DISSERTATION

DIFFERENCES BETWEEN MALE AND FEMALE COMMUNITY COLLEGE STUDENTS IN ACHIEVEMENT AND ATTITUDE ON COLLEGE REMEDIAL MATHEMATICS

Submitted by

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ABSTRACT

DIFFERENCES BETWEEN MALE AND FEMALE COMMUNITY COLLEGE STUDENTS IN ACHIEVEMENT AND ATTITUDE ON COLLEGE REMEDIAL MATHEMATICS

The purpose of this non-experimental quantitative research study is to explore sex differences between community college male and female students on mathematics achievement and attitudes toward remedial mathematics in a metropolitan community college setting in the Southeastern United States. Through comparative and associative statistics the results revealed the findings from four research questions. The research questions explored the relationship between sex differences in remedial mathematics achievement and students' attitudes towards mathematics. The study found there was a statistically significant difference between male and female students on remedial mathematic achievement. The research showed males were significantly different from females on Pre-college Algebra ($p \leq .001$). The means scores of the two groups indicated that the average male students scores were ($M = 52.10$) while the female students scores were significantly lower at ($M = 41.11$). The effect size was .6, which according to Cohen (1988) is medium or typical in this discipline. Therefore, community college male student participants performed higher than the females on mathematics achievement. Using Independent Samples *t*-test the results from this study supported previous studies regarding differences between male and female community college students' attitudes toward mathematics. The study showed males scored significantly higher on motivation and self-concept than females. Females scored significantly higher on anxiety than males ($p \leq .001$). Males scored higher than females on both enjoyment ($p = .228$) and value ($p = .111$) but the differences were not statistically significant. The means score on value for males was ($M = 3.57$) and ($M = 3.32$)

for females. The effect size for both value .2 and enjoyment .3 was small or smaller than typical (Cohen, 1988).

The results showed that the combination of sex and student's attitudes (*motivation, anxiety, value, enjoyment, and self-concept)* can predict remedial mathematics achievement $F(6, 147) = 8.80$, $p \leq .001$. The effect size was large or larger than typical (Cohen, 1988). Using 2 x 2 Factorial ANOVA this study found that male and female students who passed/failed remedial mathematics did not interact differently in regards to their attitude toward mathematics (motivation, anxiety, value, enjoyment, self-concept). There was not a significant interaction between sex and mathematics achievement (pass/fail) on motivation ($p = .429$), anxiety ($p = .165$), value ($p = .504$), enjoyment ($p = .177$), and self-concept ($p = .332$). However, there was a statistically significant main effect between remedial mathematics (pass/fail) on all of the attitude variables motivation, anxiety, enjoyment, and self-concept ($p \leq .001$) except value ($p = .411$). So those who passed remedial mathematics had higher scores on motivation, enjoyment and self-concept, but lower scores than those who failed remedial mathematics on anxiety.

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DEDICATION

This dissertation is dedicated to four very special family members who passed away before witnessing the completion of this journey. First, my parents the late, Robert A. Hughes and Lula D. Hughes who placed higher education as a high priority in my life. I am eternally grateful for the many lessons and foundation they set forth to strive for excellence and to further those principles to make a difference in the world. Next, I would also like to dedicate this research to my beloved late brother and humanitarian, Kenneth Hughes, who always kept me focused, encouraged and uplifted throughout this process. Finally, I am thankful for the wisdom and spiritual guidance of my late aunt, Margie Borders who passed away during the final stages of my dissertation journey. My only regret is that the four of them were not here to share in this moment but I know they celebrate with me in spirit.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Investigating male and female college students' achievement and attitudes with regard to remedial mathematics in different contexts provided a rich understanding of the issue that supported sound research. However, some varying perspectives constituted a limited body of work on two-year community colleges (Cohen & Brawer, 2003; Di Martino & Zan, 2011; Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006). The purpose of this non-experimental quantitative research study is to explore sex differences between community college male and female students on mathematics achievement and attitudes toward remedial mathematics in a metropolitan community college setting in the Southeastern United States. This chapter provides an overview of remedial mathematics in the community college, background of the problem, statement of the research problem, purpose of the study, research questions, significance of the study, key terms, delimitations, assumptions, limitations and the researcher's perspective.

Background of the Study

Over the past forty years several research investigations around the world have sought to explore differences in males and females mathematics learning and attitude toward the subject (Else-Quest, Hyde, & Linn, 2010; Lloyd, Walsh, & Yailagh, 2005; Santos et al., 2006). Assessing academic achievement in community colleges has been a relevant and timely area of study. The Council for Higher Education Accreditation (2003) stated, “The assessment of academic achievement has emerged as a major issue for higher education in terms of accreditation, accountability, along with performance indicators, and funding” (Seybert, 2002, p. 55). Providing valuable assessment results to community college stakeholders has been an age-

old concern for higher education. Community colleges across the nation have come under intense internal and external pressure to examine student academic achievement (Cohen & Brawer, 2003).

Assessment testing has played a critical role in the success of community colleges and has provided accountability to stakeholders. Proper accreditation mandated community colleges to meet curriculum, program, and performance requirements. The Accrediting Commission for Community and Colleges, (ACCC, 2008) focused on the achievement of expectations on student performance of freshman or first-year students in college. This accreditation provided colleges with a standard degree of quality needed for credibility. Failure to meet accreditation requirements could result in the risk of losing federal funding and the transfer merit of academic certification (Cohen & Brawer, 2003).

Remedial Education in Community Colleges

Remedial education is also known as developmental education, and was formerly known as compensatory, preparatory, or basic skills studies. It has grown as the percentage of poorly prepared students graduating from secondary schools increased (Cohen & Brawer, 2003). Community colleges have served underprepared students for decades. The high enrollment of underprepared students in community colleges is a direct result of their open door admission policy that allowed anyone, regardless of their academic preparedness, to attend and acquire skills necessary for academic success (Boyer, Butner, & Smith, 2006).

The empirical literature and trends in higher education have indicated that community colleges will continue to play a critical role in educating underprepared students in remedial education (Barh, 2008; Levin, Calcagno, & Carlos, 2008). Lesik, (2006) indicated that while four-year colleges and universities offered some form of remedial education, over ninety percent

of all two-year community colleges provided remedial courses to their students. Additionally, nearly half of all students enrolled in community colleges and two-year institutions were enrolled in at least one remedial course (Hodges & Kennedy, 2004). Nearly 98 percent of public two-year colleges offered remedial courses in at least one subject (reading, writing and mathematics) and most offered all three subjects (NCES, 2003).

Mathematics in the Community College

According to the National Center for Education Statistics (NCES, 2012) research on mathematics in community colleges, particularly remedial mathematics continues to be problematic for internal and external constituencies of the institutions. Remedial mathematics involves courses for students who lack the necessary skills to perform college-level work at the rigor required by the institution (Saxon, Sullivan, Boylan, & Forrest, 2005). Remedial mathematics has had a long controversial history involving complicated issues in higher education and society (Saxon, Sullivan, Boylan, & Forrest, 2005).

Hoachlander, Sikora, and Horn (2003) reported that around 42 percent of 4-year college students each year come from two-year community colleges. Many of those students, however have been unable to obtain an associate degree from a two-year college or a bachelor degree from a 4-year institution. Aycaster, (2001) and Lawson et al., (2002) noted that mathematics courses served as part of an academic roadblock where a significant percentage of students failed to obtain a formal degree.

Attitudes toward remedial mathematics can help explain the level of achievement of individual students. Many scholars and researchers (Chan, 1990; Ma, 1997; Thorndike-Christ, 1991; Webb, Lubinski, & Benbow, 2002) found students' attitude toward mathematics has influenced success in academic achievement. Variances in attitudes toward remedial

mathematics across sexes have been found to help explain the extent of academic achievement for students (Birenbaum & Nasser, 2006). However, the literature has or portrays a gap in terms of exploring male and female differences in attitudes toward remedial mathematics and academic achievement in post-secondary education, particularly in community colleges. Therefore, the need to help fill the gap in the research served as the foundation for this study (American Mathematical Association of Two-Year Colleges, 2012; Banta, Black, Kahn, & Jackson, 2004; Cohen & Brawer, 2003; National Council of Teachers of Mathematics, 2010).

Characteristics of the Community College Adult Learner

According to the American Association of Community Colleges (2014), community colleges serve the needs of a unique and diverse population of students. The community college learner has limited experience in higher education and comes from a variety of backgrounds. Community colleges provide the pathway to postsecondary education for many adult learners who intend to upgrade their skills for a particular job, pursue a hobby, or earn an associate degree to transfer to a 4-year institution. Community colleges provide access to education for many nontraditional students such as; students who are working while enrolled, adults seeking higher education after completing the GED, and displaced working adults (Kenner & Weinerman, 2011).

The average age of a community college student is 29, and two thirds of community college students attend part-time (Kenner & Weinerman, 2011). Additionally, these institutions not only provide access for adult students, but also serve an increasing number of traditional age and high school students who take specific courses to get ahead in their studies. Community colleges continue to provide postsecondary education for non-traditional adult learners who are minorities, and low income or first generation college students (Kenner & Weinerman, 2011).

Demographic data indicates that 33% of community college students are married, 25% are single parents, 57% work at least part-time, and 21% commute a minimum of six hours per week to and from college (Spellman, 2007).

Statement of the Research Problem

Remedial mathematics achievement offers a critical area of assessment concern for community colleges given the considerable high failure rate of students and the impact on learning outcomes and student academic success (ACCC, 2008). Nationally, many first-time freshman community college students (about two-thirds) require support regarding remedial mathematics. Yet, nearly three-fourths of the students who begin a remedial mathematics course sequence do not successfully complete a college-level mathematics course (Barh, 2008; Levin, Calcagno, & Carlos, 2008). Consequently, students who enroll in remedial mathematic courses are very likely to leave college without obtaining a degree and without transferring to a 4-year institution (Lesik, 2006).

For many women and minorities, remedial academic achievement serves as a prerequisite to career growth and yet a barrier to academic success. A disproportionately high percentage of community college students who fail remedial mathematics are women and minorities (Lesik, 2006). Females consistently score lower than males on standardized tests of mathematics, yet these differences do not exist in the classroom (Lesik, 2006). Many scholars and researchers (Chan, 1990; Ma, 1997; Thorndike-Christ, 1991; Webb, Lubinski, & Benbow, 2002) found students' attitudes toward mathematics influenced success in academic achievement. Therefore, examining sex differences in remedial academic achievement and attitude toward mathematics in community college is important given that standardize test provide the gateway to enter college-

level courses and achieve various career aspirations. If female students receive lower test scores, then they potentially also may obtain fewer career opportunities (Lesik, 2006).

Variances in attitudes toward remedial mathematics across sexes have been found to help explain the extent of academic achievement for students (Birenbaum & Nasser, 2006). However, the research problem consist of literature that has or portrays a gap in terms of exploring male and female differences in attitudes toward remedial mathematics and academic achievement in post-secondary education, particularly in community colleges. Investigations explored male and female attitudes toward learning and the relationship of academic achievement and attitude toward mathematics (Dwyer, 1993; Singh, Granville, & Dika, 2002; Webster & Fisher, 2000). While several earlier studies favored male students as having higher academic achievement than their female counterparts; in recent years, research has reported there were no significant differences in achievement between males and females while learning mathematics during their elementary school years (Fierros, 1999; Zhang & Manon, 2000; Leach & Guo, 2001; Ericikan, McCreith, & Lapointe, 2005). Consequently, it is important to investigate this research problem and the issues of remedial mathematic achievement in the educational context that have not been well explored, particularly research that addresses male and female community college students' achievement and attitude toward mathematics (DiMartino & Zan, 2011; Essles, 2005; Hannula, 2002).

Purpose of the Study

The purpose of this non-experimental quantitative research study is to explore sex differences between community college male and female students on mathematics achievement and attitudes toward remedial mathematics in a metropolitan community college setting in the Southeastern United States.

Research Questions

The research questions in this study included:

Q1. Are there differences between male and female community college students on remedial mathematic achievement Pre-college Algebra assessment as measured by the COMPASS?

Q2. Are there differences between male and female community college students on attitudes toward mathematics (motivation, anxiety, value, enjoyment, and self-concept) as measured by the (ATMI) *Attitude Toward Mathematics Inventory* survey?

Q3. How well does the combination of sex, community college students' attitudes (*motivation, anxiety, value, enjoyment and self-concept*) about mathematics predict remedial mathematic achievement results?

Q4. Is there an interaction between male and female community college students and remedial mathematic (pass/fail) achievement on (*motivation, anxiety, value, enjoyment, and self-concept*)?

Significance of the Study

This study could add to the body of research and contribute to clarifying the confusion and gap in understanding sex differences in students' attitude and academic achievement. This research contributes specifically to the understanding of sex differences in students' attitudes and academic achievement by exploring differences between male and female community college students' attitudes toward remedial mathematics and their relationship to academic achievement.

Definitions of Key Terms

The key definitions and the operational definitions used in this study:

Academic Achievement: For the purpose of this study. Academic achievement was defined by students' remedial mathematics achievement in Pre-college Algebra and a basic COMPASS 4.0 mathematics assessment as a final exam in the Pre-college Algebra course.

