sherman, 1976).

Usefulness of mathematics is the level students' perceive mathematics as being a useful subject for academics and future career (Fennema & Sherman, 1976).

Chapter Summary

This section discussed the gap between unemployed workers and the need for skilled manufacturing workers places a strain on the U.S. economy. The lack of skilled technical workers within industry is due to a decrease in high school graduates who attend career and technical education (CTE) programs (Gaunt, 2006). The emphasis on four-year academic institutions has limited the amount of students enrolled in CTE programs and students interested in CTE programs often have low mathematics performance (Arnold, 2012; Boodhoo, 2012; Levesque & Hudson, 2003). This study examines the extent that locus of control, mathematics attitudes, field of study, and mathematics preparation predict mathematics performance, and the extent that locus of control and mathematics attitudes alone predict field of study.

The remaining four sections include the review of the literature, methodology, presentation of results, and the conclusion and recommendations. The review of literature contains a broad overview to the chapter. Following the overview, a historical review of CTE is presented. The historical review will provide evidence that we are in a time of technological change by reviewing a document that has been used in industry for over 100 years. Also, the history of both locus of control and attitudes toward mathematics are reviewed to highlight the diverse selection of scales used to measure each theory. Next, previous research from each conceptual model is analyzed to provide a background of the conceptual framework. Each theory used in the study is detailed in the literature review section. Also, previous studies using similar frameworks are detailed. Lastly, a summary of the review of literature concludes the section. The methodology section provides the purpose and research questions of the study, the research design, population, sample, data collection, variables, analytical methods, and methodology limitations of this research. The presentation of results section provides the results of the data analysis. The final conclusion and recommendation section provides a report of the findings and recommendations for further research.

CHAPTER II

REVIEW OF THE LITERATURE

This review of the literature highlights the research this study is built upon and the theories used in the conceptual framework. The first section provides a comprehensive background on career and technical education and its evolution to its current state. Due to the lack of standards within CTE it is difficult to provide evidence that we are in a time of drastic change. The history of career and technical education is tracked using a reference book called the Machinery's Handbook that was first published in 1914 and has adapted to current technology. The history of the Machinery's Handbook is important to highlight the changes in technology that occurred throughout history. As technology changed throughout history, CTE curriculum was forced to adapt as well. The review provides evidence that changes in technology, in turn affects the CTE curriculum. Currently, major changes in technology has been observed in the new revisions to the Machinery's Handbook which provides evidence that higher mathematics skills are needed for students enrolling in CTE programs. The CTE section also reviews previous research focused on CTE.

The second section reviews locus of control. The historical background of locus of control and educational research using locus of control as a variable for predicting academic outcomes is the focus of section two. The third section provides a comprehensive review of the historical background of mathematics attitudes scales and educational research using mathematics attitudes as a variable for predicting academic outcomes. The final part of this literature review is a summary of the review of the literature and an introduction of the methodology chapter.

Career and Technical Education

Career and technical education came about when vocational programs were forced to change their focus to highly technical education which changed the name vocational education to Career and Technical Education (CTE) and concentrated on areas such as: computerized diagnostic repair, computer numerical control machines, and modern medical equipment (Castelano, 2003). This research project concentrates on mathematics related technical fields found in manufacturing such as computer numerical control programmers, electronics technicians, or related technical fields. Following is a historical background of CTE.

History of Career and Technical Education

This section provides a comprehensive look at the evolution of CTE through the historical background of the Machinery's Handbook. The Machinery's Handbook is a barometer for technological advancement throughout history. Technological advancements in manufacturing require workers to adapt their skills to the modern advancements. The Machinery's Handbook has served as the standard reference book for engineers, draftsmen, toolmakers, and machinists since 1914 (Industrial Press, 2012).

Late in the 19^{th}, the United States of America (U.S.) started to become the world leader in manufacturing. An abundance of natural resources such as iron, copper, and tin gave the U.S. an advantage over other countries dependent on importing resources (Wright, 1990). Industrialists such as Henry Ford shaped manufacturing by introducing manufacturing standardization methods. In 1908, Henry Ford introduced the first affordable automobile named the Model T. From 1908 to 1914, over 250,000 automobiles were manufactured and sold across the United States. The mass manufacturing of automobiles created the need for part manufactures to supply standardized parts. Workers were assigned tasks that required low skill to produce high volumes of parts (Hino, 2006). Engineers were considered high skilled workers and attended college to understand the process of designing and making standard mechanical parts for mass assembly (Hino, 2006). Parts to support the automobile industry needed high quality standards for proper assembly. Prior to 1914, hundreds of reference books were used for the mechanical trade, for example, gearing information was found in a gearing reference book and threading information was found in a threading reference book. Engineers worked with machinist to provide the many references needed to complete a task (Oberg, 1914). The need for one reference book for referencing all aspects of the mechanical trade was in demand from all areas of manufacturing (Oberg, 1914). Eric Oberg was the project leader in compiling the necessary data to create one reference book that would eventually standardize most of the data needed for the mechanical trades. The book Oberg created was the Machinery's Handbook.

The Machinery's Handbook was developed as a reference book for mechanical engineers, designers, manufacturing engineers, draftsman, toolmakers, and machinists. The book provides tradesmen with information on crucial part making data for manufacturing. Industrial Press Publishing Company originally published the first edition of the book in 1914. The Machinery's Handbook is an educational and industry standard for referencing data required for engineering and manufacturing. Engineering and technical colleges taught courses using Machinery's Handbook starting in 1915 and many schools use it today (Industrial Press, 2012). The Machinery's Handbook was the foundation for CTE during the early 1900's and is still used in most CTE institutions. This section provides information on the contents of the first edition and how the contents changed over the last 98 years. Major changes to the Machinery's Handbook represent major changes for CTE curriculum. The purpose of this section is to provide evidence that we are currently in a time period of major technological changes in manufacturing that requires CTE students to have a greater understanding of mathematics that needed in the past. In order to observe changes through history, the first edition of the Machinery's handbook is described and the evolution of the book to the current edition.

First Edition of the Machinery's Handbook

This section begins with a description of the first edition of the Machinery's Handbook and follows the historical events that evolved the Machinery's Handbook to the current twenty-ninth edition. The major events in history that made the most significant changes to the book and the changes in technology that shaped the culture of time frame is the focus. For every change made to the Machinery's Handbook, CTE curriculum was forced to adapt to the changes to meet the needs of industry.

The first edition of the Machinery's Handbook contains sections on mathematics, mechanics, strength of materials, fasteners, machine elements, gearing, machining, tooling, threading, measuring, milling machine indexing, pattern making, and units. The sections include most information needed to complete engineering and manufacturing tasks in 1914. One of the greatest differences between the modern version and the first edition is the types of materials that were used in 1914 compared to the materials available in 2013. The metals available during the time of the first edition were iron, steel, copper, tin, lead, and zinc. The metal most referenced is carbon or alloy steel. The hardest metal used in 1914 was high speed steel, which is slightly harder than the material it was cutting. Material properties determine many aspects of engineering and manufacturability. If a part made for an automobile were to sustain constant surface friction and large shear stress, it is important the material selected is able to withstand surface wear and have high shear strength. Surface wear and shear strength are two examples of material properties data that can be referenced in the Machinery's Handbook. If the amount of shear stress the automobile part will encounter is unknown, the mathematics and mechanics section provides the tradesmen with the formulas needed to calculate the physical stress a part will encounter thus affecting the size and shape of the part. The amount of materials available at the time of the first edition was limited, which is why the material properties section of this edition was small relative to later editions. Soon after 1914, a rapid advancement in metallurgical technology occurred.

The first edition of the Machinery's Handbook had few standard thread sizes comparable to modern standards. The mass number of standard thread sizes available in 2013 is a substantial difference from the limited sizes in 1914. In 1914, 31 different sizes of standard machine bolts compared to 1600 American standard and metric thread sizes in 2008. In 1914, the Machinery's Handbook dedicated one page to list the pitch, major diameter, and the minor diameter of each thread size. In 2008, 50 pages were used to list 804 American Standard thread sizes. The 31 sizes specified in 1914 represented all the standard machine bolt sizes in all the industries across U.S. manufacturing (Oberg, 1914) (Oberg, 2008). The limited amount of sizes allowed manufacturers to mass-produce standard bolts of all sizes on geared turret lathes. The limited thread sizes and low quality standards allowed machinists to make threads on geared lathes with little mathematical skills.

Technical educators, on the job trainers, apprentices, and colleges used the Machinery's Handbook as a training guide. The proper use of the book was taught so tradesmen could utilize the reference book when working in manufacturing. The outcome of training with the book led to most tradesmen having a copy at their workstation. Other machine reference books emerged after the introduction of the Machinery's Handbook; however, most did not adapt to changes in manufacturing and discontinued publication (Industrial Press, 2012). The Machinery's

Handbook continued to evolve as manufacturing technology changed. Following is an extensive overview of the evolution of technologies that shaped the Machinery's Handbook.

Evolution of Technologies that Shaped the Machinery's Handbook

Prior to the Machinery's Handbook and Henry Ford's progressive manufacturing techniques, the Morrill Act of 1861 was enacted to provide industry with skilled and educated workers (Morrill Land Grant College Act, 1861). The Morrill Act of 1861 allocated 30,000 acres of land to eligible States for developing agriculture and mechanic arts colleges. Massachusetts chartered the Massachusetts Institute of Technology (MIT) under the Morrill Act of 1861; however, MIT did not enroll their first student until after the Civil War ended in 1865 (Hockfield, 2011). Many colleges chartered under the Morrill Act became leaders in science and technology, which helped shape machine tool technology through advanced research. The Morrill Act became significant in shaping the Machinery's Handbook because many of the technological advancements in machine tool were pioneered at colleges chartered under the Morrill Act. The Morrill Act primarily affected the Northern and Western States that in turn led to a higher economic growth rate than the South (Cohen, 2010).

The early nineteenth century industrialization of the U.S. shaped public education (Rury, 2009). American life was being driven by skills required for urban industry. The U.S. economy was thriving due to the industrialization, and highly skilled workers were needed to work in factories (Rury, 2009). Research engineers played an important role in the increased economy. Henry Ford was the first manufacturer to research and apply assembly techniques to increase efficiency and quality. Ford's Model T assembly line techniques were the start of massive manufacturing in the U.S. vital for supplying World War One (WWI) machinery such as artillery, field weapons, aircraft, tanks, and motor vehicles. The need for the Machinery's

Handbook was increasing and the Industrial Press Publishing Company could not supply the book to meet the demands of industry. Within the first two years of publication, Industrial Press sold over 30,000 copies (Industrial Press, 2011).

In 1918, WWI ended and manufacturing continued to grow. Research in metallurgy-advanced cutting tools and improved manufactured products. Metals such as manganese and chromium were founded and researched to improve heat-treating and create more diverse alloys of steel. Stainless steel was developed through studying nickel metal alloys. Stainless steel also helped in advancing the marine and aerospace industries due to the high corrosion resistant qualities. Although aluminum was introduced many decades prior to 1925, aluminum alloys were researched at colleges such as MIT and introduced to consumers in 1925. The high strength to weight ratio of aluminum alloys increased the capabilities of manufacturing airplanes. Carbide, tungsten, cobalt, molybdenum, and beryllium were introduced from 1918 to 1927 (Wright, 1990). Material advancements required CTE to retrain workers for the new cutting techniques on the new materials (Industrial Press, 2012).

From the end of WWI to the start of the great depression in 1929, metallurgy drastically advanced U.S. manufacturing by increasing cutting tool technology, and increasing the types of materials used in manufacturing such as aluminum alloys, stainless steel, carbide, and thousands of new steel alloys. The first edition of the machinery's handbook published in 1914 had 1,400 pages, 10 years later the sixth edition in 1924 had over 1,600 pages. Most of the 200 pages added to the book in 10 years was updated speeds and feeds for machining each material. The advancements in materials were the beginning of increased product quality and more advanced manufacturing technology (ASME, 2011). Materials represented some of the first changes in technology since 1914 that required organized CTE programs increase standards of students.

This was the first significant change in technology with similar impacts to current technological changes. Throughout the first years of the Machinery's Handbook drastic changes occurred due to the rapid advancements in material technology.

During the great depression manufacturing continued; however, little advancement in technology occurred. One addition was the introduction and standardization of shielded metal arc welding. Shielded metal arc welding is used to fuse two pieces of metal together in a controlled setting. Arc welding had a large impact on the Machinery's Handbook, manufacturing technology, and education. Prior to arc welding, rivets and bolts were used to fasten material together. With the introduction of arc welding, ships, tanks, and machinery were fabricated using laborers with a different skill set than fabricators prior to arc welding (Weber, 2007). Trade schools were teaching welding along with rivets and bolt techniques for fabrication. The addition of welding to the Machinery's Handbook changed the standards of manufacturing in the U.S. and allowed for faster production of machinery. The introduction of welding in manufacturing was a significant time in the history because CTE schools started teaching welding during this time.

Wax casting became a manufacturing standard in 1939. Wax castings allowed engineers to quickly prototype parts for research and development. Turbine blades for gas turbine engines used in naval ships and later aircraft were prototyped using wax casting. The Machinery's Handbook published specification for wax castings in the edition following the development. In 1999, three-dimensional printing replaced the need for wax casting, which excluded wax casting from the book. The turbine engine was developed prior to the start of World War Two (WWII). The development of the turbine engine increased the U.S. advantage for at sea battles due to the increased speed of naval ships (ASME, 2011). During this time, CTE played a major role in U.S. education.