While the actual scores were obtained for Pre-college Algebra to provide more detailed information for remedial mathematic achievement, the data was re-coded to use pass/fail results for the purpose of the research questions (Two-Year Community College Data Information, 2014 p. 1).

Anxiety: This was a construct on the *Attitude Toward Mathematics Inventory*, ATMI instrument that was intended to measure the apprehension or distress a student experienced when learning mathematics. Sample items on the instrument from this category were, "I felt tensed when someone talked to me about mathematics. It scared me to have to take mathematics. It doesn't disturb me to work mathematics problems" (Tapia & Marsh, 2004, p. 12).

Attitude toward mathematics, referred to the level of perception and beliefs felt by a student regarding mathematics. For the purpose of this study, attitude toward mathematics was defined by the scores obtained on the *Attitude Toward Mathematics Inventory* (ATMI) instrument (Tapia & Marsh, 2004, p. 12).

Community College: An educational institution regionally accredited to award the associate in arts and the associate in science as its highest degrees. This definition included the comprehensive two-year institutions as well as many technical institutions, both public and private (Cohen & Brawer, 2002 p. 5). For the purpose of this study, the two-year community college in this study was a non-residential public metropolitan institution located in southeastern U.S.

COMPASS 4.0 Mathematics Exam: A standardized testing assessment of mathematic skills for college-level introductory mathematics (ACT, 2012). The ACT's e-COMPASS 4.0 was used to conduct this assessment. There were 5 COMPASS Mathematics Domains; Pre-Algebra, Algebra, College Algebra, Geometry and Trigonometry. The university system used

eCOMPASS 4.0 mathematics assessment as a final exam for the Pre-college Algebra course. The package for the exam was a basic COMPASS Algebra test. The test was set-up with a 'maximum' of 15 questions for evaluation (Two-Year Community College Course Syllabi Information, 2014 p. 1).

Enjoyment: This was a construct on the *Attitude Toward Mathematics Inventory*, ATMI instrument that was intended to measure the degree to which students liked or disliked mathematics. Sample items on the instrument from this category were, "I enjoyed talking to other people about mathematics. Mathematics was something, which I enjoyed very much. I didn't like anything about mathematics" (Tapia & Marsh, 2004, p. 12).

Males and Females (Sex): For the purpose of this study, this variable referred to the biological self-identified sex of male and female students enrolled in a community college remedial mathematics course, Pre-college Algebra (Two-Year Community College Data Information, 2014 p. 1).

Pre-college Algebra: A 4-credit hour remedial Pre-college Algebra course designed to prepare students for college level mathematics. This is a 15-week remedial mathematics course that was taught during the 2012 Fall Semester using a web-based software entitled, the *Assessment Learning Knowledge Space,* ALEKS. A basic COMPASS 4.0 mathematics assessment was used as a final exam in the Pre-college Algebra course. Topics covered included: real-number concepts, selected geometry concepts, linear equations and inequalities in one variable, problem solving involving linear or factorable quadratic equations as models, operations on polynomials, factoring polynomials, integral exponents, graphing linear and quadratic equations in two variables, rational expressions, function notation, integral and rational exponents, solving absolute value and quadratic equations and inequalities, solving rational and radical equations, problem solving linear equations,

rational equations, quadratic complex numbers, geometric concepts and calculator usage. (Two-year Community College Course Syllabi, 2014, p. 3).

Motivation: This was a construct on the *Attitude Toward Mathematics Inventory*, ATMI instrument that was intended to measure the process of a students' desire or willingness to perform in mathematics. Sample items on the instrument from this category were, "Sometimes I read ahead in our mathematics book. I had a real desire to learn mathematics. I would rather be given the right answer to a mathematic problem than to work it out myself" (Tapia & Marsh, 2004, p. 12).

Remedial Mathematics: According to the National Center for Education Statistics, courses for college-level students who lacked the skills necessary to perform college-level mathematics at the level required by the institution" (Saxon, Sullivan, Boylan, & Forrest, 2005, p.16). For the purpose of this study developmental mathematics was used interchangeably with remedial mathematics. All associate programs at the community college in this study require college level mathematics (Two Year Community College Data Information, 2015).

Self-Concept: This was a construct on the *Attitude Toward Mathematics Inventory*, ATMI instrument that was intended to measure how students think about and perceive their performance in mathematics. Sample items on the instrument from this category were, "I was good at working mathematic problems. I felt at ease in a mathematics class. I didn't do well in mathematics" (Tapia & Marsh, 2004, p. 12).

Value: This was a construct on the *Attitude Toward Mathematics Inventory*, ATMI instrument that was intended to measure mathematics usefulness or worth to the student. Sample items on the instrument from this category were, "Mathematics was a very worthwhile

and necessary subject. Mathematics courses would be very helpful no matter what I decided to study. Mathematics was important in everyday life" (Tapia & Marsh, 2004, p. 12).

Delimitations

This quantitative research study was delimited to (N = 154) participants, 62 males and 92 females at a two-year community college who were enrolled in a remedial mathematics Pre-college Algebra course during the 2012 Fall Semester. Students completed the course and the self-reported *Attitude Toward Mathematics Inventory* (ATMI) survey during the August through December 2012.

Assumptions and Limitations

This study is based on a number of assumptions and contains limitations. The central assumption in this investigation was that students would provide honest and truthful responses to the self-reported survey questions based on their personal perception of mathematics. There were three key limitations in this non-experimental study. First, the data collection was generated from only one institution and only one group of students. Second, the respondents were enrolled in the same Pre-college Algebra course in which the COMPASS served as the final assessment in the course. Third, study participants were enrolled in the course only during the 2012 Fall Semester (August-December) time period. Therefore, the results from this study could not be generalized to other public two-year colleges or four-year institutions. It is worth noting that, according to Morgan, Leech, Gloeckner, & Barrett (2009), although non-experimental studies (those with attribute independent variables) could lead to solid conclusions about the differences between groups and variables. Non-experimental designs do not address causation.

Researcher’s Perspective

The researcher’s interest in the topic emerged from having served as a proctor in a testing center for mathematics assessment and an instructor in the department of Humanities and Fine Arts at a two-year community college. From my personal observations, student's attitudes toward the COMPASS test varied. Some students were relaxed; while others appeared very anxious. However, many of the students clearly exhibited a considerable level of dislike in taking the COMPASS mathematics assessment. Many of the male students appeared less stressed during the mathematics portion of the test than their female counterparts. As a means of evaluating students' achievement in the mathematics education, I felt investigating this topic would provide some rich and valuable insights into differences between male and female students' in their academic achievement and attitude toward remedial mathematics.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a review of the literature that focused on the background of community college remediation, a clear definition of attitude toward mathematics along with a conceptual framework and research that synthesized the relationship between male and female differences in students' achievement and attitude toward mathematics.

Pedagogy in Remedial Mathematics Instructional Practices

According to the National Center for Educational Statistics (2003), a significant number of students are beginning college underprepared for a college-level mathematics course. More adult learners are pursuing higher education than ever before however their entrance into college is being challenged through the need for remedial education, particular mathematics (King, 1999; Migietti & Strange, 1998). Attempts to help students gain fluency in basic skills must incorporate learning experiences and instructional strategies that are relevant to adults Migietti & Strange, 1998). According to Kilpatrick, Swafford, and Findell, 2001), remedial mathematics pedagogy was thought to rely on procedural skill-building, which has been linked to better performance on standardized tests--but in order to understand mathematics students need more than procedural fluency. Research conducted by Kilpatrick, Swafford, and Findell, (2001) suggested that various forms of instruction may support additional components of mathematical learning beyond procedural fluency. There has been limited empirical research on the study of developmental or remedial instructional pedagogies in mathematics (Kilpatrick, Swafford, & Findell, 2001).

Taylor (2008) conducted a quantitative study that examined the effects of a computerized algebra program, *Assessment and Learning in Knowledge Spaces* (ALEKS, 2001) on remedial mathematics achievement and attitude. Taylor (2008) explored differences in 93 college students' achievement in a web-based, computer-assisted curriculum in remedial mathematics class as

compared to classed that used a traditional lecture method of instruction. The results suggested that computer-mediated curriculum does improve mathematical achievement but only for some students. However, the lecture method seemed to be the best for other students. Taylor (2008) recommended that teachers evaluate the best practices and teaching pedagogy most suitable for teaching remedial mathematics students. Furthermore, Taylor (2008) suggested that teachers become more aware of students' years of frustration and anxiety related to remedial mathematics. Taylor (2008) asserted that teachers must find ways to alleviate anxiety so that students become more confident in their ability to succeed in remedial mathematics achievement. Additionally, the research found that the use of technology using computer-mediated algebra instruction reduced anxiety in remedial mathematics problem solving (Taylor, 2008). The study suggested that future researchers need to be diligent about finding what pedagogy methods (i.e. computer algebra or lecture) in remedial mathematics instruction will best help underprepared students succeed (Taylor, 2008). Therefore, this section of the literature review examined general attitude toward mathematics.

General Attitude Toward Mathematics

Several past studies operated with the assumption that males and females had different attitudes toward mathematics (Di Martino & Zan, 2007; Hannula, 2002). Many studies did not provide a clear theoretical framework of the issue because of differences in the definitions of attitude toward mathematics (Di Martino & Zan, 2007; Hannula, 2002). Most definitions of attitude toward mathematics emerged from studies, or came about after the development of assessment instruments (Di Martino & Zan, 2007; Hannula, 2002). A clear definition of attitude toward mathematics would support the identification of a conceptual framework to support succeeding investigations (Hannula, 2002).

Definition of Attitude

Zan and Di Martino (2007) considered the different definitions of attitude toward mathematics that emerged from previous studies, and they identified three different definitions. The first definition described attitude toward mathematics as a "positive or negative degree of affect" (Zan & Di Martino, 2007, p. 158) toward mathematics as an academic subject. Studies using this definition approached the investigation through the positive or negative disposition toward mathematics by male and female students. The explanation for more males than females enrolled in mathematics-based courses in college was that males had more positive affect than females with the subject of mathematics. While this definition was able to explain male and female attitudes toward mathematics in terms of relative positive or negative disposition, this definition was unable to explain thoroughly the components of affect and the manner this definition related to behaviors between males and females toward mathematics (Zan & DiMartino, 2007).

The second definition identified two components of attitude, which were beliefs and emotions (Zan & Di Martino, 2007). Attitude toward mathematics was determined by patterns of emotions and beliefs toward the subject. Studies that employed this definition focused on the differences in the feelings and ideas of males and females toward mathematics. Positive feelings toward learning the subject matter and constructive or optimistic ideas about learning mathematics could explain the stronger disposition of males toward the subject (Dar-Nimrod & Heine, 2006). This definition expanded on the first definition by breaking down the components of affect into emotions and beliefs. However, the definition only implicitly connected emotions and beliefs to behaviors toward mathematics, particularly the selection of courses in college or completion of mathematics courses (Di Martino & Zan, 2011).

The third definition identified three components of attitude, which were emotional response to mathematics, beliefs toward mathematics, and behaviors relative to mathematics (Zan & Di Martino, 2007). This definition expanded on the first definition by considering affect as having two components, which were emotional responses to and beliefs about mathematics. It also expanded on the second definition by explicitly connecting these components with concurrent behaviors toward the subject. Both male and female students had different emotional responses and beliefs toward mathematics. Thus, these differences in students' degrees of positive and negative response could explain their attitude toward the subject. Studies using this definition explained the dominance of males in mathematics courses through relatively more positive emotional responses and beliefs toward the subject (O'Brien & Crandall, 2003). Females had less positive and more negative affect toward mathematics. The positive or negative emotional responses and beliefs toward mathematics translated into preferences in selecting an area of study in college and in completing course requirements (DiMartino & Zan, 2011).

Attitude, Emotions, and Beliefs

The definitions of attitude evolved from a single to multiple components of affect toward mathematics (Zan & DiMartino, 2007). Adoption of the multiple component definition appeared to provide the clearest conceptualization of attitude toward mathematics by connecting emotions and beliefs with behaviors relative to the subject. However, even with the emergence of a definition with multiple interconnected components, the use of the definition in different studies has created doubt on the constitution of positive and negative emotions, beliefs and behaviors. The positive-negative dichotomy operated to classify emotions, beliefs and behaviors into either positive or negative. In theory, this could be possible. In the real work setting, classifying the

range of emotions, beliefs and behaviors as only positive or negative would not be possible (Zan & DiMartino, 2007).

Due to the challenge in applying the positive-negative dichotomy in empirical studies, measures of positive and negative attitude that emerged from the literature were highly context-based (Zan & Di Martino, 2007). What constituted positive and negative emotions, beliefs and behaviors changed according to the problem for investigation in different studies? The measures of positive and negative attitude depended on the focus of studies. Moreover, Akinsola, and Olowajaiye (2008) described the measures of positive and negative attitude as measures that come first, before the determination of the definition of attitude toward mathematics, given the context of the study. The attitude dichotomy employed in past studies had determined the definition of attitude toward mathematics that emerged from the investigation.

Some studies have focused on the positive-negative dichotomy of attitude toward mathematics, and commonalities in the conceptualization of positive and negative attitudes (Fardin, Alamolhodaie, & Radmehr, 2011; Hannula, 2002; Middleton & Spanias, 1999). Positive attitude relative to emotions referred to feelings of pleasure toward mathematics, while negative attitude pertained to feelings of displeasure. Measurement of sex differences in attitude was through accounts, reports or observations of feelings of pleasure or displeasure toward the subject or while studying mathematics (Fardin, Alamolhadie, & Radmehr, 2011). Positive attitude in relation to beliefs meant greater alignment with the views toward mathematics shared by experts on the subject, while negative attitude related to beliefs meant lesser similarity with the perspective of experts toward mathematics (Fardin, Alamolhodaie, & Radmehr, 2011).

Another common context of studies on beliefs toward mathematics as a component of attitude compared the perspective of male and female students with male and female teachers

(Beilock, Gunderson, Ramirez, & Levine, 2010). Positive attitude when it came to behavior referred to successful outcomes, while negative attitudes related to behavior meant unsuccessful outcomes. The behavior component of attitude toward mathematics was measured by performance in the subject. Comparison of male and female performance in mathematics constituted a measure of male and female attitudes toward the subject (Hannula, 2002).

The common conceptualization of positive and negative attitude toward mathematics resulted in working definitions depending on the component of attitude investigated and the context of the investigation. The focus on emotions led to a working definition of attitude toward mathematics as pleasure or displeasure in dealing with the subject. The focus on two or three components, such as emotions and beliefs only, or emotions, beliefs and behavior together, created a working definition of attitude toward mathematics with dual or multiple components (Middleton & Spanias, 1999).

Moreover, the conceptualization of positive and negative emotions, beliefs and behavior were not exclusive. The definition of attitude toward mathematics was flexible depending on its components that emerged from the empirical studies (Akinsola & Olowajaiye, 2008).

Adult Learners' Attitude Toward Mathematics

Scholarly investigations on adult learners' attitude toward mathematics are quite limited, although several conclusions can be drawn from the literature on general mathematics attitudes (Jameson & Fsuco, 2014). Understanding the principles of mathematics has been presented as one of the most important skills a student can possess (Gupta, Harris, Carrie, & Caron, 2006). However, the mathematics skills of the adult learner have been somewhat limited. According to the National Center for Education Statistics (2010), more nontraditional adult learners are returning to college in order to further their career opportunities. Many of these adult learners

have been in the workforce and have not attended college in several years. Yet, many of these learners with limited mathematics skills are being ask to pick up right where they ended in their previous educational experience. Consequently, many students are placed in remedial education particularly remedial mathematics. Bryk and Treisman (2010) argued that there needs to be an integrated academic support system for students in remedial mathematics. "We need to strengthen the connections of students to successful peers, to their institutions, and to pathways to occupations and education" (20).

Hence, more of these returning adult learners are being placed in developmental mathematics courses. Gupta, Harris, Carrie, and Caron (2006) noted that these adult learners attend college with a sense of urgency and value for education along with a positive attitude toward mathematics and willingness to learn. However, despite the reported significance of mathematics skills some adult learners tend to dislike and avoid the subject even those who are competent in mathematics. Many researchers noted the reason for this dislike and avoidance is likely due to a combination of anxiety and low confidence (Jameson & Fsuco, 2014).

Dimensions of Attitude Toward Mathematics

Fennama and Sherman (1976) offered suitable ground upon which to assess students' attitudes about mathematics through different dimensions such as confidence and mathematics usefulness. They categorized these dimensions into: 1) motivation, 2) anxiety, 3) value, 4) enjoyment, and 5) self-concept. The remainder of this section was explored through these concepts.

Motivation in Mathematics

Motivation was the inspirational process instituted to arouse interest of the students in the subject. Part of the reason for the witnessed trend of poor attitudes toward mathematics was due

to students being properly motivated (Singh, Granville, & Dika, 2002). There has been a lack, or in worst-case scenarios a total absence, of interventional schemes that would be beneficial in helping the students solve problems they face. This has been the recipe for a rebellious attitude, causing more problems because students were then even less able to go about learning effectively (Singh et al., 2002). Stakeholders have not created opportunities that facilitated exploration of the relevance of mathematics learning procedures and application of noble ideas to mathematics practice. According to Omaha (2010), students' motivation was more of an extrinsic rather than intrinsic occurrence. The results had been attitudinal inertia; the students have not been able to make any meaningful headway with regard to the subject. Their analytical ability concerning the subject had not been instigated. While the motivation aspect was crucial during class work, there was also the need to ensure the same was provided during testing (Omaha, 2010).

There have been numerous studies undertaken in Indonesia that examined student achievement in mathematics. The results of these studies indicated that a significant difference existed between groups of students in achievement in mathematics (Mohanda, 2000). In a quantitative study conducted on 294 elementary schools in Indonesia, the study examined the relationship between motivation and achievement in mathematics (Siskandar, 2013). The study used questionnaires to collect data on attitude, perception and motivation of learning. The research revealed attitude and achievement in mathematics had a positive relationship, which indicated positive attitudes that produced higher achievement. Additionally, the results showed that there was a positive significant relationship between attitude of the students toward learning mathematics, motivation and role of parents related to mathematics learning along with achievement on mathematics (Siskandar, 2013).

Additionally, another study explored factors that contributed to students' motivation toward mathematics. A longitudinal qualitative research study by Mueller, Yankelewitz, and Maher, (2011) focused on grade school students of different ages and populations as they worked on mathematical tasks. The study identified key factors in encouraging positive attitudes in mathematics classrooms as well as understanding mathematical concepts. The students' mathematical levels ranged from those enrolled in remedial mathematics to those enrolled in regular mathematics classrooms. The research observed a variety of factors that contributed to students' motivation to participate in mathematics (Mueller, 2007; Mueller & Maher, 2010). These factors included classroom environment and teacher-student interaction. The factors that influenced favorable dispositions toward learning mathematics included classroom environment and teacher-student interaction (Mueller, Yankelewitz, & Maher, 2011).

A qualitative research study by Howard and Whitaker (2011) examined the perspectives and experiences of newly successful developmental mathematics students. The research was designed to ascertain developmental mathematics students' perceptions of the changes that accompanied their shift from unsuccessful experiences in mathematics to successful experiences in mathematics. The study took place at a large urban four year state college located in the west with approximately 4,000 students enrolled in developmental mathematics courses. The investigation indicated that when students were successful, they had a change in mindset. Motivation was the most common response given when students were asked about what the difference was between their unsuccessful and successful experience. Several themes emerged as motivating factors for students. First, students' motivation was fueled by feeling power over their own learning experiences. Second, having the ability to regulate the way they studied and the resources used i.e. (mathematics lab and tutors) also motivated students. Third, students'

motivation was enhanced once they understood the link between success in mathematics and career opportunities. This theme was supported by the Meyer and Turner (2006) study that found that students expressed renewed sense of value for the applicable skills in mathematics after connecting the subject to potential careers in the discipline. Fourth, the importance of using learning strategies effectively merged as a factor in motivating student success. The study noted students' past beliefs about mathematics led to unsuccessful experiences.

Anxiety Toward Mathematics

Anxiety in mathematics is defined as "a feeling of tension that interferes with the manipulation of numbers and the solving of mathematical equations in several areas of day-to-day life and academic situations" (Richardson & Suinn, 1972, p. 551). Mathematics anxiety in the adult learner is linked to limited exposure to mathematics, limited enjoyment of mathematics, and diminished self-concept in mathematics (Ashcraft, Kirk, & Hopko, 1998; Hembree, 1990). While some research investigations on mathematics anxiety and performance have identified these two constructs as having an inverse relationship (Ashcraft, Kirk, & Hopko, 1998; Hembree, 1990) other scholars have noted no relationship between the two (Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Jameson, 2013; Ma, 1999). Yet, (Galla & Wood, 2012), explained that the relationship is linked to individuals' confidence in their ability to control their emotions.

According to Beilock, Bunderson, Ramirez, and Levin, (2010), research on mathematics anxiety indicated that individuals in certain career fields have higher levels of anxiety than individuals in other areas i.e. pre-service education students and in-service elementary school teachers consistently report higher levels of mathematic anxiety. These reported high levels of

anxiety can affect female students' mathematics achievement (Beilock, Bunderson, Ramirez, & Levine, 2010). Although, much of the literature provided unclear reasons for how and why some individuals develop mathematic anxiety, it was hypothesized that self-concept played a role (Beilock, Bunderson, Ramirez, & Levine, 2010). Adults high in mathematic anxiety tend to be low in self-concept. Self-concept is a multifaceted construct that includes both general and specific perceptions an adult holds about him or herself (Marsh & Shavelson, 1985), and is negatively correlated with mathematics anxiety (Lee, 2009). There have been many opposing views on whether self-efficacy or self-concept is more predictive of an individuals' level of mathematics anxiety and performance. However, many researchers have found that self-concept contains a component of self-efficacy, particularly in mathematics (Jameson, 2013; Walker & Chapman, 2003; Usher & Pajares, 2008).

Researchers and scholars in the field have examined adult learners' anxiety and self-concept outside mathematics and have consistently found that adult learners with higher levels of self-concept are more satisfied with their postsecondary educational experience, more persistent when encountering educational roadblocks and more likely to enroll in future course (Kemp, 2002; Lim, 2001; Tyler-Smith, 2006). It appears that the constructs of self-concept and self-efficacy are significant in the success of an adult learner and particularly within the discipline of mathematics, and mathematics anxiety which has been linked to adult learners' mathematics achievement and performance.

Leong (2013) noted the relationship between students' attitudes and their mathematical achievement at a community college remedial mathematics course using a mixed-method investigative approach. The study examined the relationship between students' attitudes and learning mathematics. The research specifically, explored students' attitudes and beliefs on web-

based homework in one developmental algebra course. The investigation revealed that students with lower and average mathematics achievement had a more positive attitude toward using the web-based homework system compared to the high achieving students. The study provided evidence that the web-based homework used in the developmental algebra course maybe more beneficial to the students to receive immediate feedback through the automatic grading system. Additionally, this investigation revealed that the use of web-based homework provided more opportunities and motivation for lower performing students to learning algebra. The findings in this study were consistent with the results found in (Zeer, 2007) study on usage of web-based homework.

Mathematics is one subject that critically required peace of mind. Even if a student had the ability and motivation, if anxiety prevented focus and composure, then results were bad (Hauge, 1991). A student had to have internal composure and a sound state of mind to comprehend the problems (Hannula 2002). Unfortunately, students had a lot of anxiety during classes and taking tests. Anxiety created a feeling of fear, apprehension or tension (Hauge, 1991).

(Hauge, 1991) noted feelings of fear, apprehension or tension interfered with mathematics performance. It disoriented the functionality of the cognitive elements that would otherwise help to find an appropriate approach to mathematics problems (Hauge, 1991). According to Hannula 2002, the scenario could result in an inconceivable fear of mathematics. Some students would even undergo panic because of mathematics. Such students would experience physical rigidity or tension. Their desire to continue learning the subject was jeopardized as they became reluctant to be involved in matters of a mathematical nature. In these cases, the students became nervous. They started building negative beliefs that they could not

perform well, even before knowing what the questions required, or before an instructor explained what the problem involved. They lost focus on lectures and would rather do another activity (Hannula, 2002).

Research in mathematics education has shown that mathematics anxiety negatively affects the students' success (Thomas & Higbee, 1999; Singh, Granville, & Dika, 2002). A study by Akin and Kurbanoglu, (2011) of 372 university students in Turkey, examined the relationships between mathematics anxiety, mathematics attitudes, and self-efficacy. Using correlation analysis, mathematics anxiety was found to be negatively related to positive attitudes and efficacy, and positively to negative attitudes. Several studies demonstrated that mathematics anxiety was related to a series of variables such as working memory, age, sex, self-efficacy, mathematics attitudes, test anxiety and general anxiety (Zettle & Raines, 2000; Ashcraft & Kirk, 2001). While some studies that investigated gender differences in terms of mathematics anxiety showed that girls experienced mathematics anxiety more than boys, (Zettle & Raines, 2000; Ashcraft & Kirk, 2001). Other researchers (Zettle & Houghton, 1998) asserted that there was not a significant difference between female and male students in their levels of mathematics anxiety.

Additionally, Akin and Kurbanoglu (2011) indicated that mathematics anxiety negatively affects mathematics performance and that girls may report higher levels of mathematics anxiety than boys. Other studies (Zettle & Houghton, 1998) indicated the opposite. However, in the Devine, Fawcett, Szucs, and Dowker, (2012) study conducted with 433 British secondary school children in the 7th, 8th and 10th grades revealed that secondary school children experience mathematics anxiety. Yet, no gender differences were found in mathematics performance but levels of mathematics anxiety and test anxiety were higher for girls than for boys (Devine, Fawcett, Szucs, & Dowker, 2012). Boys and girls showed a negative correlation between

mathematics anxiety and mathematics performance. Regression analyses revealed that mathematics anxiety was a significant predictor of performance for girls but not for boys (Devine, Fawcett, Szucs, & Dowker, 2012).

Psychological literature noted the impact Cognitive Behavioral Group Therapy (CBGT) has on effectively reducing mathematics anxiety in students (Karimi & Venkatesan, 2009). Several scholars, researchers and practitioners agreed psychological treatments such as systematic desensitization, anxiety management training, and Cognitive Behavioral Group Therapy (CBGT) are highly successful in reducing levels of mathematics anxiety (Karimi & Venkatesan, 2009; Hembree, 1990). Many scholars support the research that cognitive factors should be taken into account in the treatment of mathematics anxiety and that CBGT should be the first-line of defense against reducing mathematics anxiety (Karimi & Venkatesan, 2009; Hembree, 1990; Hadfield & Madux, 1998; Genshaft, 1982).