The start of WWII increased manufacturing and helped the U.S. climb out of the great depression (Wright, 1990). The manufacturing of airplanes, ships, ammunition, vehicles, and machinery spawned another era of industrialists that would work toward increased technology to further the U.S. progress in the Europe and the Pacific. Aircraft technology was rapidly advancing from large companies such as Boeing, Lockheed, and Hughes Aircraft. Men were drafted to serve in the war and women became prevalent in factories. Technology increases during WWII made the greatest impact on the Machinery's Handbook and manufacturing throughout history with the development of numerical control. Numerical control was not linked with manufacturing at the time it was developed. Weapon control systems were the original intent. Numerical control is three-dimensional coordinate based computer programming. The start of numerical control came from research at MIT, a land grant college. Many Morrill land grant colleges such as MIT became leaders in innovative research such as MIT's involvement in the development of numerical control. Massachusetts Institute of Technology faculty and students were developing a servo-operated artillery positioning system to electrically control large 76-millimeter guns on board naval ships (Hockfield, 2011). When WWII ended in 1945, the servo numerical control system was operational; however, never was installed on naval ships until later in history.

Massachusetts Institute of Technology researchers found another application for numerical control. The numerical control system was researched to further machine tool technology by creating a numerically controlled milling machine. A numerical control milling machine would allow machinist to mass produce parts with a simple computer program using letters and numbers to program movements instead of manually moving levers. The computer repeatability of parts manufacturing would decrease human error, which would increase part quality. The advancement of numerical control technology has flourished since its original introduction. The need for skilled numerical control equipment operators was extremely low after WWII but the engineering to improve the technology for numerical control was moving forward rapidly. Although numerical control was introduced at this time, the numerical control technology was introduced to the Machinery's Handbook in 2008. The computing power necessary to take advantage of this technology for manufacturing technology became reality nearly 50 years later.

In 1958, the National Aeronautics and Space Administration (NASA) was established for the purpose of space exploration. The U.S. interest in space exploration placed an emphasis on science and technology in education. The concentration of developing a spacecraft also placed an emphasis on special materials and manufacturing processes. General Electric and MIT became partners and began to work on an advanced numerical control system. The product of their research was the development of computer numerical control (CNC) and computer aided design (CAD) systems. The addition of CNC and CAD revolutionized how products were manufactured. General Motors, Ford, and General Electric all began the migration to CNC robotic systems and cutting machines. By 1975 all major manufacturers were purchasing pick and place CNC robotic systems and CNC cutting machines (ASME, 2011).

The major impact of CNC cutting technology was the three dimensional radius moves that could be made without changing the fixtures of the parts. Programmers could program a part, manufacture the part, and conduct quality control checks to make sure the part meets the specifications of the print. If the part met quality standards, the operator would simply load a piece of metal into the machine and depress the start button and the machine would manufacture the part. If the part did not meet quality standards, the programmer could alter the program in the areas that needed to be corrected and start the process over from the beginning. The skill set of machinists drastically changed from manual machining skills to computer technology skills. The amount of workers employed in manufacturing between 1979 through 1993 in the U.S. fell from 41% to 16%, which meant students could not automatically find jobs where his or her father worked (Castelano, 2003). The effect of the manufacturing decline caused vocational course enrollments to decline in areas such as business, agriculture, and the trades (Castelano, 2003). Vocational programs were forced to change their focus to highly technical education, which changed the name vocational education to Career and Technical Education CTE and concentrated on areas such as: computerized diagnostic repair, computer numerical control machines, and modern medical equipment (Castelano, 2003).

An increase quality standards spawned new sciences within manufacturing such as quality control and Geometric Dimensioning and Tolerancing (GD&T). Quality control is a term associated with monitoring the product that is being manufacturing and GD&T is the standards for checking parts. Part qualities such as dimension tolerances, surface texture, parallelism, roundness, and angle specification became a part of GD&T standards. The Machinery's Handbook quickly adopted GD&T and computer aided drafting (CAD) standards to accommodate the changing skills requirements of machinists and engineers. The development of CAD and CNC technology has revolutionized industry and continues to become more advanced. Currently the Machinery's handbook has made drastic changes. Following is a look at the changes to the current edition, which provides evidence that we are in a time within CTE of drastic technological changes.

Current Machinery's Handbook Changes

The current edition was published in 2012 and is the 29^{th} edition. Mechanical trades' apprenticeships, colleges, and technical schools teach the Machinery's Handbook to prepare skilled workers with the necessary data for engineering and manufacturing. Referencing material is necessary in an industry that changes rapidly. During the WWII era, the U.S. experienced rapid advancements in technology that required the Machinery's Handbook have additional sections to support the changes (Oberg, 1950). Much like the WWII era, during the last five years technology has advanced at an increased rate that required the 28th edition of the Machinery's Handbook to eliminate sections containing old technology and adds sections supporting advanced technology.

The most relevant section pertinent to this study is CNC technology. Computer numerical control technology was not present in the 27^{th} addition and is now a makes up the majority of the machining section. The 28^{th} edition of the Machinery's Handbook had portions removed to make room for CNC technology. The change represents a pinnacle time for CTE because sections that had been in the Machinery's handbook for 50 years had been taken out and replaced with a new standard in machining technology. Computer numerical control equipment requires G & M code programming. G & M code programming requires students to program a computer to specific coordinates based on the print of a designed part. Most parts that require CNC equipment are intricate parts with complex angles and radii. The mathematics it takes to find the locations of the tool start and stop point for cutting requires the use of geometry and trigonometry. Calculators are available for computing but the students still need to understand what they are attempting to find. The standard of G & M code programming requires CTE professionals to change focus to the new skill demands from industry.

Each technological breakthrough in manufacturing throughout U.S. history has changed the track of CTE to require higher academic standards. Advanced material development and CNC technology made it possible to machine new materials such as stainless steels or carbide to advance aeronautics, medical, marine, and space technologies (Valentino & Goldenberg, 2008). These advancements led to commercial air travel, extensive space exploration, faster shipping, and advanced medical implants (Valentino & Goldenberg, 2008). Without advanced manufacturing, advanced technology seizes to exist (Valentino & Goldenberg, 2008). Changes to the Machinery's Handbook coincide with the major breakthroughs in manufacturing technology and manufacturing technology drives the CTE curriculum. This section provided evidence of the historical changes of the CTE curriculum throughout history. To fully review the history of CTE, it is important to understand the previous research conducted on CTE. The following is a look at previous research that has been conducted on CTE.

Research on Career and Technical Education

This section provides a foundation for common themes in CTE research to demonstrate the difference between previous research on the CTE instructional model being good for students compared to the purpose of this research project in investigating how student mathematical skills can be improved to further CTE, which in turn provides manufacturers with skilled workers.

Generally, students who participate in CTE programs learn about academic subjects such as mathematics and science while at the same time learning a skilled trade (Stone, 2008). Alfeld, Pearson, and Stone (2008) suggest that secondary and post-secondary mathematics teachers who use CTE courses for delivering mathematics concepts to students perform statistically better than students who do not receive mathematics concepts through CTE courses. High student engagement is another area often linked to CTE. Students enrolled in CTE courses tend to have a higher engagement in their education than traditional courses (Burke, 2009). CTE provides the model all courses should follow to ensure student engagement (Archambault, 2008). Gentry, Mann, and Peters (2007) suggest that both gifted and general students perceive CTE as providing autonomy, effective and caring teachers, connections to other students with similar interests, and relevant content in an applied setting. Gentry, Mann, and Peters (2007) suggest that the CTE structure helps in preventing students from dropping out of high school. Participation in CTE coursework reduces dropout rates and effectively prepares students for postsecondary education (Castelano, 2003).

Career and Technical Education (CTE) reform efforts are under researched and few scholarly attempts had been made to link CTE to research on academic components of U.S. schooling (Castellano, 2003). Much of the research conducted on CTE is focused on secondary education with little attention given to post-secondary CTE (Castellano, 2003). Due to the lack of research on CTE in post-secondary education, research on project based learning PBL in post-secondary schools is reviewed to provide a foundation for existing literature on CTE.

Career and technical education provides a model for Project-Based Learning (PBL) (Burke, 2009). Thus, CTE is commonly researched with PBL in secondary schools. Students in CTE programs frequently are assigned to projects in the start of a semester and are able work on them in any order the students choose (Gentry, 2007). Many projects allow for the student interest to drive the concentration of a project (Gentry, 2007). 80% of all elementary children are global learners, yet most reading is taught using analytical based instruction (Dunn & Hongisfeld, 2006). Many teachers understand the importance of cooperative learning but still teach all students traditionally to avoid the planning necessary to have students work in groups (Steward, 2004). Hands-on learners have difficulties with traditional learning because the formal seating, lack of mobility, and lack of hands-on manipulation tends to make learning boring and the brain exhausted (Strother, 2007).

PBL is generally divided into three phases. First the teacher must select a topic based on State standards and help students create a problem or question, second the students must collaborate with peers to create subtopics to explore, and finally the physical project work is created by using technology or physical manipulation (Foulger, 2008). Much like CTE, PBL allows the student to tap into the students' interests by allowing them to create projects that are meaningful (Bezon, 2007). Rone (2008) suggests that effective teaching and learning is fostered by active learning through field experiences, experiences that promote interaction, and diverse instruction that meet the needs of multiple learning styles. Both CTE and PBL accomplish Rone's (2008) three criterion for effective teaching (Burke, 2009; Faris, 2007). A study conducted in Loveland Colorado involved a mathematics teacher and a CTE teacher that use house construction for the delivery of geometry. The outcomes are high proficient students are staying highly proficient and 70% more non-proficient students are moving up an entire category (Burke, 2009). The geometry in construction class outperforms all other geometry classes within the district (Burke, 2009). Burke (2009) uses CTE as a PBL model to teach academic courses to general and CTE students. Project Based Learning and CTE are more effective because a real problem is presented to students and higher motivational levels exist (Alfred, 2008; Chia, 2009; Hakkarainen, 2009; Sungur, 2006). The following section provided a historical background of CTE that contained evidence that we are in a time of drastic changes within CTE and presented previous research that has been conducted on CTE. The following section provides the historical background of the theoretical framework, which includes locus of control and mathematics attitudes.

Theoretical Framework

The theoretical framework for this study includes locus of control and mathematics attitudes. Many studies have adapted the locus of control and mathematics attitudes scales for specific academic subjects; however, CTE has not been the focus nor has a study used both the mathematics attitudes scale and the locus of control scale within the same study. The historical background and previous research of each concept is detailed below.

Locus of Control

This section provides a comprehensive look at the evolution of locus of control starting with the social learning theory, which served as the theoretical foundation of locus of control. The review follows the major researchers that added to the development of the Rotter (1966) internal/external locus of control scale and the scales that were developed based on Rotter (1966). This review covers a period between 1954 and 2012.

Origin of Locus of Control: Social Learning Theory

Prior to the internal and external control scale Rotter (1954) introduced the social learning theory. The social learning theory was the beginning of the internal and external locus of control scale. The purpose of the social learning theory was to study a person's personality as it relates to the environment. Rotter (1954) suggests that a person cannot have a personality independent of their environment. Also, that a person's personality is not completely driven by the environment. To understand personality, the individuals' history, such as past experiences and family life must be looked at along with the current environment. Rotter (1954) looked at behavior and personality as a changeable. If a person has a change in environment and begins to think differently because of the environment, behavior will change. Social learning theory was developed as a model to predict behavior. The social learning theory has three main components for predicting behavior, which are behavior potential, expectancy, and reinforcement value. Behavior potential is a person's potential behavior in certain situations. Expectancy is the probability that a specific behavior will lead to a specific outcome. Reinforcement value refers to the outcome of a certain behavior and is not important whether the outcome is positive or negative. Behavior potential, expectancy, and reinforcement value are variables in a formula for predicting behavior (Rotter, 1954). The social learning theory was the beginning of looking at both internal and external factors for predicting an outcome.

Based on Rotter's social learning theory, Witkin, Lewis, Hertsman, Machover, Meisner, and Wapner (1954) suggest that people either acquire their cues from the field or from internal sources. People who acquire their cues from the environment tend to be conforming and people who acquire their cues internally, tend to be non-conforming. Phares (1957) expanded the social learning theory by researching the difference in task performance between people given skilled instructions and people given instructions based on luck. The main concept of Phare's research was to understand the influence a person's perception of a task had on completing a task. Phares found merit in studying the control that external influences have on a person's performance. Participants were given a simple task to complete with detailed skilled instructions on completing the task. The second group was given the same task; however, the second group was told the task was based on chance or luck and that no skill was involved. Even though no instructions were needed to complete the simple task, the group with the assumption the task was chance, performed significantly lower than the group given specific instructions. Phares suggested further research be conducted using a scale that derived from his research. The Phares (1957) scale measured the participant's perceptions of control when performing a task and was a 13-point Likert measurement. The introduction of the internal versus external control scale was the next phase of researching perceptions of control . The following section provides the background of the origin of the internal versus external scale.

Origin of Internal Versus External Scale

The Rotter (1954) social learning theory was the foundation for Phares (1957) research on external control. A 13-point external scale on perceptions of external control was derived from Phares (1957) research. Under the direction of Julian Rotter, James (1957) dissertation modified Phares scale by adding several items creating a 26-item scale. The 26-item scale was used to measure the perceived control of participants when performing a task under verbal direction. The group that received the internal control directions performed better on the task than the participants who were told the task was 50% luck and 50% skill. Rotter and James (1958) used the 26-item scale to conduct further research on performance based on internal control and external influences and replicated the same results as James (1957). Rotter and James (1958) were the first researchers using a scale specifically designed to measure internal and external control.

Liverant, Rotter, and Seeman (1961) altered the Phares and James scale by adding six filler questions with a forced choice format instead of a Likert format and replicated Rotter and James (1958) research with similar results. Rotter, Liverant, and Crown (1961) conducted further checks on James and Rotter's (1958) and Liverant, Rotter, and Seeman (1961) work and reinforced the results of both studies; however, concerns of behavioral influences rather than just verbal directions were reported. Holden and Rotter (1962) replicated the Rotter and James

(1958) study adding the behavioral influences as suggested by Liverant, Rotter, and Seeman, (1961). The results were similar to Rotter and James (1958) looking at both verbal and behavior based instructions and outcomes. Phares (1962) replicated the Liverant, Rotter, and Seeman study using both behavioral and verbal variables and confirmed the reliability and validity of the internal/external social learning theory scale. Rotter (1966) altered the items on the Liverant, Rotter, and Seeman scale (1961) and created the internal/external locus of control scale, which is the most prominent locus of control scale. Many variations of the Rotter (1966) scale were developed soon after Rotter introduced the scale. The following section provides a background on the prominent variations of locus of control scale.

Variations of Locus of Control Scale

The locus of control scale has been used in diverse areas. In recent years, locus of control has been used for researching areas such as, education, organizational psychology, sports performance, health, and religion. This section includes the major researchers on locus of control and areas where locus of control is used.

Rotter (1966) developed the locus of control scale primarily for psychological personality identification and was a 29-item force choice format. The Rotter (1966) scale was criticized by many researchers for the forced choice format arguing that the scale could have a higher validity when data were collected using a Likert measurement and by eliminating filler questions (Levenson 1973; Norwicki & Strickland, 1971). Norwicki and Strickland (1971) altered Rotter's scale by eliminating filler questions and used a Likert measurement. The Norwicki-Strickland locus of control scale was also modified to focus on specific age. Keyson and Janda (1972) used the Norwicki-Strickland idea of using locus of control to focus on a specific group and created a drinking locus of control scale. The Keyson and Janda (1972) scale was used as a foundation for the creation of several scales specific to addiction behavior such as eating and smoking and cocaine abusers (Ludke & Schneider, 1996; Oswald, Walker, Reilly & Parker, 1992).

Levenson (1973) supported Norwicki and Strickland's (1971) theory that Likert measurement would increase the validity of locus of control; however, they also stated chance should be included as a measurement along with internal and external control. The Levenson (1973) general locus of control scale is a prominent scale used for measuring locus of control and has been altered to study specific groups such as general health, fetal health, diabetes, depression, and economics (Desmond, & Robert, 1987; Ferraro, Price, 1987; Furnham, 1986; Labs & Wurtele, 1986; Wallstron, Stein, & Smith 1994; Wallston, Wallston, Kaplan, & Maides, 1976; Whitman, Desmond, & Price 1987). The Levenson locus of control scale has been currently used for research identifying predictors for learning in an online context and predicting work outcomes (Joo, 2012; Ng, Soransen, & Lillian, 2006). Furnham and Steele (1993) also developed several health related locus of control scales based on Levenson's (1973). The health scales were developed to measure internal factors such as preventative health care and a healthy lifestyle, and external factors such as doctor performance or bad luck (Furnham & Steele, 1993). Furnham (2010) also developed a parental health scale modified from the Wallson (1978) health locus of control scale. Although Levenson, Norwicki, and Strickland (1971) suggested the use of Likert style measurement would increase validity, the validity of both the Norwicki-Strickland and the Levenson scales were not increased from Rotter's original locus of control scale (Levenson, 1973; Norwicki & Strickland, 1971).

Reid and Ware (1974) used a combination of Rotter's (1966) force choice scale and Levenson's (1973) internal, external, and chance scale to create a general-purpose locus of control scale. The three factors used in the Reid and Ware (1974) scale are social system control or government, fatalism or luck, and self-control. The scale is used to measure peoples' perceptions of government. Rose and Medway (1981) created the teacher locus of control and is much like the Rotter (1966) locus of control scale. The scale has a force choice measurement and is a better predictor of teacher behavior than the Rotter scale (Rose & Medway, 1981). As stated previously, the locus of control scale has been used in a variety of different areas. The area most relevant to this study is previous research on locus of control in reference to academic performance. The following section is a review of previous research on locus of control as a predictor for academic performance.

Table 1. Summary of Scales of Locus of Control

Researcher (Year)	Purpose
Phares (1957)	A 13-item scale using Likert measurement for researching perceptions of external control.
James (1957)	A 26-item scale using Likert measurement for researching perceived control of participants when performing a task under different styles of verbal directions.
Rotter & James (1958)	Replication of James (1957) 26-item scale using Likert measurement for researching perceived control of participants when performing a task under different styles of verbal directions.
Liverant, Rotter, & Seeman (1961)	Used Phares (1957) and James (1957) scales as a foundation and added six filler questions with a forced choice format. Used for researching perceived external control.
Rotter (1966)	A 29-item scale using forced choice response measurement primarily for psychological personality identification. First use of both internal and external locus of control. Most prominent scale.
Norwicki & Strickland (1971)	Altered Rotter's (1966) scale by eliminating six filler items and used a Likert measurement. A 23-item scale for psychological personality identification. Internal and external locus of control.
Keyson & Janda (1972)	Altered the Norwicki-Strickland scale to focus on a specific group. A 23-item scale using Likert measurement for researching internal and external control of alcohol and cocaine abusers.
Levenson (1973)	Changed format from internal and external to internal, powerful others, and chance. This scale is highly used in research. Uses Likert measurement.
Reid-Ware (1974)	Uses Levenson's (1973) internal, powerful others, and chance format with forced choice measurement.
Wallston (1978)	Developed a general health locus of control scale based on Rotter's (1966) scale.
Rose & Medway (1981)	Much like the Rotter (1966) locus of control scale with wording changes to measure teachers' locus of control.
Furnham & Steele (1993)	Developed a general health locus of control scale based on the Levenson (1973) and Wallston (1978) scales.
Furnham (2010)	Developed a parental health locus of control scale based on the Levenson (1973) scale.

Locus of Control and Educational Performance Research

Locus of control scales are common to use in secondary and post-secondary schools to focus on general performance and attendance (Crede et al., 2010; Edwards & Waters, 1981). This review focuses on several educational research studies that includes locus of control and its relationship with academic performance. Locus of control does not predict students' attitudes toward mathematics. Students who posses an internal locus of control do not had a significantly different attitude toward mathematics than a student who possesses an external locus of control (Ifamuyiwa and Akinsola, 2008). Ifamuyiwa and Akinsola (2008) differ from this research because a mathematics attitudes scale to determine mathematics attitudes was not used.

Tella, Tella, and Adeniyi (2009) used the Trice (1985) academic locus of control scale to see what extent locus of control had on academic achievement of young secondary students in Nigeria. The Trice (1985) locus of control scale is based on the foundation of Rotter's (1966) locus of control scale and has a true/false format instead of forced choice. The Trice (1985) scale uses questions that are worded specific to academics. The results indicate that the participants' locus of control significantly predicts academic achievement. With a similar methodology, Yazdanaphah, Sharagard, and Rahimi (2010) used locus of control and age as predictor variables for academic achievement among Iranian English language learners. Final grades were used to measure achievement. Students with an internal locus of control had a higher academic achievement than students with an external locus of control had. No relationship existed between age and locus of control.

Hadsell (2010) used the Rotter (1966) locus of control scale to measure the extent that locus of control predicts economics performance. Achievement goals, academic goals, interest in economics, and fear of failure were also measured using specific scales. Final grades of exams were used to measure performance in economics. The results indicate that locus of control was not significant in determining economic performance; however, locus of control was significant in predicting interest and enjoyment in the subject. Hadsell (2010) concluded that the desire to be viewed as a middle or upper level student helps increase performance. Joo, Lim, and Kim (2013) had similar results as Hadsell (2010) using the Levenson (1981) Internal, Powerful Others, and Chance scale to measure locus of controls effect on the achievement of online learning. Other variables used along with locus of control were self-efficacy, task value, learner satisfaction, and persistence. The results indicated that locus of control had no significance for achievement of online learning; however, students with an internal locus of control had greater learner satisfaction. Learner satisfaction was found to be a significant predictor for online learning achievement and locus of control was found to predict learner satisfaction. Indirectly, having an internal locus of control will predict online learning achievement because students with an internal locus of control had increased learner satisfaction, which increased achievement.

Although several studies had found a significant relationship between locus of control and academic performance, Daniels and Stevens (1976) suggest that locus of control is one measure to predict academic performance; however, locus of control alone will not predict performance. Edwards (1981) concluded that to link locus of control to academic performance, locus of control must have a significant relationship with another variable that is a known variable in predicting academic performance. This research used mathematics attitudes along with locus of control to examine predictors for mathematics performance. The following section is a review of research involving mathematics attitudes.

Mathematics Attitudes

The Fennema-Sherman mathematics attitude scale (FSMAS) is considered the most prominent scale for measuring effect of mathematics attitudes (Hyde et al., 1990). The FSMAS was designed to collect data using nine scales, each containing 12 items. The nine scales are confidence in learning mathematics; mathematics anxiety; father; mother; usefulness of mathematics; mathematics in male domain; attitude toward success in mathematics; teacher; and effectance motivation in math. Each construct is has six negative and six positive statements. Following each statement is five response alternatives, which are strongly agree, agree, undecided, disagree, and strongly disagree. The response that corresponds to a positive response scores a five and the negative response scores a one. The cumulative response score determines students' attitude toward mathematics from a range of positive to negative. A low score represents a negative attitude toward mathematics and a high score represents a positive attitude toward mathematics. The following section provides a background on the prominent variations of the mathematics attitudes scale.

Background

Mathematics attitude measurement scales had been developed and used for many purposes throughout history such as predicting mathematics performance, finding relationships between enjoyment and mathematics performance, and measuring perceptions on mathematics value. This section provides a background on the prominent scales developed for measuring mathematics attitudes.

Dutton (1954) developed one of the earliest mathematics attitudes scale using a Likert measurement for 22 statements on elementary students feeling toward arithmetic. The scale tested positive for validity and reliability. Dutton (1954) suggests that feeling toward mathematics are developed in all grades, attitudes of elementary students' feelings are important for progress in mathematics, and teachers ability to make mathematics practical is important for positive feeling toward mathematics. The Dutton (1954) scale served as the foundation for Aiken and Dreger's (1961) further research in developing a scale that includes value of mathematics and enjoyment of mathematics. The Aiken and Dreger (1961) scale was a 20-item Likert scale containing 10 positive statement and 10 negative statements and tested positive for reliability and validity. Aiken and Dreger (1961) used the scale to determine the relationship between mathematics attitudes and mathematics performance. The results indicate that positive mathematics attitudes correlate with high mathematics performance. The Dutton (1954) and Aiken and Dreger (1961) scales were widely used until the introduction of the Fennema-Sherman (1976) scale was developed.

Fennema and Sherman (1976) created the Fennema-Sherman Mathematics Attitude scale (FSMAS), the most prominent research scale on mathematics attitudes (Frost & Hopp, 1990). The FSMAS has 9 constructs, which are confidence in learning mathematics, mother, father, teacher, attitude toward success in mathematics, mathematics as a male domain, usefulness of mathematics, anxiety, and effectance motivation in mathematics. Each of the nine constructs has 12 items in each construct. Each of nine FSMAS has been tested for reliability as a whole or as individual scales (Fennema and Sherman, 1976). In all, the FSMAS has 108 items. The FSMAS has been criticized because of the time required to complete (Mulhern & Rae, 1998). Several construct validation studies on the FSMAS had been completed all resulting in the scale being valid and reliable (Broadbooks, Elmore, Pedersen, & Bleyer, 1981; Melancon, Thompson, & Becnel, 1994).

The FSMAS has been modified several times since its development to incorporate English attitudes (Stricker et al., 1993), physical education attitudes (Lirgg, 1993), and to accommodate different age groups (Elliot, 1990). The FSMAS has been used in many variations, such as using all nine scales with 12 items per scale or selecting scales to test certain aspects of mathematics attitudes. Zakaria and Nordin (2007) used the mathematics anxiety scale to assess college students' anxiety toward mathematics and its relationship with motivation. A study on web-based instruction and mathematics anxiety modified the FSMAS using six of the nine scales and used only 10 of the 12 items within each scale (Gundy et al., 2006). Gender studies are another purpose for selecting individual scales. The mathematics as a male domain scale has been used to understand the differences in mathematics attitudes between males and females (Tocci & Engelhard, 1991). McCoy (2005) used the confidence in using mathematics, perceived usefulness of mathematics, and mathematics anxiety to investigate the variables that may affect algebra achievement. The scale was administered using a pre-test and post-test methodology and found that the participants in the eighth grade course had significantly lower confidence, higher anxiety, and lower usefulness of mathematics scores on the post-test than the pre-test.

Michaels and Forsyth (1977) developed a multidimensional scale based on several one-dimensional scales (Dutton, 1954; Aiken and Dreger, 1961). The scale consisted of four constructs: enjoyment of word problems, enjoyment of pictorial problems, appreciation of the utility of mathematics, and security with mathematics. The scale contains 32 items with Likert measurement mathematics enjoyment, appreciation, utility, and confidence. Although Michaels and Forsyth (1977) scale was a valid and reliable multidimensional scale, the scale was overshadowed by the more popular Fennema-Sherman (1976) scale developed the year prior.

Sandman (1980) criticized the validity of previous mathematics scales and found merit in researching attitudes toward mathematics. Sandman (1980) developed the mathematics attitude inventory (MAI) designed to measure secondary students' attitudes toward mathematics. The scale was supported by the National Science Foundation to create a valid instrument for collecting data on mathematics attitudes. Six constructs were used to measure mathematics attitude: perception of the mathematics teacher, anxiety toward math, value of mathematics in society, self-concept in math, enjoyment of math, and motivation in math. The scale contains 48 items uses a Likert style measurement, and tested positive for reliability and validity. Although Sandman (1980) criticized previous mathematics attitudes scales, the items from the MAI are built on the foundation of previous scales. The reliability and validity of the scale is similar to previous scales in this review.