Value of Mathematics

According to Reynolds and Walberg (1992) values usually in mathematics, refers to the output of a function. This concept could be borrowed to give meaning to the value obtained from mathematics; hence, value was the output of benefits accrued from output of a function. The value of mathematics helps students to develop strong beliefs of its relevance, usefulness and worth in relation to their everyday lives (Reynolds & Walberg, 1992). Based on definition, it was important to note that mathematics was one of the most important disciplines in academia. Reynolds and Walberg (1992) noted mathematics is utilized in different spheres of life, including: economics, politics, education, and all of the sciences. Mathematics knowledge was helpful in any subject that a person opts to pursue. It had particular usefulness in research skills, which every subject incorporates. The value achieved from learning mathematics enabled

students to develop theoretical constructs, which could be utilized to create relational frameworks that helped in problem solving or decision making procedures (Reynolds & Walberg, 1992).

The study by Meelissen and Luyten (2008) investigated factors that affected male and female attitudes and achievement in mathematics of students in the Netherlands. Their study followed the findings of the "Trends in Mathematics and Science" (TIMMS, 2003) study that showed that despite developments in sex equality in the country, a male and female gap in mathematics remained significant. Meelissen and Luyten's (2008) study reported a number of key findings. One was that class and school factors influenced attitudes toward mathematics in different degrees, and most of these effects were on female students. There were stereotyped views, covering male dominance in mathematics, between schools to account for 11.2 percent of variance. The study reported that feeling safe in class, a good class atmosphere, and ability grouping could be considered to mitigate the effect of stereotyped perspectives of mathematics by male and female students. Class and school factors affected the liking of mathematics by male and female students, but only to a limited extent. Good class atmosphere and feeling safe in class were positively linked to liking the subject (Meelissen & Luyten, 2008).

Another study Beilock, Gunderson, Ramirez, and Levin, (2010) revealed the impact of factors influence on performance in mathematics differed with male and female. Three factors emerged as having influence on mathematics achievement: self-confidence, feelings of being safe or unsafe, and liking mathematics. However, the influence was only true with female students. Female students who expressed unsafe feelings in mathematics class also tested lower than other students. School curriculum and teaching strategy had moderate to small influence on mathematics achievement. Having a female teacher, more teaching experience, learning

opportunities in class, and a safe class environment as perceived by the teacher, have moderate to small positive effects on mathematics achievement. Other instructional factors, including technique in instruction, did not have any significant relationship to the attitudes toward mathematics (Beilock, Gunderson, Ramirez, & Levin, 2010).

In addition to Meelissen and Luyten's (2008) study that, in part, looked at the influence female mathematics teachers had on attitude and performance. Beilock, Gunderson, Ramirez, and Levin (2010) focused their study on the attitudes of female mathematics instructors and their students. The results showed that if female instructors had mathematics anxiety, they were more likely to have a negative effect on the attitudes toward mathematics and the achievement of female students. Measurement of the effect of female instructor's mathematics anxiety on the attitudes and achievement of female students happened at the beginning of class and then after the course ended. In the beginning, the mathematics anxiety of female instructors showed no significant effect on the attitudes and performance of female students. By the end of the course, when female instructors expressed greater anxiety during the more advanced or difficult topics in class, their female students were more inclined to hold the view that mathematics was the domain of male students, and have lower mathematics achievement (Beilock, Gunderson, Ramirez, & Levin, 2010).

Beilock et al. (2010) reinforced the results of Meelissen and Luyten (2008) on the impact of female instructors on performance, but differed on the influence of female instructors on the attitudes of male and female students. Meelissen and Luyten (2008) reported no impact of female instructors on female students' attitude toward mathematics and a significant impact on male students' attitude toward the subject. Beilock et al. (2010) reported a strong impact of female instructors on female students, especially through the mathematics anxiety of female instructors.

Female mathematics instructors needed to be further examined as an external factor on male and female students' mathematics attitude and achievement. Nevertheless, both studies (Meelissen & Luyten, 2008) and (Beilock et al., 2010) supported sex differences in attitudes toward mathematics.

Enjoyment Toward Mathematics

Many past studies have examined the relationship between students' attitude toward mathematics and their disposition to like or dislike the subject (Nosek, Banaji, & Greenwald, 2002; Ma, 1997; Tapia & Marsh, 2004). In a study conducted by (Ma, 1997), the researcher noted critical intuitive aspects of solving mathematical problems through knowledge or reasoning. Ma (1997) explained that this enabled students to show some positive emotional reaction to mathematics (Ma, 1997). The study linked various aspects of enjoyment to perseverance, interest, enthusiasm, and inspiration toward a mathematical task. These critical elements enabled a student to continue working out a mathematical problem whether it was difficult or not (Ma, 1997).

Mathematics enjoyment was an extremely significant aspect of learning the subject. Therefore, it helped if students had the right attitude to ensure they loved the subject (Tapia & Marsh, 2004). This would contribute to creating enjoyment. Enjoyment of the subject involved a psychological dimension that made students like mathematics, in terms of problems, routine computations, concepts, symbols, as well as the subject's related terms (Aiken, 1974). Enjoyment of the subject was critical given that it aroused appreciation of the underlying mathematical concepts. This enabled a student to recognize the fundamental benefits as well as relevance of mathematics to individuals and society in general. If enjoyment was felt, it could

negate the detrimental elements that surround mathematics among students (Tapia & Marsh, 2004).

A research study by Nosek, Banaji, and Greenwald (2002) examined factors that influenced the male and female attitudes of mathematics students. They noted that female students expressed a stronger negative assessment of mathematics than male students. While there was an assumed negative view of mathematics by students in general, even with the recognized positive contribution of the subject to society, a strong negative evaluation from the responding students in this study could have been due to the liberal arts thrust of the institution resulting in more students engaged in humanities majors instead of the natural sciences (Nosek, Banaji, & Greenwald, 2002).

An online survey by the same authors of 19,000 students from different universities showed the same findings (Nosek et al., 2002). This suggested that the results were not limited to the sample of students majoring in liberal arts. The authors found sex identity did influence likability of mathematics. Their results indicated that sex identification, relative to mathematics, coincided with liking the subject. Students identified with the mathematics stereotype assigned to their sex did typically express the expected liking or disliking of the subject. Female students who aligned themselves with the sex stereotype that mathematics was for men expressed a disliking or low liking of the subject. Females who do not associate themselves with the sex stereotype were more inclined to like mathematics. Upon further investigation of the intervention of college major on the 'sex stereotype-sex identification' effect on attitude, the study found no significant relationship between sex and major (Nosek et al., 2002).

In a study (Hooker, 2011) of small peer-led collaborative learning groups in developmental mathematics classes at a two-year tribal community college revealed that

students' demonstrated overall satisfaction toward remedial mathematics while improving in their mathematics skills. The results of this mixed method study showed that the use of small peer-led groups in developmental mathematics courses had an impact on course completion. Surveys conducted for the research provided evidence that small peer-led collaborative learning groups made the work more fun and worthwhile even when doing very difficult task. The students in the treatment group scored higher on the time spent on out of class studying. The notion was that working with others was more fun, more motivational, and more satisfying than working alone. The treatment group felt that by working together to learn the mathematical concepts they would earn a better grade than working alone. The results supported and focused on the importance of small peer-led collaborative learning groups in education remediation (Hook, 2011).

Self-Concept in Mathematics

Several past studies have identified self-concept as an important element that correlates positively with mathematics achievement (Al-Hebaish, 2012; Stankove, Lee, Luo, & Hogan, 2012). Self-concept affects various aspects of an individual's mathematics performance and learning (Kleanthous & Williams, 2011). For example (Tschannen-Moran, Woolfork , Hoy, and Hoy, (1998) noted low self-concept had an impact on a learners' effort to complete a course or mathematical tasks. Kleanthous and Williams (2011) further explained there was a correlation between self-concept and individual's enrollment in mathematics courses.

The results of the "*Trends in International Mathematics and Science Study*" (TIMSS, 2008) revealed eighth grade Asian students with low self-concept in mathematics (Mullis, Martin, & Foy, 2008). The research study compared the confidence level of students from the eighth grade and the fourth grade. The students at the eighth grade had lower self-concept than

students at the fourth grade, which implied that students lose their confidence toward learning mathematics with the increase in age (TIMSS, 2008). These results alarmed Brown, Brown, and Bibby (2008), who warned that these findings may lead to negative attitudes in students with low self-concept in mathematics and may discourage further learning in the subject. The "*Trends in International Mathematics and Science Study*" (TIMSS, 2008) enhanced awareness of the need to assist students to build their self-concept about learning mathematics (Brown, Brown & Bibby, 2008).

According to Ku, Chen, Wu, Lao and Chan (2013) many students possess low confidence learning mathematics, which in turn, may lead them to give up pursuing more mathematics knowledge (p.65). Moreover, (Pilgrim, 2010) noted that mathematics academic performance and students' belief about mathematics can influence confidence. Self-confidence is critical to the learning process because it provides an indication on learning behavior as well as the degree of effort needed to meet expected outcomes (Kloosterman & Cougan, 1994; Kloosterman & Stage, 1992). The Ku et al., (2013) Game-Based Learning (GBL) study investigated whether the (GBL) learning strategy that engages students through digital games could benefit all students with various levels of mathematics abilities. The results demonstrated that the GBL approach provided better outcomes in both students' confidence and students' performance. The students with high and low levels of mathematics ability in GBL group gained significant improvement in their confidence toward mathematics. Additionally, low-ability students attained better mathematics performance in GBL learning environments (Ku et al., 2013). While GBL may be a possible solution to address the issue of student's confidence in mathematics not all GBL studies consistently reported positive results (e.g. Chen, 2012; Ke, 2009; and Sitzmann, 2011), the

majority of the studies revealed positive effects by applying digital games to the learning environment (Ku et al., 2013).

Several past studies supported the Ku et al., (2013) study which indicated digital games have the potential to enhance students' confidence (Cunningham, 1994; Radford, 2000). Furthermore, students with high self-confidence may attain better performance in tasks and actively engage in task (Kleitman, Stankov, Allwod, Young, & Mak, 2013). Although past studies found a positive effect on GBL, the results were usually reported holistically. Therefore, it was not clear whether every student could benefit from GBL (Ku et al… 2013).

Theories and Empirical Evidence on Male and Female Attitudes Toward Mathematics

While the lack of a commonly accepted definition of attitude toward mathematics created weakness in the conceptual framework of studies and confusion in the emerging working definition of attitude toward the subject, a single definition would likely be too general to be useful in specific studies (Daskalogianni & Simpson, 2000). Zan and Di Martino (2007) suggested that it was best to consider attitude toward mathematics as a functional construct able to include different issues in mathematics learning. Having a guide in studying attitudes toward mathematics through the components of attitude could sufficiently support investigations on this issue. In a later study, Di Martino and Zan (2011) recommended the alternative approach of considering the attitude constructs not in terms of the positive or negative dichotomy, but by exploring different emotional dispositions toward mathematics, visions of mathematics, and perceived competencies in mathematics. This alternative approach widened the components of attitude toward mathematics. It was left to upcoming empirical studies to explore different emotional dispositions, visions, and perceived competencies in mathematics.

Given the functional characteristics of the definition of attitude toward mathematics in the literature, two theories provided solid frameworks in understanding and investigating the topic for this study. One theory was the Disposition Model (Beyers, 2011), which expanded on the emotions, belief and behavior components of attitudes toward mathematics. The other was the theory on self-determination, which added motivation as a component of attitude toward mathematics. These two theories have existed for decades but were applied to studies on male and female attitudes toward mathematics only recently (Beyers, 2011; Yee, 2009).

Mathematical Disposition Model

The mathematical disposition or Disposition Toward Mathematics Model explained attitude toward mathematics in terms of disposition, which had three components, as summarized in Table 2.1 (Beyers, 2011). The mathematical disposition model provided an alternative means of understanding and measuring male and female attitudes toward mathematics by moving beyond the positive-negative dichotomy to exploring multiple components of attitude. These different components could be used to assess male and female attitudes toward mathematics in different learning settings (Beyers, 2011).

The cognitive component of the Mathematical Disposition Model was similar to the beliefs component but it was sub-categorized into connections and argumentation (Beyers, 2011). Connections referred to the interlinking of topics within and across mathematics subjects, such as through the following statement, "In general, I tried to see how mathematical ideas in different mathematics classes were connected to each other" (Beyer, 2011, p. 21). Argumentation pertained to assessments of correctness of mathematical propositions or statements, to reflect a deeper involvement in mathematics, such as the statement, "Even if I am not asked to, I tried to develop and evaluate mathematical arguments to explain things in mathematics class" (Beyer,

2011, p. 21). The affective component of attitude toward mathematics eCOMPASS beliefs and emotions (Beyers, 2011). The affective component was sub-categorized into: nature of mathematics, usefulness, worthwhileness, sensibleness, mathematics self-concept, emotions and mathematics anxiety. The cognitive component was akin to the behavior component and referred to effort or persistence exerted toward mathematics, as exemplified by the following statement, "If someone was having difficulties in mathematics, they could eventually do well if they persist" (Beyer, 2011, p. 21).