Mulhern and Rae (1998) supported the content of FSMAS, but criticized the length of time it takes to complete suggesting that participants lose interest toward the end of the scale, which sacrifices validity. Mulhern and Rae (1998) developed a shortened version of the Fennema-Sherman Mathematics Attitudes Scale (FSMAS-SV). The FSMAS-SV was designed to collect data using six constructs. Several constructs were combined to make six constructs: attitude toward success in mathematics, parents' attitudes, mathematics as a male domain, teachers' attitudes, mathematics related affect, and usefulness in mathematics. Like the FSMAS, each construct is made up of positive and negative related statements. A response corresponding to a positive response scores a five and the negative response scores a one. The cumulative response score determines students' attitude toward mathematics from a range of positive to negative. A low score represents a negative attitude and a high score represents a positive attitude.

The Attitudes Toward Mathematics Inventory (ATMI) is the most recent scale (Tapia & Marsh, 2004). The ATMI is a 49-item scale to measure underlying dimensions of attitudes toward mathematics using the following constructs: confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations. Motivation to develop the ATMI came from the time required to complete mathematics attitudes scales previously developed. Tapia and Marsh (2004) refer to the Fennema-Sherman (1976) as the prominent mathematics attitude scale; however, much like Mulherm and Rae (1998), Tapia and March (2004) criticized the length of time to complete the scale. The ATMI was developed to create a shorter mathematics attitude scale. The scale tested positive for both validity and reliability. The mathematics attitude scale has been used in a variety of different areas. The area most relevant to this study is previous research on mathematics attitudes in reference to academic performance. The following section is a review of previous research on locus of control as a predictor for academic performance.

Table 2. Summary of Scales of Mathematics Attitudes

Researchers (Year)	Purpose
Dutton (1954)	One of the earliest mathematics attitudes scale. A 22-item scale using Likert measurement for researching elementary students feeling toward arithmetic
Aiken & Dreger (1961)	Used the Dutton (1954) scale as the foundation and included the measurement of value and enjoyment of mathematics.
Fennema & Sherman (1976)	Use nine constructs to measure confidence in learning mathematics, mother, father, teacher, attitude toward success in mathematics, mathematics as a male domain, usefulness of mathematics, anxiety, and effectance motivation in mathematics. Twelve items in each construct. Most prominent mathematics attitude scale.
Michaels & Forsyth (1977)	A 32-item scale based on Dutton’s (1954) and Aiken and Dreger’s (1961). Likert style measurement for researching enjoyment of word problems, enjoyment of pictorial problems, utility of mathematics, and confidence.
Sandman (1980)	Developed the mathematics attitude inventory (MAI) for measuring secondary students’ attitudes toward mathematics. Six constructs are used which are: Perception of the mathematics teacher, anxiety toward math, value of mathematics in society, self-concept in math, enjoyment of math, and motivation in math. The scale contains 48 items and uses a Likert style measurement.
Mulhern & Rae (1998)	A shortened version of the Fennema-Sherman Mathematics Attitudes Scale (FSMAS-SV). Several constructs of the FSMAS were combined to make six constructs, which are attitude toward success in mathematics, parents’ attitudes, mathematics as a male domain, teachers’ attitudes, mathematics related affect, and usefulness in mathematics.
Tapia & March (2004)	Developed the Attitudes Toward Mathematics Inventory (ATMI) Tapia and Marsh (2004). A 49-item scale to measure underlying dimensions of attitudes toward mathematics using the following constructs: Confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations. Much like the Fennema-Sherman (1979) scale.

Mathematics Attitudes and Educational Performance Research

Much of the research on mathematics attitudes suggests that positive attitudes in mathematics are a predictor for mathematics performance. Ma and Kisher (1997) found inconsistencies in the research findings of mathematics attitudes predicting mathematics achievement. A meta-analysis of studies containing mathematics attitudes as a predictor for mathematics achievement was conducted summarizing the findings of 113 studies. The studies were chosen under the following criteria; had a definition of attitude toward mathematics similar to that of Ma and Kisher (1997), investigated the relationship between attitudes toward mathematics and achievement in math, measured attitudes toward mathematics and achievement in mathematics using psychometrically developed instruments, did not include any experimental interventions on either attitude or achievement, contained students at the elementary and/or secondary school level, and reported quantitative data in sufficient detail for calculation of an effect size. Attitudes toward mathematics had a significant effect on achievement in mathematics the higher the positive attitude the higher the achievement.

Similar to the findings of Ma and Kisher (1997), Aiken and Dreger (1961) researched the effect attitudes toward mathematics had on college students' performance in mathematics. A positive attitude in mathematics predicts mathematics achievement. Previous experiences with mathematics teachers provide the best predictor for a students' attitude toward mathematics. Positive attitudes exist when a student has a positive mathematics teacher experience. Students with negative mathematics teacher experiences tend to have a negative attitude toward mathematics. Sherman (1979) used eight constructs of the FSMAS along with three cognitive tests to predict mathematics performance of high school girls and boys. The results indicate that the best predictors of mathematics performance are cognitive tests such as spatial aptitude, vocabulary, and mathematics achievement. Of the eight constructs of the FSMAS, six were found to be significant in predicting mathematics performance. The six constructs are confidence in learning math, mother, father, teacher, usefulness of math, and effectance motivation in math. Also, both girls and boys perceive mathematics as being a male domain.

Parents' attitudes toward mathematics were found to have a significant influence on students' academics (Levine, 1972). Levine (1972) found parents' who had strong positive attitudes toward a given subject, the students performed at a higher level. The study was not specific to mathematics, the study included English, science, and social studies. Gender was also included in the Levine (1972) study and females were found to score significantly higher in English and science than in mathematics. In contrast to Levine's (1972) research, Hill (1967) analyzed the influence the mother and the father had on a high school son. No correlation was found between the mothers' or father's attitude and the students performance in mathematics. Although no correlation existed between parents' attitudes toward mathematics and mathematics performance, the students' attitude mirrored that of both the mother and father with greater significance in relation to father (Hill, 1967).

Teachers' attitudes affect student learning. Teachers' attitude toward academics was found to have a significant influence on students' attitudes toward learning (Hazzan, 2003). If students perceive the teacher as having a negative attitude toward a subject, the student will mirror the attitude modeled by the teacher (Hazzan, 2003). Different than mirroring a teachers' attitude, Duan, Depaepe, and Verschaffel (2011) found that teachers who develop content that is meant to challenge students by creating questions for exams that require the students to draw from life experiences are more likely to influence students negative attitudes. Teaching approaches have also been known to influence students' attitudes toward learning (Beausaert, Segers, & Wiltink, 2013). Teachers' attitudes toward learning effects the approach that teachers' use for instruction. If teachers' have a student centered attitude toward learning as apposed to teacher centered instruction, the students' are more likely to develop positive attitudes, which will lead to greater student interest (Beausaert, Segers, & Wiltink, 2013).

Student interest in mathematics is a predictor for attitude toward mathematics (Fennema, & Sherman, 1976). Fennema and Sherman (1976) and Aiken and Dreger (1961) suggest students with a positive attitude in mathematics are more likely to have higher achievement in mathematics than students with a negative attitude have. If interest were a predictor of attitude and attitude is a predictor of achievement, interest should serve as a predictor for achievement. A longitudinal study of students' grades seven through 10 was conducted on interest and achievement (Koller, Baumert, & Schnabel, 2001). Achievement data were collected through the standardized achievement tests and students' interest in mathematics was measured using a student interest scale. Students' interest was not a significant predictor for mathematics achievement. This study contradicts the research of Fennema-Sherman (1976) and Aiken and Dreger (1961).

Tapia and Moldavan (2007) investigated the attitudes toward mathematics of pre-calculus and calculus students. Students enrolled in the pre-calculus course were enrolled in the course because they did not meet the mathematics SAT scores in mathematics to enroll in calculus. Students who were enrolled in calculus course had a significantly higher self-confidence, enjoyment, and motivation than those enrolled in pre-calculus. No significant difference was observed between both groups perception of value in mathematics. Taylor (2008) used the Fennema-Sherman mathematics attitudes scale to collect data on first year college students' achievement in a computer based algebra course compared with a lecture style algebra course.

Taylor (2008) suggests that freshmen students taking a computer based algebra course had a significantly higher attitude in mathematics than students enrolled in the lecture based algebra course. Lipnevich, Krumm, MacCann, Burrus, and Roberts (2011) created a mathematics attitude questionnaire to study mathematics attitudes and outcomes. The longitudinal study included 382 13-year-old participants from five States. Achievement was measured using a mathematics skills assessment and was administered along with the mathematics attitude questionnaire. The results indicate that students with a positive attitude toward mathematics are more likely to have positive performance in mathematics than students with a negative attitude have.

Nisbet and Williams (2009) researched middle school students learning of probability and chance through games using five constructs based on both the Fennema and Sherman's (1976) scale and Tapia and Marsh's (2004) scale. The constructs used were enjoyment and interest, confidence, perception of usefulness of chance, anxiety, and motivation. The students' grades on tests following the games served as the achievement variable. Significance were found between students' attitudes and achievement. Students perceived the games as being fun along with their achievement scores being above average.

Ajzen and Fishbein (as cited in Nisbet and William, 2009) suggest that attitudes influence intentions, which influences behavior. Behavior then leads to experiences, which affects attitudes (see Figure 2). High mathematics performance is the desired experience for students, which makes attitudes toward mathematics an appropriate variable for predicting mathematics performance.

Nisbet and William (2009) assumed that students with a high achievement in mathematics will have a positive attitude in math. Students with a positive attitude toward mathematics will have higher mathematics achievement (Aiken and Dreger, 1961; Ma and Kisher, 1997; Tapia and Moldavan, 2007; Taylor, 2008). Ma and Kisher (1997) studied the reciprocal relationships between attitude toward mathematics and achievement in math. The participants for the study were 1,044 high schools students from the Dominican Republic. The results indicate that students with a positive attitude in mathematics are more likely to have a high achievement in mathematics and students with a high achievement in mathematics are more likely to have a positive attitude toward mathematics. The findings from Ma (1997) supports the attitude cycle found in figure 2.

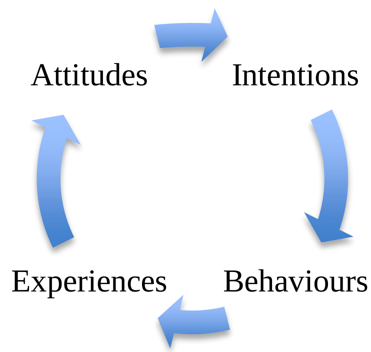

Figure 2. Attitude Cycle

Perry (2011) researched the attitudes of pre-service elementary teachers toward mathematics compared to the types of goals they possess. Performance goals had two categories, which are performance-approach and performance-avoid. Performance approach learners desire their performance to be judged where performance-avoid learners avoid placing themselves in a position to be judged. The research used three constructs taken from the Fennema-Sherman (1976) mathematics attitude scale. The constructs used were confidence in learning mathematics, mathematics as a male domain, and the usefulness of mathematics. The results indicate that pre-service teachers had a low confidence in math, view mathematics as a male domain, and find little use in mathematics. No significant relationship existed between the types of performance goal orientation the participants possessed and the negative attitude in mathematics.

This study is important to report due to the relationship between teachers' attitudes toward mathematics and the teacher influence of the FSMAS-SV that is used for data collection. This section has provided evidence that mathematics attitudes are a variable commonly used to predict performance in mathematics. The following section summarizes the chapter.

Chapter Summary

The literature review examined career and technical education, locus of control, and the mathematics attitudes. The career and technical education section provided a historical look at CTE through history by tracking technology changes observed in the Machinery's Handbook. The historical review provided evidence that we are in a time of major technological changes that will require the manufacturing sector to switch from a manual workforce to a technical mathematically skilled workforce. The locus of control section provided a historical background on the evolution of the study of locus of control and provided evidence that locus of control is a variable commonly used for predicting performance in a variety of fields of study and organizations. The mathematics attitudes section provided a historical background on study of mathematics attitudes and provided evidence that mathematics attitude is a variable commonly used for predicting performance in a variety of fields of studies and organizations. The following methodology presents the research design used for collecting data on variables for predicting mathematics performance.

CHAPTER III

METHODOLOGY

This chapter outlines how the research questions were answered. The chapter includes the research design, population of the study, sample of the study, data collection methods, variables, analytical methods, methodological limitations, and the chapter summary. The purpose of this study is to address extent to which locus of control and mathematics attitudes predict performance in mathematics. The study also addresses the extent mathematics performance differs by the field of study and if locus of control and mathematics attitudes are predictors for the differences. The following research questions guide the study:

Research question 1: To what extent does locus of control and mathematics attitudes predict field of study?

Research question 2: To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics?

Research Design

This research study uses a non-experimental, cross-sectional, predictive research design. The research is non-experimental because this study is looking for the relationship among two or more variables with data collected in the real world and not user experimental conditions (Creswell, 2009). The study is cross-sectional because it is looking at data through a snapshot in time (Field, 2010). The data collection process spanned over one semester during the fall semester of 2013. The predictive piece of the design is used to help examine predictive relationships in the study (Field, 2010). The non-causal design is appropriate because the researcher is addressing the extent that locus of control, mathematics attitudes, and mathematics preparation are predicting mathematics performance and field of study, which can also be researched non-experimentally.

Population and Sample

The population for this study is all students required to take intermediate algebra (MA 100) and college algebra with applications in science and technology (MA 104) at a rural State university. Intermediate algebra and college algebra with applications in science and technology are the minimum required mathematics courses for many two and four year programs at the rural State University. The rural State University has nearly 9,400 undergraduate and graduate students. The university was intentionally chosen for this research study because it also serves as a community college for the region. The university awards diploma, certificate, associate, bachelor, master, and educational specialist degrees and has over 180 offered programs. The closest community college is 60 miles away. Most students enrolled in the one and two-year programs are students from the local area because the closest community college is located over 60 miles away.

Students at this university take their preliminary classes together regardless of degree level. For the preliminary mathematics classes, students enrolled in CTE programs have a choice to take either MA 100 or MA 104 to fulfill the mathematics requirements within their specific program. Students enrolled in mathematics or science related programs are often required to take MA 104. Many programs not related to science and technologies most commonly have the minimum requirement of MA 100. The majority of students attending the university are required to take either MA 100 or MA 104. Having the majority of programs represented at a State university provided the study with a diverse population of programs

Sample

The sample is a non-probability purposeful sample. The sample is purposeful because the surveys were deliberately sent to specific courses within the participating institution (Field, 2010). The surveys were sent to all course sections of MA 100 and MA 104 at a rural State University during the fall semester of 2013. Considering there are five variables and one variable having five constructs, a minimum of 135 participants was needed. Over 280 surveys were distributed to get at least 135 participants. The surveys were sent electronically through each students Moodle account. One hundred and eighty two students completed the survey and are represent the population of all students who are required to take MA 100 and MA 104.

Data Collection

Mathematics performance was measured by attaining the participant's final grade within the course. The grades are collected as a continuous variable on a zero to four scale. The survey was administered using a survey tool within the university's Moodle platform. The participants completed the survey within Moodle that was linked to their final grade at the end of the semester. Moodle has the option to output the data anonymously by using numbers for each participant instead of names. To keep the study anonymous, the numbers issued to the students were not related to the students' identification number at the institution or any other personally identifiable information.

Survey Instrument

The data collection instrument is a survey containing categorical and concept levels of measurement. Two concept data measurement scales. The first concept scale is the Rotter (1966) 29-item locus of control scale. Locus of control is the independent variable for research question one and is a variable in predicting field of study and mathematics performance. The 29-item locus of control scale has two statements for each item. The participants were asked to choose the statement that most applies to their beliefs. Of the 29 items, 6 filler items are not scored. The filler items are added to the scale to make the purpose of the test somewhat ambiguous (Rotter, 1966). The remaining 23 items were scored from the participant's statement choice. The participants received one point for each question that applies toward internal locus of control. The higher the score, the farther the participant is from having a high external locus of control and the closer to having a high internal locus of control. The Rotter (1966) locus of control scale was tested for validity and reliability between 1961 and 1966 using 2,200 college age participants and was found to be both valid and reliable. The validity and reliability of the Rotter (1966) locus of control scale has been verified by several studies (Lange & Tiggemann 1981; Zerega, Teseng, & Greever 1975). The Cronbach's alpha score for the scale is .714 (Rotter, 1966).

The second concept scale is the shortened version of the Fennema-Sherman Mathematics Attitudes Scale (Mulhern & Rae, 1998). The FSMAS-SV was designed to collect data using six constructs. Each construct has an independent Cronbach's alpha score at or exceeding .85. The Mathematics as a male domain construct was not used, as this research is not focusing on gender. The five constructs used in this study are attitude toward success in mathematics, parents' attitudes, teachers' attitudes, mathematics related affect, and usefulness in mathematics. Mulhern and Rae (1998) tested the FSMAS-SV for validity and reliability using 196 participants from a secondary school in Ireland and found the scale both valid and reliable. The Cronbach's alpha for the constructs of the Mulgern and Rae (1998) FSMAS-SV are Attitude Toward Success in Mathematics .870; Parents' Attitudes .900; Teachers' Attitudes .790; Mathematics Related Affect .930; and Usefulness in Mathematics .880.

Each construct is made up of positive and negative related statements. Five response alternatives follow each statement, which are strongly agree, agree, undecided, disagree, and strongly disagree. The response that corresponds to a positive response receives a score of five, and the negative response scores a one. The cumulative response score determines students' attitude toward mathematics from a range of positive to negative. A low score represents a negative attitude and a high score represents a positive attitude.

Asking students to choose their field of study from a list collected the field of study data. Mathematics preparation data were collected using a question on whether the participant has taken remedial mathematics and highest level of mathematics completed in high school. The remaining questions include variables such as age, college level, if the student authorized their final grade to be used in the study, and if the student agreed to participate in the research.

Variables

There are four independent variables and two dependent variables in this study. This section lists the variables in reference to each research question. The second section describes the dependent variables and the third section describes the independent variables.

Research question 1: To what extent does locus of control and mathematics attitudes predict field of study? The independent variable for this question is locus of control and mathematics attitudes. The dependent variable is field of study. Table 3 describes the relationship between the variables and the survey instrument.

Research question 2: To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in math? The independent variables for this question are locus of control, mathematics attitudes, field of study, and mathematics preparation. The dependent variable is mathematics performance.

Table 3. Relationship between Variables and Survey Items

Variable Name	Description of Items on Survey
Dependent Variable: Mathematics Performance	Measures the degree to which students perform in the mathematics course.
Dependent Variable: Field of Study	Used to identify the participants field of study at the university.
Independent Variable: Locus of Control	Measures the degree of a person's perception on the type of control he or she possesses, but locus of control is not in the conscious awareness for the individual. People fall along a continuum from completely internal to completely external (Rotter, 1966).
Independent Variable: Mathematics Attitudes	Combined five constructs below to determine mathematics attitudes.
Attitudes Toward Success in Mathematics	Measures the degree to which students anticipate positive or negative consequences as a result of success in mathematics (Fennema & Sherman, 1976).
Parents' Attitudes	Measures the degree to which the students' perception of their parents' interest, encouragement, and confidence in the students' ability (Fennema & Sherman, 1976).
Teachers' Attitudes	Measures the degree to which students' perceptions of their teachers' attitudes toward them as learners of mathematics (Fennema & Sherman, 1976).
Mathematics-related Affect	Measures the degree to which students' confidence in ones ability to learn mathematics; Feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics; and the affectance as applied to mathematics (Fennema & Sherman, 1976).
Usefulness of Mathematics	Measures the degree to which students' beliefs about the usefulness of mathematics and in relationship to their future education, vocation, or other activities (Fennema & Sherman, 1976).
Independent Variable: Mathematics Preparation	Measures the highest level of mathematics the participants completed in high school.
Independent Variable: Field of Study	Used to identify the participants field of study at the university.

Mathematics performance was used as the dependent variable for questions two. Mathematics performance data were collected by the professor for each of the mathematics courses used in the study. The grades were collected at the end of the semester using a continuous scale that ranges from zero to four. Field of study is the dependent variable for question one was collected using a self-reporting question on the survey.

Data Analysis and Interpretation

The research questions of this study are listed and the analytical methods to answer the questions are explained in the following sections.

Research Question One

To what extent does locus of control and mathematics attitudes predict field of study?

Question one has several independent variables and one dependent variable. The independent variables for question one are locus of control and mathematics attitudes. The dependent variable is field of study. Field (2009) suggests when having one categorical dependent variable and two continuous independent, a logistic regression is the appropriate test used to analyze the data. The logistic regression measures the relationship between categories of field of study and the continuous predictor variables locus of control and mathematics attitudes. The logistic regression is analyzed using SPSS software.

Research Question Two

To what extent does locus of control, attitudes toward mathematics, field of study, and mathematics preparation predict performance in mathematics?

The independent variables for research question one are locus of control, attitudes toward mathematics, field of study, and mathematics preparation. The dependent variable is performance in mathematics. Field (2009) suggests using a multiple regression when having one continuous dependent variable and two or more continuous and/or categorical variables. Locus of control and attitudes toward mathematics are continuous independent variables, field of study and mathematics preparation are nominal categorical variables and mathematics performance is a continuous dependent variable. A multiple regression is used to analyze question one. The multiple regression test explains the relationship between two or more independent variables and a single dependent variable (Field, 2009). The multiple regression is analyzed using SPSS software.

Table 4. Statistical Description of Research Questions

Nature of Question	Number of Independent Variables	Number of Dependent Variables	Type of Score Independent/ Dependent Variables	Statistical Test
Relate the Variables	2 or more (Locus of Control and Mathematics Attitudes)	1 (Field of Study)	Continuous (Concept)/ Categorical (Nominal)	Logistic Regression
Relate the Variables	2 or more (Locus of Control, Mathematics Attitudes, Mathematics Preparation, Field of Study)	1 (Mathematics Performance)	Continuous (Concept), Categorical (Nominal)/ Continuous (Interval)	Multiple Regression

Methodology Limitations

Several limitations exist in the research study. First, the sample is a small percentage of the CTE population and may not translate to other universities. Second, locus of control and attitudes toward mathematics are two aspects that could contribute to the level of performance in math. Locus of control and attitudes toward mathematics are not looking at all variables that could be affecting performance. This study seeks to determine whether locus of control, attitudes toward mathematics, and mathematics preparation are predictors for performance in math, does not suggest why they are or are not a predictor. Lastly, studying the population of a rural Midwest State university is unique and does not translate to most of the population across the United States. If the participants are primarily from the Midwest region of the U.S., the sample may not translate to other populations.

Chapter Summary

To improve mathematics performance, predictors for mathematics performance must be identified. This research study uses a non-experimental, cross-sectional, predictive research design. The non-causal design is appropriate because the researcher is addressing the extent locus of control, mathematics attitudes, field of study, and mathematics preparation are predicting mathematics performance. Also, the research addresses the extent locus of control and mathematics attitudes predicts field of study. The population for this study is all students enrolled in intermediate algebra (MA 100) and college algebra with applications in science and technology (MA 104) at a State university and the sample is a non-probability purposeful sample. The sample is purposeful because the surveys are deliberately sent to specific courses within the participating institution (Field, 2010). A survey tool within Moodle was used to collect data along with a report from Moodle for final grades.

The foundation of this research is based on two questions. The first question is, to what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predicts performance in math? The independent variables for this question are locus of control, mathematics attitudes, field of study, and mathematics preparation. The dependent variable is mathematics performance. The second question is, to what extent does locus of control and mathematics attitudes predict field of study? The independent variable for this question is locus of control and mathematics attitudes. The dependent variable is field of study. The analytical methods for this research include a multiple regression and a logistic regression.

CHAPTER IV

PRESENTATION OF RESULTS

The purpose of this study was to address the extent to which locus of control and mathematics attitudes predict field of study. The study also addresses the extent locus of control, mathematics attitudes, field of study, and mathematics preparation predicts performance in mathematics. This chapter presents the results from the analysis presented in chapter three. The following research questions guide the study:

Research question 1: To what extent does locus of control and mathematics attitudes predict field of study?

Research question 2: To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics?

Descriptive Statistics

A total of 184 students submitted a survey for this research study. Five participants were removed from the study because they selected “no” on the survey in regard to the researcher using their data. Three others were removed from the study due to incomplete survey responses. The final number of participants used in analyzing the first research question is 176. Final grades were collected at the end of the semester. Thirteen participants had dropped the course during the semester. The number of participants for the second research question is 163. Raw data were exported from the survey tool within the Moodle system and opened in SPSS statistical analysis software. Descriptive statistics were analyzed and all variables were checked for normality, skew, and kurtosis. Skew and kurtosis required no adjustment. Outliers were calculated by subtracting and adding three times the standard deviation from the mean score. A total of three outliers were adjusted for attitude toward success in mathematics on the minimum and four outliers were adjusted for usefulness of mathematics on the minimum. All outliers were brought to the minimum of the calculated three times less the standard deviation for each variable. Upon correcting for outliers, descriptive statistics were analyzed for mean, standard deviation, skewness, and kurtosis. Again, no corrections were needed.

The participants self-reported their highest mathematics course completed in high school and can be viewed in Table 5. The participants' highest level of mathematics in high school was used to measure mathematics preparation. The frequencies for high school mathematics preparation were combined into three categories of low, medium, and high. The combined mathematics preparation frequencies can be viewed in Table 6. The courses that make up the low mathematics preparation category are lower than algebra I, algebra I, and algebra II. The courses that make up the medium mathematics preparation category are geometry, trigonometry, and pre-calculus. The courses that make up the high mathematics preparation category are calculus and higher than calculus. 60% of the participants had medium mathematics preparation, which is similar to the national statistics of college freshmen, while only 4% had higher mathematics preparation.

The participants reported their field of study by choosing from a list of majors. The list of majors reported can be found in Table 5. Four categories are used for field of study, which are technical associate's degrees, all associate's degrees, non-technical associate's degrees and bachelor's degrees combined, and bachelor's degrees. The frequencies for the combined categories of field of study can be found in Table 6. The technical associate degree category is made up of the automotive associate's, welding certificate, mechanical design associate's, industrial maintenance associates, CNC associate's, electrical related associate's, other technical associate's and aviation associates.

Table 5. Frequencies of Categorical Independent and Dependent Variables Detailed

Variable	Frequency (n)	Percent
High School Mathematics Preparation		
Lower than Algebra I	6	3.4
Algebra I	12	6.8
Algebra II	45	25.6
Geometry	28	15.9
Trigonometry	35	19.9
Pre-Calculus	43	24.4
Calculus	6	3.4
Higher than Calculus	1	.6
Field of Study		
Automotive Associates	2	1.1
Welding Certificate	3	1.7
Mechanical Design Associates	1	.6
Industrial Maintenance Associates	11	6.3
CNC Associates	3	1.7
Electrical Related Associates	4	2.3
Other Technical Associates	5	2.8
Aviation Associates	1	.6
Other Associates	33	18.8
Art and Design Bachelors	5	2.8
EET Tech Bachelors	1	.6
MET Tech Bachelors	11	6.3
Mathematics Related Bachelors	6	3.4
Other Bachelors	84	47.7

Table 6. Frequencies of Categorical Independent and Dependent Variables Combined.