Empirical Studies Using Mathematics Disposition

Some empirical studies used the mathematics disposition model to investigate male and female attitudes toward mathematics in college students as context. In an earlier study, Royster, Harris, and Schoeps (1999) surveyed 423 college students enrolled in different mathematics courses to determine their disposition toward the subject. They used major, mathematics background, and sex as sample classifications. Initial attitudes of the 423 students were determined beforehand and succeeding attitudes of 268 students were measured again after six months, this led to having 182 students participating in the initial and follow-up surveys. The results of the initial survey indicated males had greater experience and greater disposition toward mathematics than females. More females (47.28 percent) than males (17.74 percent) expressed anxiety about having to take mathematics subjects. Both males (93.01 percent) and females (95.9 percent) had similarly high satisfaction in being able to solve mathematics (Royster, Harris, & Schoeps, 1999).

The results of the follow-up survey (Royster, Harris, & Schoeps, 1999) showed that after six months, more females (86.4 percent) had increased positive disposition than males (13.6 percent). Nevertheless, there were more males (56.2 percent) than females (43.8 percent) with

decreased disposition after six months. In using the disposition model, the study was able to determine sex-based similarities and differences in disposition toward mathematics and the change in disposition as measures of attitude toward the subject (Royster, Harris, & Schoeps, 1999).

Beveridge (2004), who investigated the link between student disposition toward mathematics and mathematics activities and learning used the *Mathematical Disposition Survey* which is closely aligned with the instrumentalist perspective of mathematics. The results showed a significantly stronger disposition of males than females toward mathematics.

Gresalfi and Cobb (2006) raised the development of discipline-specific literacies accessible to all college students to provide them with equal opportunity to participate in the classroom and build competencies in the learning area. The differences in the disposition of males and females toward mathematics, together with factors explaining the dispositional differences, could support learning strategies that encouraged mathematics learning in males and females.

Gresalfi and Cobb (2006) found that reorganizing classroom practices to include a focus on the dispositions that students are developing towards a particular subject matter involves reframing what it means to teach and learn. Gresalfi and Cobb (2006) noted that it is not sufficient to focus exclusively on the ideas and skills that we want students to learn. Teaching with students' dispositions in mind requires attending to how the discipline is realized in the classroom and the implications for students' development of a sense of affiliation with the discipline (Gresalfi & Cobb, 2006).

Table 2.1*: *Mathematical Disposition Model

Scale	Sub-Category	Description	Sample Statement/Question
Cognitive	Connections	A tendency to try and connect ideas with or across mathematical topics.	In general, I try to see how mathematical ideas in different mathematics classes are connected to each other.
	Argumentation	A tendency to evaluate the mathematical correctness of statements, make mathematical arguments, justify mathematical statements, etc.	Even if I am not asked to, I try to develop and evaluate mathematical arguments to explain things in mathematics class.
Affective	Nature of Mathematics	A belief about mathematics being more procedural or conceptual in nature.	In general, mathematics is made up of procedures and algorithms.
	Usefulness	A belief about the usefulness of mathematics for meeting current of future needs in or out of school, for your career, etc.	I need to learn mathematics because, If I want to be a teacher, I need to learn mathematics.
	Worthwhileness	A value judgment that the work put forth in learning mathematics has been worth it to the student.	All the work I have to put in to learn mathematics has been worth it to me.
	Sensibleness	A belief that mathematics is composed of ideas that can be made sense of.	In general, mathematics is a connected system that can be made sense of.
	Mathematics Self-Concept	What the student believes about him or herself as a learner of mathematics.	In general, math is too challenging for me to really understand it well.
	Emotions	The emotional reactions to mathematical activity in or out of school, e.g. like or hate, etc.	I like doing mathematics in school.
	Mathematics Anxiety	Whether or not the student experiences anxiety in relation to mathematics.	In general, I get stressed out when I have to take a mathematics test.
Conative	Effort/Persistence	A tendency to persist or exert effort if necessary.	If someone is having difficulties in mathematics, they can eventually do well if they persist.

Source: (Beyers, 2011)

Self-Determination Theory

The self-determination theory (Yee, 2009) integrated with attitudes toward mathematics considered motivation as a component of attitude toward the subject, as shown in Table 2.2. The measurement of attitude was through the determination of the extent of motivation toward mathematics (Yee, 2009). The sub-categories of motivation were: amotivation, extrinsic motivation, and intrinsic motivation. These sub-categories of motivation operated in a continuum, which coincided with the degree of self-determination that underlined motives and behavior toward mathematics.

Yee (2009) explained amotivation as falling along the extreme left side of the continuum because it represented beliefs of low value, feelings of incompetence, and non-expectation of positive outcomes from learning mathematics. Table 2.2 Self Determination Continuum Model showed students falling under the left side of the continuum as characterized by low levels of self-determination when it came to mathematics.

Table 2.2: Self-determination Continuum Model (Yee, 2009, p. 682)

Low Self-determination Level Low Autonomy Low Sense of Control			High Self-determination Level High Autonomy High Sense of Control	
Amotivation	Extrinsic motivation		Intrinsic motivation	
	External Regulation	Introjection	Identification	To know, To accomplish To stimulate
Characteristics				
Non-valuing Incompetence	External rewards or punishments	Internal rewards or punishments Valuing	Personal importance Inherent	Interest Enjoyment satisfaction

Extrinsic motivation was in the middle part of the continuum because engagement in mathematics was in pursuance of an unrelated result. Extrinsic motivation was further categorized into external regulation at the leftmost side, introjections in the middle, and identification at the rightmost side. External regulation referred to the motivation to learn mathematics because of anticipated reward or punishment. Introjection meant motivation to engage in mathematics through an individual's imposition of personal rewards or punishment. Identification pertained to motivation to participate in mathematics by accepting the reasons for the subject requirement. Intrinsic motivation was at the extreme right side of the spectrum because it represented high levels of autonomy and control in learning mathematics. Individuals categorized at this point in the spectrum had personal desire to learn and complete tasks in mathematics and, in doing so, experienced pleasure from the process (Yee, 2009).

The levels of motivation corresponded with the degrees of self-determination toward mathematics (Yee, 2009). Higher levels of motivation (intrinsic motivation) were linked to greater self-determination in learning mathematics. Greater self-determination expressed better attitudes toward the subject (Yee, 2009). When applied to investigations on male and female attitudes toward mathematics, the self-determination model provided a spectrum with which to classify male and female students to identify similarities or differences in self-determination and attitude toward mathematics.

In another study, Perry (2011) focused on the goal orientation of education students as a measure of motivation in learning mathematics. Goal orientation was classified into mastery goals, performance-approach goals, and performance-avoidance goals. The results showed that the mastery goals weighed more than performance-avoidance goals, which weighed more than performance-approach goals. Students were more motivated by the desire to understand the

lessons in order not to look bad in class. This study points to a mismatch between the prioritized goals of students and the goals set for the class. There was a need to develop mathematics content in academic courses that also aligned with the mastery goals of students (Perry, 2011).

In addition, mastery goals had a positive correlation with: confidence in learning mathematics, usefulness of mathematics, and mathematics as a male domain (Perry, 2011). Male and female students carried the attitude that mathematics was a male domain and males were able to achieve mastery of the subject better. In performance-avoidance goals, female students' tried to not perform the worst among female students, but it was acceptable to perform worse than the male students. Concurrently, it was acceptable for male students to perform better than others or even worst among male students, as long as performance did not reach the level of the worst female student, or the worst student in the entire class. The male and female motivations of students had varying effects on their attitudes toward mathematics (Perry, 2011).

The Mathematical Disposition Model and part of the Self-Determination theory focused on the individual factors that affected attitudes toward mathematics, specifically male and female attitudes toward the subject (Beyers, 2001; Yee, 2009). Additionally, five factors (motivation, anxiety, enjoyment, self-concept, and value) established specific, yet equally important, indicators of male and female attitudes toward mathematics (Tapia & Marsh, 2004).

Theory on Male and Female Attitudes and Mathematics Achievement

A relevant theory regarding male and female attitudes and achievement was the expectancy value model of achievement-related choices of Eccles (2005), which mapped out male and female attitude constructs and connected these with achievement-related choices and performance. Similar to the theories explaining male and female attitudes toward mathematics discussed in the previous section, the expectancy value model distinguished attitudinal factors

into internal (perception, beliefs, behavior based on expectations and experience of mathematics) and external (sex roles and stereotypes related to mathematics) (Eccles, 2005). The internal and external factors affected goal setting and expectations on mathematics performance, subjective value of mathematics, and identification with mathematics. These had an influence on choices related to mathematics achievement and performance (Eccles, 2005). A recurring explanation for the effect of male and female attitudes on mathematics achievement was the stereotype threat reported in a number of studies. O'Brien and Crandall (2003) explained sex stereotype threat as knowing that there was male and female difference in performance on a course or test in the course. In this case, it was shown by the stronger threat felt by students who were told about the mathematics male and female stereotype, which were females and the concurrent worse performance of females who took the test (O'Brien & Crandall, 2003).

Dar-Nimrod and Heine (2006) further investigated knowledge of male and female stereotype in mathematics and found that the source of the knowledge affected the extent of stereotype threat. They found that female students who read about genetic sex differences experienced greater stereotype threat than female students who read about experiential sex differences.

Schmader (2002) explained that the effect of sex stereotype threat on performance depended on the extent that individuals associated with male and female identity, meaning that women with stronger sex identification performed poorly but women with weaker sex identification performed at par with male students. Kiefer and Sekaquaptewa (2007) found a similar result, with female college students who expressed low sex identification achieving high performance on the final exam and with more likelihood of pursuing mathematics majors in college. Schmader, Johns, and Barquissau (2004) also explained sex stereotype as costly to

female students by affecting self-perception and career pursuit. Female students in mathematics-based courses who held stronger beliefs of the sex stereotype felt a greater threat, which likely limited their performance and continuation of their career path in jobs applying mathematics.

Miller and Bichsel (2004) explained that stereotype threat caused mathematics anxiety, which comprised the strongest determinant of students' performance in basic and applied mathematics. Keller (2002) reported that strong stereotype threat heightened self-handicapping by female students and found that decreasing the stereotype threat by lessening expectations on sex stereotypes in mathematics caused significant improvements in performance. Moreover, Kiefer and Sekaquaptewa (2007) also explained that efforts to reduce stereotype threat in mathematics offered the most benefit to female students who strongly identified with sex stereotype in mathematics.

Hyde, Lindberg, Linn, Ellis, and Williams (2008) used sex similarities between males and females found in a previous study by Hyde and Linn (2006). They used the characteristics of mathematics achievement in assessing the mathematics performance of around seven million students on a standardized test conducted in all fifty U.S. states. The authors reported the mean difference in mathematics performance of female and male students was 0.0065, which is statistically insignificant. The authors found that sex similarities explained the insignificant relationship between male and female attitudes and mathematics achievement (Hyde & Linn, 2006).

The evidence supporting and negating the relationship of male and female attitudes and mathematics performance were both worth considering. The focus of evidence supported the link of male and female attitudes with mathematics performance were mostly on external components of attitude. Moreover, the strategies or techniques to reduce stereotype threats had not been well

explored in the literature. Evidence negating the link focused only on test performance without exploring actual attitudinal impact (Hyde & Linn, 2006; Kiefe & Sekaquaptewa, 2007).

Investigations on Male and Female Differences in Attitudes and Mathematics Achievement

Over the past four decades, there has been ongoing speculation about the reasons for sex differences in both science and mathematics careers. Differences between male and female students in mathematics attitude and achievement have been extensively investigated, by researchers and scholars in the field (Lloyd, Walsh, & Yailagh, 2005; Santos, Ursini, Ramirez, & Sanchez, 2006). Several earlier studies indicated males' mathematics achievement was superior to that of their female counterparts (Wainer & Steinberg, 1992; Hedges & Nowell, 1995; Randhawa, 1994). It has been well-documented that females score lower on the standardize test (SAT) Scholastic Aptitude Test on average than males (Liu & Wilson, 2009). 'Males have outperformed females on many domestic and international assessments such as the National Assessment of Educational Progress (NAEP), SAT, Trends in Mathematics and Science Study (TIMSS), and Program for International Student Assessment (PISA) in the United States (Liu & Wilson, p. 165). However, according to more recent studies indicated mathematical skills of males and females, men and women, are notably equal (Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006).

Sex Differences in Mathematics Achievement

According to a study conducted by the National Assessment of Educational Progress (2007), mathematic achievement of males and females as well as men and women, have shown to be substantially equal. The *Trends in International Mathematics and Science Study* (TIMSS) conducted mathematics assessments between (1990-2007) of over 1.2 million people analyzed in 242 scholarly journals. The study researched male and female differences in mathematics

achievement. The findings indicated that the differences between the two sexes were so close that it proved meaningless. Amongst scholars in the field of social science, the idea that both males and females have equal mathematical ability was widely accepted (Hyde, 2010). Data released in 2003 that examined both the *Trends in International Mathematics and Science Study* (TIMSS) and the *Programme for International Student Assessment* (PISA), represented 493,495 students between the ages of 14-16 from nearly 70 countries. Although not all countries participated in both studies, the two tests offered a quality sampling of students' mathematical abilities. While these measures tested different mathematic achievement, on average there was only a slight difference in abilities between the two sexes. The two studies also, examined students' confidence level in the mathematical abilities and how imperative students felt it was to do well in mathematics in order to have a successful career. Regardless of the overall similarities in mathematics skills, boys felt significantly more confident in their abilities than girls and were additionally more motivated to do well (Else-Quest, Hyde, & Linn, 2010).