Variable	Frequency (n)	Percent
High School Mathematics Preparation		
Low	63	35.8
Medium	106	60.2
High	7	4
Field of Study for Question 1 T-Tests		
Technical Associate’s Degrees	30	17.6
All Except Technical Associate’s Degrees	140	82.4
Field of Study for Both Regressions		
All Associate’s Degrees	63	37.1
Bachelor’s Degrees	107	62.9

The mean and standard deviation of the continuous variables can the found in Table 7. Following will be an explanation of all continuous variables. The first continuous variable is locus of control, which describes the perceived control a person possesses and is measured on a continuum from internal to external. The mean score for locus of control of 11.06 suggests the participants had a neutral locus of control. All scores above 11.5 represents an external locus of control while scoring below an 11.5 represents an internal locus of control. The closer the score is to zero, the higher the internal locus of control. The closer the score is to 23, the higher the external locus of control.

The second continuous variable is attitude toward success in mathematics, which measures the participants’ attitude toward their success in mathematics. The mean score for the participants' attitude toward success in mathematics is 34.25. The highest score of 45 represent the participants' having a positive attitude and the low score of 9 would represent a negative attitude. A mean of 34.25 describes the participants as being positive on the average in their attitudes toward being successful in mathematics.

The third continuous variable is parents' attitude, which measures the students' perceptions of their parents' attitude toward mathematics. The mean score of the participants' perception of parents' attitudes is 33.67. The highest score of 45 would represent the participants' having a positive perception of their parents' attitudes and the low score of 9 would represent a negative perception. A mean score of 33.67 describes the participants as having a positive leaning perception of their parents' attitudes toward mathematics.

The fourth continuous variable is teachers' attitudes, which is the students' perceptions of their teachers' attitudes toward the students. The mean score of participants' perception of their teachers' attitudes is 20.47. The highest score of 30 would represent a positive perception of a teachers attitudes and a score of 6 would represent a negative perception of a teachers attitudes. A mean score of 20.47 describes the participants as perceiving teachers as being slightly positive.

The fifth continuous variable is mathematics related affect, which measures the affect mathematics has on students' attitudes. The mean score for mathematics related affect is 30.90. The highest score of 50 would represent a positive affect mathematics has on participants' attitudes and a low score of 10 would represent a negative affect. A mean score of 30.90 would describe mathematics not having a positive or negative affect on the participants' attitudes.

The sixth continuous variable is usefulness of mathematics, which measures the students' perception of the usefulness of mathematics. The mean score for usefulness of mathematics is 29.20. The highest score of 40 would represent a positive attitude toward the usefulness of mathematics and the low score of eight would represent negative attitude. A mean score of 29.2 describes the participants' as having a slightly positive attitude toward mathematics being useful.

The seventh and last continuous variable is mathematics performance, which measures the students' performance in a mathematics course. The mean score for mathematics performance is 78.18. The highest score of 100 would represent the highest performance and the lowest score of zero would represent the lowest performance. On a standard grading scale, the mean score of 78.18 would describe the performance as a C+, which is just above average.

Table 7. Descriptive Statistics of locus of control, attitudes toward mathematics, and performance in mathematics.

	N	Mean	SD	Min	Max	Skewness	Kurtosis
Locus of Control	176	11.06	3.61	2.00	20.00	-0.04	-0.49
Attitude Toward Success in Math	176	34.25	4.86	19.70	45.00	-0.11	-0.13
Parents Attitude	176	33.67	6.3	18.00	49.00	0.18	-0.18
Teachers Attitude	176	20.47	3.93	9.00	30.00	-0.32	0.01
Mathematics Related Affect	176	30.90	9.13	11.00	50.00	-0.18	-0.77
Usefulness of Math	176	29.20	6.44	9.75	40.00	-0.68	0.13
Mathematics Performance	163	78.18	13.26	39.00	97.00	-.694	-.171

Research Question 1.

To what extent does locus of control and mathematics attitudes predict field of study?

A logistic regression test was conducted with the binary categorical dependent variable of field of study. The logistic regression was conducted to determine whether mathematics attitudes and locus of control is a predictor in the students' choice of a technical major. The two categories are all technical CTE associates degree students and all other degree students. The independent variables are the five constructs of mathematics attitude and locus of control.

Although significant results in several constructs were identified, the logistic regression model statistic was not significant. The number of CTE participants for the initial regression was 30. The low number of CTE participants caused the total predicted percentage of the regression to be zero. If a predicted percent of a logistic regression is zero and the -2 log likelihood is low, the regression has a bad model fit, and the regression cannot be used. The independent variables did not explain the choice of field of study. The bad model fit was due to the low number of technical associate's degree participants.

Due to the bad model fit of the initial regression, t-tests were used to analyze field of study against each construct of mathematics attitudes and locus of control. The dummy variable categories used for the t-tests were technical CTE associates and all other degrees. The results of the t-tests suggest a significant difference in attitude toward success in mathematics between students enrolled in technical CTE associates degree program (M = 32.17, SD = 4.73) and students enrolled in all other degrees (M = 34.74, SD = 4.84); t (168) = -2.65, p = .009. These results suggest that students with a lower attitude toward success in mathematics are more likely to enroll in a technical CTE associates program than students enrolled in all other degrees. No significant differences between the CTE students and other degree students in terms of the other mathematic constructs and locus of control.

Table 8. Mathematics Attitudes and Locus of Control Between Technical CTE and all other Students

	CTE Students	All Other Students	*t*	df
Locus of Control	10.73 (3.52)	11.01 (3.64)	-.386	168
Attitude Toward Success in Math	32.17 (4.73)	34.74 (4.84)	-2.65**	168
Parents Attitude	32.07 (5.85)	34.16 (6.35)	-1.66	168
Teachers Attitude	20.60 (2.86)	20.51 (4.15)	.117	168
Mathematics Related Affect	29.57 (9.43)	31.25 (9.15)	-.910	168
Usefulness of Math	30.13 (5.54)	29.03 (6.58)	.854*	168

Note. ** = $p < .01$. Standard Deviations appear in parentheses below means.

Table 9. Logistic Regression results of locus of control and attitudes toward mathematics against the dependent variable field of study.

Variable	Odds Ratio	SE
Locus of Control	1.04	0.05
Attitude Toward Success in Math	0.94	0.04
Parents Attitude	0.95	0.03
Teachers Attitude	1.07	0.05
Mathematics Related Affect	1.02	0.02
Usefulness of Math	1.01	0.03
-2 Log Likelihood = 216.04, Percentage Predicted = 59.4		

*** = $p < .01$, ** = $p < .05$

An additional logistic regression was conducted with a different field of study dummy variable. Instead of using only technical CTE associates students, all associate degree students were used. There were several reasons for conducting a second logistic regression combining all associates degree student. First, due to a low number of technical associates degree participants a bad model fit existed in the first regression. Second, analyzing predictors for students who choose associate's degrees over bachelor's degrees could have provided similar results to what the original methodology was designed. The binary dependent variable used in the regression was field of study. The two categories within field of study were associate degree students and bachelor degree students. The logistic regression test was used to analyze the continuous independent variables against the binary categorical dependent variable. The binary categorical variable is field of study. The binary categories within the field of study are all associates degree students and all other majors.

The independent variables are locus of control, attitude toward success in math, parents attitude, teachers attitude, mathematics related affect, and usefulness of math. The -2 log likelihood was 216.04 and the percentage predicted was 59.4%. The predicted percentage suggests that the model predicts 59.4% of students' choice of field of study. Although the second regression had an improved model statistic, the percent predicted of 59.4% is still not much better than the initial regression and does not accurately predict field of study. No significance was found in any of the predictor variables. The odds ratio for each construct of mathematics attitudes and locus of control are near one. An odds ratio of one suggests each independent variable is not a significant factor in predicting of a students' field of study. Therefore, mathematics attitudes and locus of control may not be the established concern in selecting field of study.

Research Question 2.

To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics?

Before running the regression, the assumptions of a multiple regression were checked. Linearity was analyzed and no corrections were needed. Next, the regression was conducted and homoscedasticity was tested within the regression by examining the error term and no relationship was found between the predicted Y against the residual variable. The adjusted R^2 value suggests that all independent variables account for 11.4% of the variation in the participants' performance in mathematics. The F score for the regression was found significant and is 3.235. The F score suggests the regression has a high significance level ($p = .001$) in predicting performance in mathematics.

Teachers' attitudes, mathematics related affect, and low mathematics preparation had a significant relationship with mathematics performance. The beta for teachers' attitude is .587, which means when students' perceptions of teachers' attitudes are increased by one, mathematics performance is increase by .587. The beta for mathematics related affect is .261, which means when the affect mathematics has on participants' attitude is increased by one in the positive direction; mathematics performance will increase by .261. The beta for low mathematics preparation is -14.14, which means a decrease of one in mathematics preparation will result in a 14.14-point reduction in mathematics performance. The teachers' attitudes and mathematics related affect independent variables had a medium to low significance value. Teachers' attitude has a significance of $p = .060$ and mathematics related affect has a significance of $p = .058$. Having low mathematics preparation had a high significant relationship with a significance of $p = .006$. Locus of control, attitude toward success in mathematics, usefulness of mathematics, and field of study has no significance in predicting mathematics performance.

Table 10. Locus of Control, Mathematics Attitude, Field of Study, and Mathematics Preparation in Relation to Mathematics Performance

Variable	Beta	SE
Locus of Control	-0.012	.278
Attitude Toward Success in Math	-0.006	.231
Parents Attitude	-0.068	.194
Teachers Attitude	0.587*	.309
Mathematics Related Affect	0.261*	.137
Usefulness of Math	-0.230	.182
Field of Study	4.154	2.632
Mathematics Preparation (High Level Excluded)		
Low	-14.14***	5.107
Medium	-7.501	4.839
Adj R^2 = .114, F = 3.235***		

*** = $p < .01$, ** = $p < .05$, * = $p < .10$

A second multiple regression was conducted excluding mathematics preparation from the list of independent variables. A second regression without mathematics preparation was ran because if attitudes are negatively affected by mathematics, students are less likely to enroll in mathematics courses that are not required. Enrolling in fewer mathematics courses would lower a participants' mathematics preparation. When mathematics preparation is left out of the regression, the significance level of mathematics related affect increases. The increase in significance shows a relationship between mathematics related affect and mathematics preparation.

Chapter Summary

The purpose of this study is to address extent to which locus of control and mathematics attitudes predict field of study and the extent locus of control, field of study, mathematics attitudes, and mathematics preparation predicts performance in mathematics. Two research questions were addressed in the study.

A logistic regression analyzing question one showed that locus of control and mathematics attitudes were not predictors of students' field of study choice. No significance was found in any of the predictor variables within the regression. Therefore, mathematics attitudes and locus of control may not be the established concern in selecting field of study. A t-test was also used to further analyze the first research question. CTE students were significantly different from other students in terms of attitude toward success in mathematics, but not in terms of all other mathematics attitude constructs and locus of control. The results of the t-tests suggest a significant difference in attitude toward success in mathematics between students enrolled in technical CTE associates degree program and students enrolled in all other degrees. These results suggest that students with a lower attitude toward success in mathematics are more likely to enroll in a technical CTE associates program than students enrolled in all other degrees are.

Using a multiple regression, the second question showed that teachers' attitudes, mathematics related affect, and low mathematics preparation were significant in predicting performance in mathematics. The results show that increasing students' perceptions of teachers' attitudes, mathematics preparation, and mathematics related affect increases mathematics performance. Locus of control, attitude toward success in mathematics, usefulness of mathematics, and field of study do not significantly predict mathematics performance.

The following chapter will provide a detailed analysis of the results presented in this chapter. The following chapter will include an analysis of each research question individually and the implications of the complete results as they pertain to practice, theory, and policy. The limitations and implication for future research will also be discussed.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Summary, Implications, and Interpretations of Findings

A skills gap exists between unemployed workers and jobs available for skilled technical labor. One of the stated reasons for the lack of skilled technical workers is the decrease in the number of high school graduates that attend career and technical education (CTE) programs (Gaunt, 2006). Mathematics is becoming increasingly important for careers that once did not require the use of mathematics (Castelano, 2003). The emphasis on four-year academic institutions has limited the amount of students enrolled in CTE programs. Students who are interested in CTE programs are generally those with low mathematics performance (Arnold 2012; Boodhoo, 2012; Levesque & Hudson, 2003). According to the U.S. Secretary of Education Arne Duncan, mathematics scores for fourth graders have not increased from 2007-2009, and eighth graders only increased slightly by two-points from 2007-2009. Mr. Duncan issued the following statement “Today’s results are evidence that we must better equip our schools to improve the knowledge and skills of America’s students in mathematics” (U.S. Department of Education, 2009, p. 1).

Companies have started training students in-house due to the lack of students graduating from CTE programs. These manufacturers are having difficulties with these training programs because of the low mathematical abilities of their employees (Arnold, 2012). The best way to increase the supply of highly skilled manufacturing employees is to understand the mathematics attainment problem in relation to these students. This research identifies predictors related to mathematics performance. Understanding these predictors will help develop policies to solve the problem.

This research used a non-experimental, cross-sectional, predictive research design. The purpose of this study was to identify predictors for students' field of study choice and performance in mathematics. The predictor variables used in the study were field of study, locus of control and five mathematics attitudes variables, which are attitudes toward success in mathematics, parents' attitudes, teachers' attitudes, math related affect, and usefulness of mathematics. The research examined the extent that locus of control and mathematics attitudes predicted field of study. Also, the research examined the extent that locus of control, mathematics attitudes, field of study, and mathematics preparation predicted performance in mathematics. Data were collected from all students enrolled in first year math courses at a rural university. The previous chapters discussed fully the methodology used to conduct the research and the quantitative results from the analysis. The following section will discuss the results of each research question. Also in this section, the implications for practice, policy, and theory will be presented. Following the implications for practice, policy, and theory, the limitations and implications for future research will be presented. The conclusion is the last section of this chapter.