Several studies concurred with the two landmark studies *Trends in International Mathematics and Science Study* (TIMSS, 2003) and the *Programme for International Student Assessment* (PISA, 2003) that there were just no differences in mathematic performance between males and females. (Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006). A team of researchers compiled and examined data including SAT results and mathematic scores from 7 million students tested in accordance with the No Child Left Behind Act (Else-Quest, Hyde, & Linn, 2010). The researchers revealed that the mathematic performance of females measured up to their male counterparts. The study examined detailed statistics from the sample including gender, grade level, and ethnicity in 10 different states. This quantitative study revealed an 'effect size,' the statistic that reports the degree of difference

between girls and boys average mathematic scores in standardized units. The effect size ranged from 0.01 to 0.06 -- were basically zero, which indicated that the average scores of girls and boys were nearly identical (Hyde, 2008; Else-Quest, Hyde, & Linn, 2010).

In a 2007 study, 'Is Victor Better than Victoria at Math' examined whether males and females in their early adolescents differed in actual mathematic achievement and attitude toward mathematics. The findings in this research provided contradictory evidence that boys were better in mathematics than girls and their better attitudes toward mathematics led to better mathematic performance (Georgiou, Stavrinides, & Kalavana, 2007). This quantitative investigation examined 225 eighth grade students (within an average age of 14 years old) during a randomly selected public junior high school in Cyprus. The findings of the study revealed there were no significant differences found between boys and girls in their mathematic achievement (Georgiou, Stavrinides, & Kalavana, 2007). The study participants completed a questionnaire that not only measured their attitude toward mathematics but their attributions of their own mathematics achievement. The study found a significant difference in the way the two sexes viewed their individual performances. The boys more than girls in the study, believed that their mathematical abilities were the cause of their high marks in mathematics. Additionally, the findings revealed that the high mathematical achievement could predict a positive attitude toward mathematics but not vice versa.

Santos, Ursini, Ramirez, and Sanchez (2006) reported that there were no significant differences between male and female mathematical achievement. The study provided a distinction between sex versus gender and determined through a quantitative study of 1056 students ages 12-13 years old that there was a significant differences in mathematic performance when gender trait of (*masculine, feminine, androgynous and undifferentiated*) was taken in

account however, there was no significant difference when sex (biological characteristics) were examined. This study was part of a longitudinal research that analyzed data of male and female students' mathematical differences as the focus of the investigation. The data revealed that no significant differences were found ($X^2 = 2.71$, with $p > .05$ and $df = 3$, which corroborated with the findings in recent international research investigations (Georgiou, Stavrinides, & Kalavana, 2007).

In a four-year longitudinal quantitative study conducted by (Lachance & Mazzocco, 2005) designed to explore sex differences in mathematics achievement, mathematics ability and mathematics related task during the primary school age years. The overall purpose of this investigation was to determine if sex differences were apparent during the primary school years. This research investigation focused on three areas; 1) whether girls or boys were overrepresented in either the upper or lower percentile of mathematics performers, 2) whether the rate of mathematic development differed for boys and girls and 3) whether there were potential sex differences in predictors of poor mathematic achievement. The participants included over 200 children from a large suburban public school district. All kindergartners at the schools were invited to participate, except children with mental retardation or limited English proficiency. Of the participating schools 66.67% of eligible participants enrolled, resulting in 249 respondents of which 120 were boys in the initial sample (Lachance & Mazzocco, 2005).

The findings in the study revealed that sex differences in mathematics were minimal or nonexistent on standardized psychometric tests routinely given in assessments of primary school age children. Additionally, the study supported no persistent finding that suggested a male or female advantage in overall mathematics performance. Growth rates for all skills were comparable for both boys and girls. The findings in this study failed to support either persistent

or emerging sex differences on non-specialized mathematical ability measured during the primary school age years (Lachance & Mazzocco, 2005).

According to (Lloyd, Walsh, & Yailagh, 2005) study that claimed sex differences in mathematics achievement were related to boys' and girls' differing achievement-related beliefs. The research compared the mathematics report cards grades, 2001 Foundation Skills Assessment (FSA) Numeracy subtest scores, performance attributions, and self-efficacy of 161 British Columbian public school students (62 fourth-graders, 99 seventh-graders). Fourth-grade participants were drawn from five public elementary schools, and seventh-grade participants were drawn from two public middle schools. All schools were located in one school district in a suburban area of a moderate-sized city in British Columbia.

The findings in the Lloyd, Walsh, and Yailagh (2005) study revealed promising results in terms of girls' mathematics performance for several reasons. First, the results showed that girls' achievement in mathematics met or exceeded that of boys. Second, it seems that there have been relative gains for girls in terms of attributions. However, girls were more apt to display under-confidence relative to their actual mathematics achievement and they attributed mathematics failure to a lack of teachers' help than boys.

Sex Differences in Attitudes Toward Mathematics

Mathematics education has noted attitude as one of the important variables that determined a students' success. Cetingoz and Ozkal (2009) noted that attitudes affect the students' interaction with their friends, families, school and lessons. Therefore, a student's attitude toward mathematics could add to the success of their performance in a course (Cetingoz & Ozkal, 2009).

In an investigation conducted by Mohd and Mahmood (2011), the purpose of this research was to determine the effects of attitude in problem solving toward mathematics achievements of *Malaysian Institute of Information Technology* (MIIT), Unviersiti Kuala Lumpur (UNIKL) students during the January-June 2011 semester. The *Student Attitude Questionnaire* used was adopted from Charles, Lester, and O'Daffer, (1997) and was translated by Effandi (2003). The sample comprised a total of 153 diploma and degree students of various programs. There were 70% male and 30% female students involved in the study. From the analysis of the data, it was found that there was no significant difference between the sexes and their attitude toward problem solving. The findings of this study concurred with the research conducted by (Mokhtar, 2000; Effandi & Normah 2009; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Popoola, 2000).

According to Effandi and Norman (2009), explained that in general there was a correlation between students' attitudes and their ability to solve mathematical problems. They added that negative attitudes needed to be overcome, so that students will not suffer from lack of problem-solving abilities in their later years. The two scholars noted that it was important that students' mastered problem solving because these skills would be essential for dealing competently with everyday life. Their claim was supported by O'Connell (2000) who pointed out that students must have positive attitude toward problem solving if they were to succeed. He proposed that solving problems required patience, persistence, perseverance and willingness to accept risks. This concurred with Papanastasiou (2000) who claimed that students with positive attitude toward mathematics would generally succeed.

In a study conducted by (Tapia & Marsh, 2000), who examined the effects of gender, mathematics achievement, and ethnicity on attitudes toward mathematics were explored using

the *Attitude Toward Mathematics Instrument* (ATMI). This survey was completed by 545 students at a college preparatory, bilingual school in Mexico City. Mathematics attitudes (self-confidence, value, motivation, and enjoy) served as the dependent variables. Gender, mathematics achievement and ethnicity were the independent variables. Multivariate analysis of variance was performed. The findings revealed that male students scored higher than female students on self-confidence and value. Students who received a failing grade scored the lowest on self-confidence, motivation, value, and enjoyment (Tapia & Marsh, 2000).

In accordance with much of the literature in the field, (Farooq & Shah, 2008; Pilgrim, 2010) noted, that there is a relationship between achievement and students' attitude toward mathematics and that students' success in mathematics depends upon attitudes toward mathematics. Farooq and Shah (2008) also pointed out that attitudes toward the subject also influenced the participation rate of the learner. In their quantitative study (Farooq & Shah, 2008) surveyed 685 students (379-males and 306 females). The study participants were 10^{th} graders conveniently selected from 10 private and public sector schools. Students' attitudes were measured by using the *Fennema-Sherman Mathematics Attitude Scale* questionnaire (a = 0.7452). This instrument was based on a Five Point, Likert scale. The data from the study was analyzed through SPSS by applying statistical measures accordingly. Descriptive statistics and *t*-test with ($p < 0.05$) level of significance. The conclusion of the study revealed, that 10th grade male and female students of the secondary schools of Lahore had the same type of attitude toward mathematics. Therefore, the findings in this study found that sex differential had no impact on the attitude of students toward mathematics in Pakistan (Farooq & Shah, 2008).

According to another study conducted in Ghana, attitudes toward mathematics and associated anxiety were found to plague students with diverse socio-economic backgrounds

(Asante, 2012). The participants for this study were high school students in the Greater Accra region in Ghana. Three high schools were selected to participant in the study. A total of 184 students participated in the study, which included 111 boys and 74 girls. The mean age of the students were 17.39 years ranging from 16 to 21. The researcher measured students' attitudes by using the well validated measure, *Attitude Toward Mathematics Inventory* (ATMI), developed by Tapia and Marsh (2000). The ATMI questionnaire contained 40 items rated on a Five Point, Likert scale of (Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree). It had a reliability Cronbach alpha coefficient of (0.97). Data were analyzed using SPSS (16.0). The findings of this study showed that there was a significant difference in attitudes toward mathematics between males and females in the study. The researchers noted that the significant sex differences observed in the attitudes between the sexes could be due to the large effect size of .80 for self-confidence and .68 for enjoyment. The analyses suggested that high school males in the study showed more positive attitude toward mathematics than females. The findings in this study indicated sex differences in attitude toward mathematics between boys and girls in high schools in Ghana. This investigation coincided with several other scholarly literature research regarding sex differences in mathematic attitudes (Asante, 2012; Tapia & Marsh, 2000).

According to another study in Turkey noted, that gender did not affect students' attitudes toward mathematics (Guner, 2012). The research examined whether students' attitudes toward learning mathematics varied based on the type of high school and gender; and whether they used different metaphors to describe their mathematical learning experiences. The study utilized 699 12^{th} grade students (317 females and 352 males) of two Anatolian and two vocational high schools located in a city center in the Aegean region of Turkey. The findings revealed that vocational high school students had more negative attitudes than Anatolian high school students

toward learning mathematics. However, sex did not affect students' attitudes toward mathematics (Guner, 2012).

A research investigation, in Italy by Muzzatti and Agnoli, (2007) revealed that as students progress from primary to secondary school, independent of gender, adjusting to mathematics became more difficult. However, six to seven year old female students, who had just started school considered themselves better than male students of the same age; yet that perception was reversed when students reached the ages of 12 and 13. Furthermore, in a study conducted by Wilkins and Ma (2003), students showed a decline in students' attitudes toward mathematics. The study investigated 3116 students from 6^{th} grade until the 12^{th} grade.

Prediction of Students' Attitudes on Mathematics Achievement

Several mathematics educators, scholars and researchers have established the importance predictors of attitudes toward mathematics on achievement (Singh, Granville & Dika, 2002; Webster & Fisher, 2000). Student achievement in the study of mathematics has been linked to attitudes toward the subject and influenced by many variables including success and perseverance (Webb, Lubinski, & Benbow, 2002). However, attitude is one of the variables that have been known to be a critical factor that relates to mathematics achievement (Ma & Kishor, 1997). Self-confidence has been positively associated as a good predictor of success in mathematics achievement. Preliminary evidence from attitudinal research, however, has been primarily concerned with students in K-12 and little is known about college students (Tapia & Marsh, 2005). The following research studies reflect students' attitudes toward mathematics and factors that predict mathematics achievement.

According to Ganley and Vasilyeva (2011) whose quantitative study examined mathematics achievement and attitude as predictors of mathematic performance in middle-school

students. The research compared the patterns of the predictive relationships for both boys and girls. The participants in the study were 114 eighth-grade students (67 girls and 47 boys). The respondents were recruited from a middle-class Northeastern suburb. The average age of each of the participating student was 14 years old. The researchers used two curriculum-based assessment measures: (a) scores on the state-administered test, the *Massachusetts Comprehensive Assessment System* (MCAS) and (b) grades received in the course. Two of the subscales of the *Fennema-Sherman Mathematics Attitude Scales* (Fennema & Sherman, 1976) were used in conducting this research; The *Confidence in Learning Mathematics Scale* and the *Mathematics Anxiety Scale*. Both the mathematics attitude scales and the mathematics grade questionnaire were administered to the students by their mathematics teacher. Ganley and Vasilyeva (2011) findings revealed that middle-school boys and girls, generally, demonstrate the same levels of mathematics achievement. Additionally, the findings indicated that attitudes, as indexed by confidence and anxiety about mathematics, were related to mathematics performance in both girls and boys in middle school. The relationship, however, appeared to be more consistent in girls.

Ma and Kishor (1997) reported in an early meta-analysis study that mathematics attitude was a significant predictor of mathematic achievement whereas the reverse model was not significant. However, in a later study, Ma and Xu (2004) found that prior mathematics achievement had stronger impact on anxiety than did anxiety on mathematics achievement. Thus, existing research has produced mixed results. Most likely, the relationship between attitudes and performance was bi-directional. For instance, higher levels of anxiety may have led to lower levels of mathematics performance, which in turn, may have reduced students' confidence and further increased their anxiety (Ma & Xu, 2004).

A research investigation by Mohd, Mahmood and Ismail (2011) examined the relationship between attitudes (patience, confidence, and willingness) toward problem solving and mathematics achievement. The study used a survey questionnaire to gather data from 153 students in their first semester of a diploma and bachelor program. The analysis of the data found that there were no significant difference between confidence and willingness toward problem solving and their mathematics achievement. On the other hand, there was a significant relationship between attitude toward problem solving and mathematics achievement.

Effandi and Normah (2009), found that students' attitudes toward mathematics were not only related to mathematic achievement but also to problem solving in a students' personal life. The researchers explained that negative attitudes needed to be overcome, so that later in life, students would not suffer from poor problem-solving skills. The importance of mastery in problem solving skills was noted as skills essential for dealing successfully with everyday life. This study was supported by O'Connell (2000) who pointed out that "students must have positive attitude toward problem solving if they are to succeed. The study proposed that solving problems required not only a positive attitude but patience, persistence, perseverance and a willingness to accept risks" (p. 50). This coincided with Papanastasiou (2000) study, which stated that generally students with positive attitudes toward mathematics excel in the subject.

According to Andrew, Salamonson and Holcomb (2009), a students' self-concept and expectations of their individual ability to succeed in mathematics provided a reliable predictor of whether or not they would attempt a task, the amount of effort they would spend on a task, and their level of evaluation of performance in a variety of academic areas but a major focus was related to mathematical skills. Likewise, Tooke and Lindstrom (1998) found that confidence in

learning mathematics and problem solving was critical to ensure excellent achievement. Therefore, it was assumed that confidence played a significant role in mathematics achievement.

Interaction Between Sex and Mathematics Achievement on Attitude

According to (Kadijevich, 2008) a *Trends in International Mathematics and Science Study* (TIMSS, 2003) quantitative study examined the interaction between sex, mathematics achievement on attitude. The sampled consisted of 137,346 eighth grade students from thirty-three countries. Both individual and collective interactions of the dimensions were explored to determine the dimension most related to attitudes. The study found that each dimension of mathematics attitude alone was positively related to mathematics achievement for nearly thirty three countries; self-confidence in learning mathematics (SCLM) was primarily related to mathematics achievement for thirty-one countries; liking mathematics (LM) was negatively related to mathematics achievement for thirty countries, whereas usefulness of mathematics (UM) was not related to mathematics achievement for twenty-one countries; and positive collective relationships of self-confidence, liking mathematics and usefulness to mathematics achievement considerably varied from country to country (Kadijevich, 2008).

A study conducted by Wilkins (2004) agreed with the finding from the *Trends in International Mathematics and Science Study* (TIMSS, 2003) which found a positive relationship between achievement and self-concept in 8th graders from almost all countries that participated in the earlier investigation. Furthermore, a positive relationship for almost all countries that participated in the *Trends in International Mathematics and Science Study* (TIMSS, 1999) study was reported by (Shen, 2002) but not only for 8th graders' achievement and self -perceived competence, but also between their achievement and how much they liked the subject.

The correlation of self-confidence in learning mathematics and mathematics achievement varied considerably from country to country (from 0.04 for Indonesia to 0.61 for Korea). Although smaller in scale, the study found the correlation of liking mathematics and mathematics achievement (from 0.02 for Indonesia to 0.48 for Korea) as well as the correlation of usefulness of mathematics and mathematics achievement (from 0.00 for Macedonia to 0.40 for Korea). These same patterns could be found in other studies (Shen, 2002; Wilkins, 2004).

Several earlier studies noted that there was a positive interaction between mathematics attitude and achievement (Ma & Kishor, 1997). They additionally, stated there was a positive relationship between self-concept about mathematics and achievement in mathematics. In general, mathematics attitude, mathematics achievement and self-confidence in mathematics had been well-documented in the literature for a positive relationship particularly for problem solving. In regards to the *Trends in International Mathematics and Science Study* (TIMSS, 2003) research, a positive association was found not only between mathematics attitude and achievement but also between self-perceived competence in mathematics and mathematics achievement (Kadijevich, 2008).

A quantitative study conducted by Tapia and Marsh (2000), examined gender, mathematics achievement and attitudes toward mathematics. The investigation used the ATMI, *Attitude Toward Mathematics Inventory* to analyze data from 545 bilingual students at a college preparatory school in Mexico City. Multivariate analysis was performed. The study found that there was an effect of the achievement variable on self-confidence, value, enjoyment and motivation. ‘A’ students scored higher than B, C, D, and F on all four factors. ‘B’ students scored higher than C, D, and F students on self-confidence, enjoyment, and motivation and higher than ‘F’ students on value. ‘C’ students scored high than ‘F’ students on all four factors.

'D' students scored higher than 'F' students on self-confidence and enjoyment. Overall, on self-confidence and value the male students in the study scored higher than female students. Letter grade was significant with 'A' students scoring higher than others on all four factors of the ATMI. Failing students scored the lowest on self-confidence, motivation, value, and enjoyment (Tapia & Marsh, 2000).

Gap in the Research

Contradictory evidence on the significance of sex on attitudes toward mathematics and performance emerged from the literature. One explanation was the varying strengths of influence of the factors involved and explanations on the effect depending on the context. There was need for further studies on the topic to draw evidence to clarify contradictory evidence. Solutions to the issues had not been widely addressed in the literature. It was also important to investigate evidence from the literature in contexts that had not been well explored, such as community college students (DiMartino & Zan, 2011; Eccles, 2005; Hannula, 2002).

Summary

Overall, theory and empirical literature supported differences in the attitudes of male and female students toward mathematics. Yet, most of the more recent literature indicated there were no significant difference between mathematics achievement between boys and girls, males and females. However, the common conceptualization of positive and negative attitudes toward mathematics resulted from working definitions depending on the component of attitude investigated and context of the investigation. Moreover, varying strengths of influence and explanations emerged from the different attitudinal factors. In addition, the existence of varying perspectives pointed to the need for further studies on the topic, to draw evidence and support the majority of findings and explain the outcome of the minority findings in the research. This

chapter focused on the extensive literature in the field on the background of community college remediation, a clear definition of attitude toward mathematics along with a conceptual framework and theory that synthesized the relationship between sex differences in students' achievement and attitude toward mathematics.

CHAPTER 3: METHOD

This chapter provides the structural framework for the data collection and analysis. The comparative investigative approach used in this study evolved from the research questions and subsequent literature review presented in Chapter 2. The literature in the field provided an overview of dominant trends in studies on differences in male and female mathematics achievement and presented research on 'attitude' as the bridge between the two factors. This chapter discusses the components of research design, participants and sampling, measurements, instruments, reliability, validity, data collection, and analysis.

Research Approach

This non-experimental quantitative research design utilized a descriptive, comparative, and associative approach to investigate the relationships between male and female community college students' academic achievement and attitude toward remedial mathematics. This random sample of $N = 154$ students consisted of 62 males and 92 females. The attribute independent variable (male and female students) was the primary focus of this investigation. The dependent variable of students' remedial mathematic achievements was measured by the Pre-college Algebra course results. The study examined attitude differences in remedial mathematics on five constructs using the *Attitude Toward Mathematics Inventory*, ATMI survey; 1) motivation, 2) anxiety, 3) value, 4) enjoyment and 5) self-concept. More specifically, the research questions helped to guide this investigation. Figure 3.1 provided a diagram of the overall research approach used to answer the research questions.

RESEARCH APPROACH AND PURPOSE

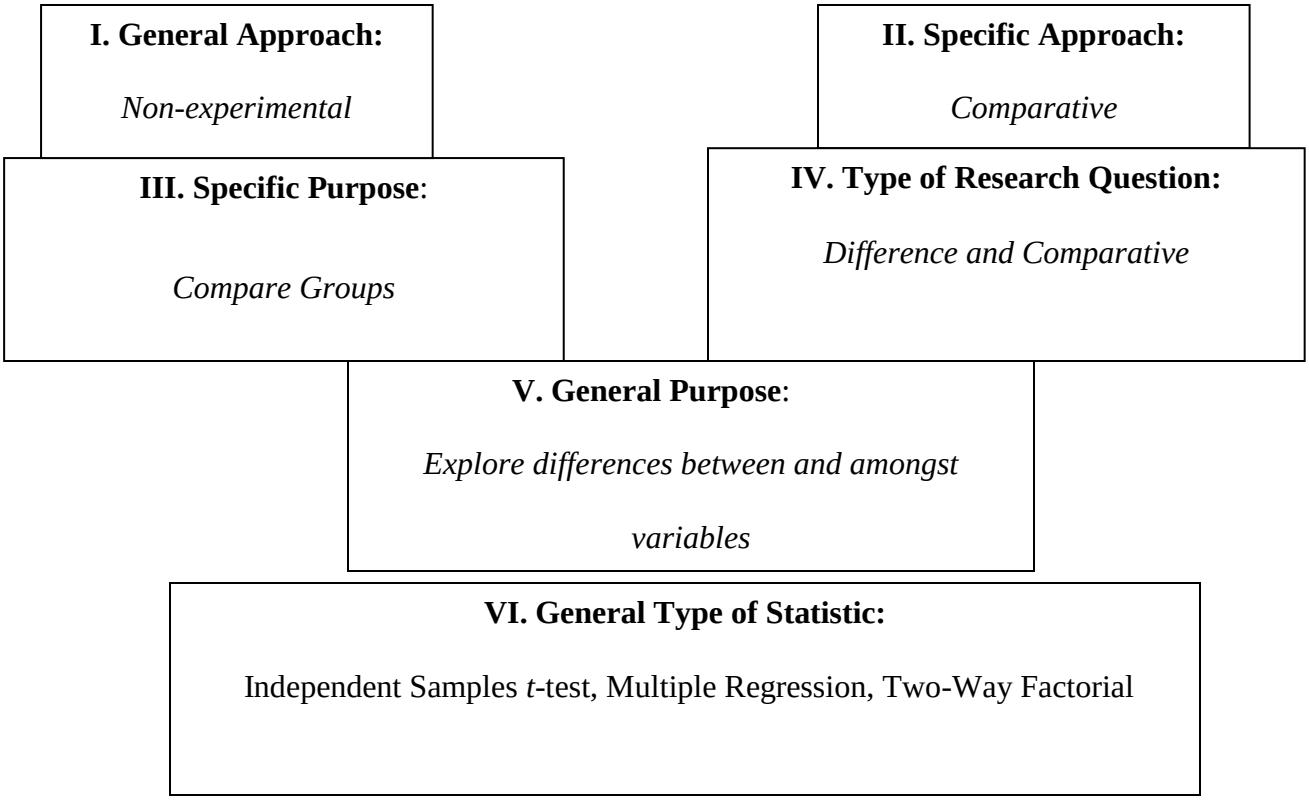

***Figure 3.1*. Overall research approach, purpose, and general statistics used to answer the research questions.**

Research Questions

The research questions in this study included:

Q1. Are there differences between male and female community college students on remedial mathematic achievement Pre-college Algebra assessment as measured by the COMPASS?

Q2. Are there differences between male and female community college students on attitudes toward mathematics (motivation, anxiety, value, enjoyment, and self-concept) as measured by the (ATMI) *Attitude Toward Mathematics Inventory* survey?

Q3. How well does the combination of sex, community college students' attitudes (*motivation, anxiety, value, enjoyment and self-concept*) about mathematics predict remedial mathematic achievement results?

Q4. Is there an interaction between male and female community college students and remedial mathematic (pass/fail) achievement on (*motivation, anxiety, value, enjoyment, and self-concept*)?

Participants in the Study

The participants in this study consisted of $N = 154$ first year freshmen students (62 males and 92 females) enrolled in the same 15-week remedial mathematics Pre-college Algebra course at a two-year community college located in southeastern United States. The participants were first-year freshman students who performed poorly on the COMPASS Mathematics Exam and were required to enroll in a remedial Pre-College Algebra course before advancing on to college level mathematics courses. Participants were enrolled in the 4-credit hour course during the 2012 Fall Semester. The respondents who participated in this study attended classes offered from 7:00 a.m. until 5:00 p.m. on Monday/Wednesdays and Tuesday/Thursdays course sections. Based on the total number of (Pre-college Algebra) courses offered on the northeastern campus 19 out of 35 sections were selected by the community college Mathematics Department Chair for participation in this study because these sections were taught by full-time faculty members.

All student participants in this study were enrolled in (Pre-college Algebra) courses taught by full-time mathematics professors. Student participants enrolled in course offering on Fridays and Saturdays were not included in this study. Those course sections were taught by part-time instructors. Respondents were asked to complete the self-reported survey questionnaire ATMI, *Attitude Toward Mathematics Inventory* administered by the mathematics professor. Only those students who answered all items on the survey and who took the

COMPASS Mathematics Exam were included in the study. The ATMI self-reported survey was administered to students during the twelfth week into the course. This timeline allotted for student(s) to drop or add the course and for the participants to establish their attitude and perception about the course in an effort to provide valuable feedback and insight.