Research Question 1: To what extent does locus of control and mathematics attitudes predict field of study?

The first research question was intended to identify whether perception of control and attitudes toward mathematics are predictors for students' choice of field of study. Locus of control was measured using the Rotter (1966) 29-point locus of control scale and mathematics attitudes was measured using the Mulhern and Rae (1998) mathematics attitude scale. The locus of control scale is one construct where the Mulhern and Rae scale includes five constructs: attitudes toward success in mathematics, parents' attitudes, teachers' attitudes, mathematics related affect, and usefulness of mathematics. Field of study was measured by having participants select their field of study from a list of majors offered at the university. The predictor variables for question one are the five constructs of attitudes toward mathematics and locus of control. The outcome variable for research question one is field of study. Mathematics attitudes and locus of control were found not be the established concern in students' selecting field of study.

The results contradict much of the research on locus of control, which has been found to be significantly lower in students that choose degrees lower than bachelor's and perform poorly academically. Students who are interested in CTE programs are often those with low mathematics performance (Arnold 2012; Boodhoo, 2012; Levesque & Hudson, 2003). Many manufacturers are having difficulties with in-house training programs because of low mathematic abilities of the employees seeking technical training (Arnold, 2012). Statistically, students with a lower high school grade point average (GPA) are more likely to attend a two-year career and technical education programs compared to students with a higher high school GPA (Levesque & Hudson, 2003). This study did not align with current research that students with lower academic abilities are found to choose lower than bachelor's degree programs.

Levinson (1981) found that locus of control had no significance for academic achievement; however, students with an internal locus of control had greater learner satisfaction. Learner satisfaction has been found to be a significant predictor for achievement and locus of control was found to predict learner satisfaction. Indirectly then, having an internal locus of control will predict achievement because students with an internal locus of control had greater learner satisfaction, which increases achievement. Based on Levinson (1981), the constructs of attitudes toward success in mathematics and mathematics related affects were related to learner satisfaction and based on research, a relationship should have been observed between associate's degree students and bachelor's degree students because associate's degree students perform generally lower academically. Also, students who had a positive attitude toward a subject are more likely to perform well academically. Although most of the research is based on achievement, CTE students had been found to have significantly lower academic performance. Considering, CTE students had been found to perform lower academically and those who perform lower academically had been found to have a higher external locus of control, it can be assumed that CTE students had a high external locus of control. Looking at the research, CTE students had a higher external locus of control, lower attitudes toward academics, and are less likely to excel academically. Significance should have been observed between both locus of control and attitudes toward math and field of study. One reason this study does not represent what much of the research suggests concerning locus of control and attitudes toward mathematics could be the low number of CTE participants in this study.

To further analyze question one, t-tests were used to analyze field of study against each construct of mathematics attitudes and locus of control. Significance was found between attitude toward success in mathematics and field of study. Students' with a lower attitude toward success in mathematics are more likely to enroll in a technical CTE associates program than students enrolled in all other degrees. The significance in CTE students having a negative attitude toward their success in mathematics mirrors much of the research on attitudes toward mathematics and field of study and is what would be expected from analyzing attitudes and degree choices. Although a significance was present with attitudes toward success in mathematics and field of study, no significant differences between the CTE students and other degree students in terms of the other mathematic constructs and locus of control.

Research Question 2: To what extent does locus of control, mathematics attitudes, field of study, and mathematics preparation predict performance in mathematics?

The second research question was intended to identify whether locus of control, attitudes toward mathematics, field of study, and mathematics preparation are predictors for students' performance in mathematics. Students' success in their first mathematics course in college plays an important role in the success of a student academic career. A successful mathematics course for a first year college student has been found to retain students at the university and had higher graduation rates (Moses, Hall, Wuensch, Urquidi, Kauffman, Swart, Duncan, & Dixon, 2011). Seeing that universities are striving to explore strategies to retain students, this study provides evidence for predictors for performance in mathematics, which is known as an indicator for student retention and graduation rates. The predictor variables for question two are the five constructs of attitudes toward mathematics, locus of control, field of study, and mathematics preparation. The outcome variable for question two is performance in mathematics. The model for question two was found to be significant in predicting students' performance in mathematics. Specifically, teachers' attitudes, mathematics related affect, and low mathematics preparation has a significant relationship with mathematics performance. Locus of control, attitudes' toward success in mathematics, usefulness of mathematics, field of study, and parents' attitudes were not found to predict performance in mathematics.

The result of teachers' attitudes being significant with performance in mathematics aligns with existing research on attitudes. Ma and Kisher (1997) suggest that attitudes toward mathematics had a significant effect on achievement in mathematics the higher the positive attitude the higher the achievement. Aiken and Dreger (1961) researched the effect attitudes toward mathematics had on college students' performance in mathematics. The results indicated that a positive attitude in mathematics predicts mathematics achievement. Also, the results indicated that previous experiences with mathematics teachers provide the best predictor for a students' attitude toward mathematics. Positive attitudes exist when a student has a positive experience with mathematics teacher. Students with negative mathematics teacher experiences tend to have a negative attitude toward mathematics.

Mathematics related affect was found to be significant in predicting students' mathematics performance. When the affect mathematics has on participants' attitude is increased, mathematics performance will increase. The significance of this construct is consistent with previous research on attitudes toward mathematics. As stated above, Ma and Kisher (1997) suggest that attitudes toward mathematics had a significant effect on achievement in mathematics the higher the positive attitude the higher the achievement. The interesting piece of the mathematics related affect construct being significant is the attitude toward success in mathematics construct was not significant. Mathematics related affect asks questions concerning the students' feeling while they are exposed to mathematics and attitude toward success asks similar question as to how the students feel when they succeed or fail in mathematics. Learner satisfaction has been found to be a significant predictor for academic achievement (Joo, Lim, & Kim, 2013). Both mathematics related affect and attitudes toward success in mathematics are related to learner satisfaction yet mathematics related affect was found to be significant and attitudes toward success in mathematics were not. Hadsell (2010) concluded that the desire to be viewed as a middle or upper level student helps increase performance which provides further evidence that attitudes toward success in mathematics should have been significant in predicting performance. In this study, students' desire to be viewed as an upper level student was not significant.

Mathematics preparation was found to be a significant predictor for mathematics performance. Students who had taken fewer rigorous high school courses had a significantly lower performance in mathematics at the college level. This was the highest level of significance and the one construct that was not surprising to see significant in predicting performance in mathematics. Students who have a higher preparation level should perform better than those with lower preparation. When looking at the other constructs where significance was observed, both teachers' attitudes and mathematics related affect have been found to be predictors in students' academic performance (Aiken & Dreger, 1961; Joo, Lim, & Kim, 2013; Ma & Kisher, 1997). If students have a negative attitude toward their mathematics teachers and a negative attitude when exposed to mathematics, the students are less likely to enroll in advanced mathematics courses not required. Lower attitudes in mathematics are found to predict lower performance, which in turn leads to less preparation. A second multiple regression was ran excluding mathematics preparation from the list of independent variables. A second regression without mathematics preparation was ran because if attitudes were negatively affected by mathematics, students are less likely to enroll in mathematics courses that are not required. Enrolling in fewer mathematics courses would lower a participants' mathematics preparation. A relationship was found between mathematics related affect and mathematics preparation. A significance in mathematics preparation being a significant predictor for mathematics preparation was the least surprising variable to see significance although possibly the most important when enrolling students with low mathematics preparation at a university. Students with low mathematics preparation should have a support system in place at the university to retain the student.

Locus of control, attitude toward success in mathematics, usefulness of mathematics, and field of study has no significance in predicting mathematics performance. The lack of significance in each of these constructs is significant because it defies the results of previous research. Locus of control was found not to be a predictor mathematics performance. The results of this study do not align with the majority of the existing literature on locus of control and academic performance. Although several studies had found a significant relationship between locus of control and academic performance, Daniels and Stevens (1976) suggest that locus of control is one measure to predict academic performance; however, locus of control alone will not predict performance. Perhaps locus of control is a factor in predicting performance and the research model should have included a different or additional variable.

Another interesting connection with the non-significant locus of control variable is the connection with the teachers' attitude construct that was found to be significant in predicting mathematics performance. The questions within the teachers' attitude construct had an external and internal style question similar to the Rotter (1966) scale. A high score within the construct has a similarity to an internal locus of control and a low score is similar to an external locus of control. It was suspected that if either teachers' attitude or parents' attitude were significant in predicting performance in mathematics, locus of control would also be significant because of the control relationship between the constructs. Also, if both predictor variables were significant, could be why both were not found to be significant. Several studies had looked at the relationship between locus of control and attitudes toward math and had found that students who posses an internal locus of control do not have a significantly different attitude toward mathematics than a student who possesses an external locus of control (Ifamuyiwa & Akinsola, 2008). Although the study does not support the idea that certain elements of mathematics attitudes should be consistent with that of locus of control, Ifamuyiwa and Akinsola (2008) did not look at attitudes that deal with outside influences as this study did.

No significance was found in field of study predicting mathematics performance. This was another outcome that does not correlate with existing literature on field of study and academic performance. Statistically, students with a lower high school grade point average (GPA) are more likely to attend a two-year career and technical education programs compared to students with a higher high school GPA (Levesque & Hudson, 2003). It is important to understand the problem and identify the implications this research has on practice, policy, and theory. The last two sections had provided details on each research question individually. The next two sections will provide details on the implications for practice, policy, and theory in reference to the findings of this research study.

Implications for Practice and Policy

This section will provide details on the implications the results has on practice and policy. The results of this research suggest four areas of importance. Each will be discussed below along with the implications for practice and policy of each area of importance. This research identifies predictors related to mathematics performance. Understanding these predictors will help develop policies to the problem. The implications for policy based on the results are ultimately about all students being successful in mathematics. The introduction of this study referenced the skills gap between the high unemployment rate and the thousands of skilled jobs that remain available. Unemployed workers do not have the skills needed to fill the U.S. manufacturing positions because of the switch from low skill repetitious work, to work requiring technology and mathematics skills. Companies have started training students in-house due to the lack of students graduating from CTE programs. These manufacturers are having difficulties with these training programs because of low mathematic abilities of their employees (Arnold, 2012). Thus, companies are providing high support for CTE programs at post-secondary institutions, which have the ability to remediate mathematics skills. However, a huge problem is attracting students that are interested in technology positions and have the mathematical abilities to complete the courses work (Arnold, 2012). Several implications exist based on the finding of this research that are directly related to the needs of U.S. manufacturing.

The first implication for practice and policy is connected with two areas of significance. Students enrolled in CTE programs have a low attitude toward success in mathematics and students with a negative mathematics related affect perform significantly lower than students with a positive mathematics related affect. Both areas of significance have a similar implication for practice and policy, which will be discussed as one implication with two areas of significance found in this study. The implication for practice and policy will be the implementation of mathematics courses offering sections that include experiential learning. First, details of the negative attitude toward success in mathematics will be discussed followed by the details of mathematics related affect.

The idea that students are entering a technical field such as CNC programming with a negative attitudes toward success in mathematics is alarming because CNC programming requires constant use of math. High-level mathematics will help students program more difficult parts. If mathematics courses were taught using experiential learning, students may understand the practical application of mathematics and increase student engagement. The increased student engagement could help students' performance level, thus, increasing attitudes toward success in mathematics. It would not require the mathematics teachers to become CNC programmers or to organize a mathematics lab. Rather, partnerships could be created to have a mathematics laboratory instructor that takes the concepts learned in lecture and create practical application where the concepts could be used. The mean score of attitudes toward success in mathematics suggests that students have a low attitude toward success in mathematics.

The idea of having an experiential learning is not a new concept in CTE, many programs exist across the U.S. that incorporate mathematics into a building trades or machining courses. The only difference is the mathematics department changing their structure to incorporate a experiential learning instead of experiential courses like CTE programs incorporating mathematics. Mathematics is a practical subject that has value in completing tasks, yet students' have negative attitudes toward success in mathematics. People who love mathematics are satisfied with the end result of finishing a mathematics problem, where others are not satisfied until the solution can be used in an application. Many mathematics teachers lecture students about how amazing it is that a formula can be solved when others do not get satisfaction from the solution of a formula. Considering the amount of students that perceive mathematics as having no practical application, the way mathematics is taught in both high schools and colleges is structured to help some students make the connection but not all learners.

Students who are uncomfortable when exposed to mathematics are performing lower academically. The grade in which students become uncomfortable when exposed to mathematics must be identified so strategies can be put in place to help students feel comfortable with mathematics. When the grade students begin to be uncomfortable with mathematics is identified, support systems can be put into place to help students understand that mathematics is useful and practical. Further research on this topic could involve all grades, kindergarten through 12th grade to see when students' attitudes toward mathematics begin to fall. An interesting connection could be made between how mathematics is taught and when negative attitudes begin. Changing the structure of how mathematics is taught could solve the problem of students having a negative attitude toward their success in mathematics. The change in mathematics delivery from lecture based to experiential based could be fun and relieve students of being uncomfortable with mathematics. The descriptive statistics mean score of all participants suggest that on average, students are not positive or negatively affected when exposed to mathematics. Changing the structure of mathematics delivery could change students' perception to be positively affected when exposed to mathematics. Also, seeing that mathematics teachers not only understand how to complete mathematics in a lecture setting, but also are able to complete practical work with their knowledge could improve students' attitudes toward mathematics.

Policy should be developed to ensure mathematics courses are taught using experiential learning. Experiential learning could be help students feel less anxious about mathematics when they become accustomed to experiential learning in mathematics. Policy should be implemented that students must take an experiential learning mathematics course in K-12 education. The purpose of the experiential learning mathematics course would be to expose students to the practical application of mathematics and careers that incorporate mathematics and help students to have positive attitudes toward their success in mathematics. Mathematics laboratory instructors would create laboratories based on concepts learned in lecture. Current mathematics teachers would teach traditionally in lecture format; however, the day after lecture would be a mathematics laboratory day that would be taught by a different instructor. If 50 students enrolled in a laboratory based mathematics course, 25 would be in lecture while the other 25 would be in laboratory. The two groups would switch lecture to laboratory every day.

The second implication and the third area of significance is students' who perceive their teachers' as having a negative attitude toward them are found to have lower academic performance. Positive relationship between teachers and students is known to have a positive affect on learning and is validated through this research. Many mathematics courses are taught with rather large course numbers and taught using a lecture-based format. With a lecture-based format for mathematics delivery, relationships are often difficult to create because of the lack of teacher/student interactions. Unless a student utilizes office hours, shows up early, or stays after class to speak with the instructor, one on one time with the instructor may not exist. The participants viewed their perceptions of teachers' attitudes as being neutral to slightly positive. Teachers' are perceived as having very positive attitudes' toward student success. If positive relationships were known to increase student performance, a mathematics delivery method that improves relationships would increase students' perceptions of teachers' attitudes and ultimately improve performance. Students' perceiving their teachers' as having a positive or negative influence in their success provides evidence that an active, laboratory based mathematics delivery method should be implemented to improve students' perceptions of their teachers' attitude. If teachers observe students that are more engaged in mathematics, teachers' attitudes will increase, which will increase student performance. As stated above, implementing a policy that requires students to enroll in a laboratory-based mathematics courses will improve students' performance. Improving students' perceptions of teachers' attitudes is another benefit of a laboratory based mathematics delivery system.

The fourth and most significant finding in this study is the effect mathematics preparation has on students' mathematics performance. The link between mathematics preparation and students attitudes' toward mathematics needs to be further investigated. When mathematics preparation was removed from the regression in the second research question, the significance of each mathematics attitudes construct increased. Mathematics preparation is affected by students' attitude toward mathematics. As attitudes decrease, the students' motivation to enroll in further mathematics courses decreases. Thus, decreasing the mathematics preparation the students' have prior to post-secondary training. The significance of mathematics preparation effecting performance in mathematics provides further evidence that mathematics delivery needs to change not only to increase attitudes toward mathematics, but also to increase the level of mathematics preparation students will have entering college. University academic career advisement should look at incoming students' highest level of mathematics in high school and make a determination on what type of mathematics they should enroll in. If students had a high level of mathematics preparation, they should be able to enroll in traditional mathematics courses because they had evidence of being successful in mathematics. If students' high school transcripts show a low level of mathematics preparation, a policy should be in place to enroll the student in a mathematics course that has a laboratory associated with it. Changing the structure of mathematics courses would be a major change to mathematics education and would align with recent educational research on how students learn best.

The perception of CTE related careers often have a stigma associated with them because many jobs related to CTE were considered low skill. As the skills needed have increased, the stigma associated with CTE remains the same. In order to change the perception of CTE programs, a recruitment effort must take place to get atypical students bound for 4-year institutions not associated with CTE to understand industry and the opportunities that exist involving high skilled, high pay positions. Mathematics laboratories could expose students to careers that involve the application of mathematics. If students want to be in a mathematics course, they will likely take courses beyond the required. Mathematics preparation is significant in increasing mathematics scores. A major change needs to happen to how mathematics is taught to increase the mathematics preparation of high school students. Implementing a new delivery system for mathematics such as a laboratory based mathematics course would address all of the findings of this research.

Current mathematics courses are not taught to show the relationship between mathematics and application. Mathematics teachers cannot assume that all students enjoy mathematics. Mathematics teachers must create an environment of application of mathematics and not mathematics for the sake of doing mathematics. Mathematics labs much like science or CTE labs would be a step in the right direction.

Implications for Theory

This section will provide details on the implications this research has on theory. Following the implications for theory, implications for research will be briefly discussed. Two scales were used in this research, which are the Rotter (1966) internal and external locus of control scale and the Mulhern and Rae (1998) mathematics attitude scale. First, the locus of control scale was used to determine whether locus of control is a significant predictor for both students' field of study choice and students' performance in mathematics. Locus of control was not found to be a significant predictor for either performance in mathematics or field of study choice. The low sample size could have affected the outcome of the study; however, locus of control may not serve as a good predictor for mathematics performance or field of study. Replicating the study with a larger sample size would either validate the results or contradict the findings of this research, thus requiring further research.

Second, the mathematics attitudes scale was used to determine whether students' attitudes toward mathematics are a predictor of success in mathematics and field of study choice. The five constructs, usefulness of mathematics was found to be a significant predictor for students' choosing CTE programs and mathematics related affect and teachers' attitudes were found to significantly predict mathematics performance. There are concerns that the low sample size has affected the results of this study. If low sample size was not a concern, the results of this study could be used to first measure students attitudes toward the usefulness in mathematics and make assumptions that the lower the attitude concerning the usefulness of mathematics, the higher the chance that students will choose CTE programs. Based on this research, all other mathematics attitudes constructs would not be needed to predict field of study. The mathematics attitudes constructs found to be significant in predicting mathematics performance were mathematics related affect and teachers' attitudes. Based on the findings of this research, only the constructs that were found to have significance could be used to predict performance in mathematics. If universities wanted to predict students' performance in mathematics, a survey tool could be used that includes both the mathematics related affect and teachers' attitudes constructs. This would provide insight as to the students that will most likely require support to be successful in mathematics. The Mulhern and Rae (1998) scale has been tested for validity and reliability for measuring attitudes toward mathematics; however, to ensure the assumption that the mathematics related affect and teachers' attitudes constructs can be separated from the rest of the scale to measure performance in mathematics, a validity and reliability study would need to be conducted. Validity and reliability would also need to be checked for usefulness of mathematics being a predictor for field of study choice.

This study has several implications on research. The following will detail those implications. The first implication for research is locus of control may not be a good predictor for performance in mathematics or field of study. Although locus of control has been found to both predict mathematics performance and not, locus of control has been found to predict attitudes in academic subjects. This study identified areas of attitudes toward mathematics to predict mathematics performance without significance in locus of control. Further research needs to be conducted with a similar research model to further explore locus of control and academic performance of CTE students. Having a low sample size may have skewed locus of control into not being significant.

Field of study was found not to be a good predictor in performance in mathematics; however, as stated above, sample size of CTE students may not have been enough. Field of study not being a good predictor is surprising because of the evidence that supports CTE students having lower academic abilities. The significance of mathematics preparation being a predictor for mathematics performance aligns with current research and was expected. It was also expected that CTE students would be less prepared for mathematics courses based on existing literature. In the last section, the relationship between math preparation and usefulness of mathematics, mathematics related affect, and teachers' attitude were discussed. Much of the research on mathematics preparation does not include the relationship that mathematics preparation has on attitudes toward math. Further research needs to be conducted on the relationship between attitudes toward mathematics and mathematics preparation. Is mathematics preparation a predictor for attitudes toward mathematics or are attitudes toward mathematics a predictor for mathematics preparation? Seeing that mathematics preparation had the greatest significance in predicting performance in mathematics, further research could better explain the relationship.

The two external control related constructs of mathematics were parents' attitudes, which was not significant in predicting performance in mathematics and teachers' attitudes, which was found to be a good predictor for performance in mathematics. The lack of significance in the parents' attitude was interesting because it was expected that parents' play a role in students' attitudes. The significance of teachers' attitudes on mathematics performance will serve as further evidence for research on attitudes toward mathematics and external factors in mathematics performance. The two external control related mathematics attitudes constructs are similar in design to the locus of control construct but locus of control was not found to be significant along with parents' attitudes.

Usefulness in mathematics was found not to be a predictor for mathematics performance but a difference was found in usefulness of mathematics between CTE students and all other students. This adds complexity to the existing research because usefulness of mathematics has been used to identify success in academics and CTE students had been found to have lower academic abilities. Yet, usefulness of mathematics predicts students' selection of CTE programs and doesn't predict their performance in mathematics.

The construct of attitudes toward success in mathematics was not a predictor for success in mathematics and mathematics related affect was found to be a predictor for performance. Both constructs were similar in their design yet only mathematics related affect was significant. The implication of this is students are unaffected by the feeling of success in mathematics and do not need to be an exceptional student; however, those perception are not the same as students having a negative feeling when exposed to mathematics. The difference of students feeling negative toward mathematics and not caring if they are successful is distinguishable and significant in understanding students' attitudes toward mathematics.

Limitations and Implications for Future Research

This section will highlight the limitations and implications for future research. Several limitations exist in the research study. First, the sample has a small percentage of the CTE population and may not translate to other universities. There were a low number of CTE students who participated in the research and a low overall sample size. The first research question was analyzed using a logistic regression. The binary dependent was field of study with the two categories being CTE associates students against all other degrees. Because of the low numbers within the CTE category of the dependent variables, t-tests had to be conducted along with an additional logistic regression with a change in the groups within the dependent variable. The two groups used were all associates degrees against all bachelors' degrees. The main problem with the second regression is it included associates degrees such as surgical lab technician students that typically carry a higher GPA than the typical CTE associates degree students. To address this limitation, extending the research to a region that includes similar institutions would increase the number of CTE participants. If similar institutions cannot be found, surveys could be sent to technical education centers that do not have bachelor's degrees along with surveys being sent to four-year institutions that do not have technical associate's programs. Another recommendation would be to collect data over the course of several years to build up the amount of participants. Studying the population of a rural Midwest State university is unique and does not translate to most of the population across the United States. If the participants are primarily from the Midwest region of the U.S., the sample may not translate to other populations.

Second, locus of control and attitudes toward mathematics are two aspects that could contribute to the level of performance in math. Locus of control and attitudes toward mathematics are only several variables used to predict performance, the study is not looking at all variables that could be affecting performance. This study determines whether locus of control, attitudes toward mathematics, and mathematics preparation are predictors for performance in math, it does not suggest why they are or are not a predictor. This area could be improved by including a section on the survey that asks more about the participants' path to college. For example, a question could be asked whether the student received special education services or whether they were traditional or non-traditional students. More information on the students could help in understanding other variables that were not accounted for in this study. If a large percentage of CTE students received special education services in high school, it would be helpful in identifying solutions to poor mathematics skills and low mathematics preparations.

Third, gender was intentionally left of out this study; however, research on females losing interest in Science, Technology, Engineering, and Mathematics (STEM) disciplines has been conducted (Ahlqvist, London, & Rosenthal, 2013; Robelen, 2012). The number of females attending college programs has substantially risen. In 1972, 7% of the law degrees were earned by women, and in 2011, 47% of law degrees were earned by women (Robelen, 2012). Although there has been an increase in women attending college programs and an increase in female performance in academics, STEM programs have not increased in the number of female students attending (Ackerman, Kanfer, & Beier, 2013; Ahlqvist, London, & Rosenthal, 2013; Robelen, 2012). Future research should include a model that identifies gender traits that predict female success in STEM disciplines and predicts the age females lose interest in STEM programs. (Ackerman, Kander, & Beier, 2013; Ahlqvist, London, & Rosenthal, 2013). If predictors are found why females lose interest in STEM disciplines, new policies on STEM instructional delivery could be implemented to increase performance and increase the number of female students' entering STEM fields.

Lastly, conducting the same research project in a school that uses a laboratory based mathematics delivery could be used to validate the implications of this study. If further research can be conducted to confirm the implications of this research, more evidence will exist to change the current mathematics delivery within education.

Conclusion

This research used a non-experimental, cross-sectional, predictive research design. The purpose of this study was to identify predictors for students' field of study choice and performance in mathematics. The predictor variables used in the study were field of study, locus of control and five mathematics attitudes variables which are attitudes toward success in mathematics, parents' attitudes, teachers' attitudes, math related affect, and usefulness of mathematics. The research examined the extent that locus of control and mathematics attitudes predicted field of study. Also, the research examined the extent that locus of control, mathematics attitudes, field of study, and mathematics preparation predicted performance in mathematics. Data were collected by distributing a survey through Moodle to all students enrolled in first year math courses at a rural university.

Question one was intended to identify whether perception of control and attitudes toward mathematics are predictors for students' choice of field of study. The predictor variables for question one are the five constructs of attitudes toward mathematics and locus of control. The outcome variable for question one is field of study. Mathematics attitudes and locus of control were found not be the established concern in students' selecting field of study. To further analyze question one, t-tests were used to analyze field of study against each construct of mathematics attitudes and locus of control. Significance was found between attitude toward success in mathematics and field of study. Students' with a lower attitude toward success in mathematics are more likely to enroll in a technical CTE associates program than students enrolled in all other degrees.

The second research question was intended to identify whether locus of control, attitudes toward mathematics, field of study, and mathematics preparation are predictors for students' performance in mathematics. The model for question one was found to be significant in predicting students' performance in mathematics. Specifically, teachers' attitudes, mathematics related affect, usefulness of mathematics, and low mathematics preparation has a significant relationship with mathematics performance. Locus of control, attitude toward success in mathematics, usefulness of mathematics, and field of study has no significance in predicting mathematics performance.

The implications for this research suggest that changing the delivery methods of mathematics within K-12 and universities needs to be explored. Further research on mathematics delivery and predictors for mathematics performance should be conducted. Efforts must be continued to help understand the gap between high and low performers in mathematics.

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