Setting of the Study

The community college setting for this research study took place on the northeastern suburban campus of one of its five locations. The total enrollment of the college at the time of this study was 21, 371. The college was founded in 1964. It is one of the five largest institutions in its university system and the top associate degree granting institution in its state. The average age of students enrolled in the institution was 25.2 years old. The age demographics by gender consisted of 12,458 (58%) females and 8,913 (42%) males campus wide. The ethnicity profile of the students were Asian: 2,451 (11.7%); African American: 9,018 (42%); Hispanic: 2,140 (10%); Multiracial: 754 (4%); Native American: 51 (.2%); Native Hawaiian/Pacific: 25 (.1%); White: 6,653 (31%); Unknown/Undeclared: 279 (1%).

The setting for this course was unique in that students were taught in a lab using computer-based learning technology entitled, the *Assessment Learning Knowledge Space*, ALEKS. Students navigated through the course at their own pace. ALEKS is a software package that assesses what students currently know and through artificial intelligence customized according to the student's needs and abilities. Once a student has mastered the prerequisite topics for a more advanced topic, ALEKS will then make that advanced topic available. If the student is unable to master the new advanced topic in a set amount of tries, then the software will have the student re-work the pre-requisite topics again. If the student fails to re-master one of the pre-requisite topics, it will then make the student rework the pre-requisite. ALEKS works on the idea

if a student is struggling with a topic, then there must be some lack of mastery on a previous topic that leads to the current one. A student can go back several layers of topics in order to build up to the advanced topic again. This technology ensures that students gain topic mastery from the course beginning to the end. Table 3.1 illustrates the sampling design utilized for this study.

Table 3.1: Sampling Design for Mathematics Achievements and Attitude

Theoretical or Target Population	**Accessible Population**	**Selected Sample**	**Actual Sample**
Students enrolled in a remedial mathematics course at all two-year colleges in the U.S.	Students enrolled in a remedial mathematics course at a two-year college in southeastern U.S.	Students enrolled in a 15-week remedial mathematics course at one of five-campus two-year college in southeastern U.S during the Fall Semester 2012.	Students enrolled in 19 sections of a 15-week remedial mathematics course taught by full-time faculty at one of five-campus two-year college in southeastern U.S. who participated in the study by completing the *Attitude toward Mathematics Inventory* survey and completed the COMPASS EXAM as a final test.

Research Measurements

The research measurements were utilized to explore differences between and amongst independent and dependent variables. The variables in the study were coded as follows:

Sex: measured by (0 = Males; 1 = Females) male and female two-year community college students enrolled in a remedial mathematics (Pre-College Algebra) course.

Academic Achievement: measured by (0 = Failed; 1 = Passed) Pre-College Algebra course and (8 - 90) raw scores on the COMPASS Exam as a final assessment in the course. (NOTE: Students were not eligible to take the COMPASS Exam Final without first passing the course with a 'C' grade or better--however, course grades were not collected in the data set. This data reported Pre-college Algebra course results as pass/fail). This study used ACT's eCOMPASS, which was in use during the time this research was conducted. There are five COMPASS Mathematics domains –

1.) COMPASS Pre-Algebra

2.) COMPASS Algebra

3.) COMPASS College Algebra

4.) COMPASS Geometry

5.) COMPASS Trigonometry

The university system uses eCOMPASS Algebra exam 4.0. The package for COMPASS exam was a basic COMPASS Algebra test. The test was set up at "Maximum (about 15 questions)" for evaluation as recommended by the university system. Students in both tests would be asked basic demographic information - Name, Date of Birth, Student ID, Gender, and Ethnicity.

The COMPASS exam was designated as a post-test final exam for students enrolled in (Pre-college Algebra). This post-test final was entitled the COMPASS Exam by the college and used as the final exam in Pre-college Algebra.

Attitude toward Mathematics: measured by the scores on the 32-item, Five-Point Likert *Attitude Toward Mathematics Inventory* (ATMI) self-reported questionnaire. The five constructs of attitude consisted of: 1) motivation in mathematics; 2) anxiety toward mathematics; 3) value toward mathematics 4) enjoyment toward mathematics; and 5) self-concept in mathematics indicated by 1) - *Strongly Agree*, 2) - *Agree*, 3) - *Neutral*, 4) - *Disagree*, and 5) - *Strongly Disagree*).

Research Instruments

Two instruments were used in the data collection process for this investigation. First, the *Attitudes Toward Mathematics Inventory* (ATMI) was the instrument used to measure students' attitudes toward mathematics. Second, Pre-college Algebra course was used to measure students' remedial mathematic achievement.

Attitude Toward Mathematics Inventory (ATMI) Instrument

Attitude Toward Mathematics Inventory (ATMI) was the most current instrument designed by the Minnesota Research and Evaluation Project and was intended to measure the perception of students' attitude toward mathematics. The ATMI was initially developed using high school students in a private school. Over the past ten years, the ATMI has been modified to increase its effectiveness in measuring students' attitude toward mathematics. The instrument was constructed to address factors deemed important in the area of mathematics attitudinal research (Tapia & Marsh, 2004).

This study utilized the ATMI survey. The questionnaire provided a 32-item multi-dimensional self-rating scale containing statements about perceptions of mathematics. The items were constructed using a Five-Point, Likert scale consisting of: 1) - *Strongly Disagree*, 2) - *Disagree*, 3) - *Neutral*, 4) - *Agree*, and 5) - *Strongly Agree*. The survey took approximately 10 to 15 minutes to complete. The five ATMI categories included:1) motivation, 2) anxiety, 3) value, 4) enjoyment, and 5) self-concept. Each of these constructs was used to operationally measure students' perception and beliefs about mathematics.

Motivation: This was a construct on the ATMI instrument that was intended to measure the process of a students' desire or willingness to perform in mathematics. Sample items on the instrument from this category were, "Sometimes I read ahead in our mathematics book. I had a real desire to learn mathematics. Sometimes I worked more mathematics problems than were assigned in class" (Tapia & Marsh, 2004, p. 12).

Anxiety: This was a construct on the ATMI instrument that was intended to measure the apprehension or distress a student experienced when learning mathematics. Sample items on the instrument from this category were, "I felt tensed when someone talked to me about mathematics. It scared me to have to take mathematics. Working numbers upset me" (Tapia & Marsh, 2004, p. 12).

Value: This was a construct on the ATMI instrument that was intended to measure mathematics usefulness or worth to the student. Sample items on the instrument from this category were, "Mathematics was a very worthwhile and necessary subject. Mathematics courses would be very helpful no matter what I decided to study. Mathematics was important in everyday life" (Tapia & Marsh, 2004, p. 12).

Enjoyment: This was a construct on the ATMI instrument that was intended to measure the degree to which students liked or disliked their experience in mathematics. Sample items on the instrument from this category were, "I enjoyed talking to other people about mathematics. Mathematics was something, which I enjoyed very much. I didn't like anything about mathematics" (Tapia & Marsh, 2004, p. 12).

Self-Concept: This was a construct on the ATMI instrument that was intended to measure how students think about and perceive their performance in mathematics. Sample items on the instrument from this category were, "I was good at working mathematic problems. I felt at ease in a mathematics class. Mathematics was easy for me" (Tapia & Marsh, 2004, p. 12).

Reliability of the Instrument

Reliability in quantitative research designs determines a study's effectiveness. Producing reliable results was the inherent objective of this research design. Otherwise, the results produced in this study could not be accurately assessed (Morgan, Gilner, & Harmon, 2006, p. 153). Morgan et al. (2006) defined reliability as follows:

> Reliability referred to consistency of scores on a particular instrument. It would be incorrect to state that a test was reliable. Instead, we were interested in the scores from the test, taking into account the sample that took the test....When we used tests or instruments to measure outcomes, we needed to make sure that they provided us with consistent data. (p. 44)

Agresti and Finley (2009) also concur, stating:

> The extent to which results were consistent over time and an accurate representation of the total population under study was referred to as reliability and if the results of a study could be reproduced under a similar methodology, then the research instrument would be considered to be reliable. (p. 52)

A study would be reliable when its results and observations were repeatable or replicable. Kirk and Miller (1986) asserted three different ways in which reliability was achieved in a quantitative study based on: (a) the degree to which any measurement, given repeatedly, would

remain the same; (b) the stability of any measurement over an amount of time; and (c) the similarity of all measurements in a given period of time (p. 41). Even if a researcher could prove repeatability, the internal consistency of the instrument itself could still be invalid. Developers of an instrument hold responsibility for showing the reliability of their scores from their tests (Morgan, Gilner, & Harmon, 2006).

Validity of the Instruments

According to Morgan et al. (2006) measurement validity was "concerned with the quality of accuracy of individual measures or scores, and the extent of measurement that a score achieves" (p. 102). Furthermore, Winter (2000) suggested that validity was the result and climax of empirical conceptions like universal laws, truth, objectivity, empirical evidence, deduction, actuality, reason, and mathematics.

Agresti and Finley (2009) defined validity as follows:

> Validity determined whether the research truly measured that which it was intended to measure or how truthful the research results were. In other words, did the research instrument allow you to hit "the bull's eye" of your research object? Researchers generally determined validity by asking a series of questions, and would often look for the answers in the research of others. (p. 32)

ATMI Instrument: Comparative Analysis

Over the past several decades, attitudinal research in the field has examined many instruments to measure students' attitude toward mathematics utilizing both one-dimensional and multi-dimensional scales (Tapia & Marsh, 2004). One of the initial instruments used to measure students' attitudes toward mathematics was the Dutton Scale, which specifically measured students' 'feelings' toward arithmetic (Dutton, 1954; Dutton & Blum, 1968). The Dutton one-dimensional Likert Scale was further developed by Gladstone, Deal, and Drevdahl (1960). A Number Anxiety Scale was also developed utilizing eighth, ninth, and tenth-grade students.

Numerous scale designs were developed to measure enjoyment of mathematics and the value of mathematics (Tapia & Marsh, 2004). Multi-dimensional attitude scales were developed by Michaels and Forsyth (1977) and by Sandman (1980). Some researchers developed scales dealing exclusively with mathematics anxiety e.g. *Mathematics Anxiety Rating Scale* (Richard & Sinn, 1972), which was revised by Plake and Parker's (1982) *Mathematics Anxiety Questionnaire* (Wigfield & Meece, 1988).

One of the most widely used instruments over the last two decades was the 1976 *Fennema-Sherman Mathematics Attitude Scale*. While the *Fennema-Sherman Mathematics Attitude Scale* had become one of the most popular instruments used in measuring attitude toward mathematics, when compared with the ATMI instrument, it had some drawbacks. Particularly, the over 35-year-old *Fennema-Sherman* scale took a longer time to administer the over 100-item questionnaire, which took over 45 minutes to complete (Tapia & Marsh, 2004). Subsequent research had questioned the *Fennema-Sherma*n scale's validity and reliability (Suinn & Edwards, 1982), and the integrity of its scores (O'Neal, Ernest, McLean, & Templeton, 1988). Six of the factors proposed by Fennema and Sherman (1976) might not gauge what they were intended to measure (Mulhen & Rae, 1998).

Reliability of the ATMI Instrument

The ATMI was developed in stages and consisted of forty-items designed to measure students' attitude toward mathematics (Tapia & Marsh, 2004). Exploratory factor analysis of the ATMI used a sample of high school students that resulted in five factors, identified as 1) motivation, 2) anxiety, 3) value, 4) enjoyment and 5) self-concept. The motivation scale consisted of five items. Anxiety, enjoyment, and value were each measured by ten items. Five items measured self-concept. Alpha coefficients for the scores of these scales were found to be

.95, .95, .89, .89, and .88, respectively. These values indicated a high level of reliability of the scores on these factors (Tapia & Marsh, 2004).

Validity of the ATMI Instrument

The original design of the ATMI was to measure five dimensions of students' attitudes toward mathematics. An extensive exploratory factor and item analysis utilized students in an American high school located in Mexico City resulted in a questionnaire of forty items measuring five factors previously identified (Tapia & Marsh, 2004).

The appropriateness of the use of the ATMI could be determined by an examination of its content validity. The instrument was constructed for a large-scale evaluation project because "existing attitude measures did not seem to be appropriate" (Tapia & Marsh, 2004, p. 20). In 1972 and 1976, a total of 5,034 eighth through eleventh-grade mathematics students, from throughout the states of California and Indiana, were surveyed with the ATMI and samples were stratified by community size. Factor analyses were performed on each year separately, and then on the years combined, and all produced the same factors eventually used. Factor validity was thus established. Face validity was evident by simple inspection of the test (Tapia & Marsh, 2004). See the literature review for extended details of the numerical data from this study.

COMPASS Mathematics Exam

The COMPASS Exam was an adaptive, computerized assessment program that measured student abilities in three areas: mathematics, reading, and writing (ACCC, 2008). The COMPASS test was not designed as an entrance exam, but an assessment tool used within community colleges that helped to determine the appropriate mathematics level for all new and incoming students. The scores determined the appropriate mathematics course college-level courses or remedial courses. The COMPASS Mathematics Exam formed one section of the

COMPASS and focused on the subject of mathematics (ACCC, 2008). This e-COMPASS 4.0 test was used as the final exam in Pre-college Algebra remedial mathematics course and was administered at the end of the 2012 Fall semester. Therefore, this investigation utilized the COMPASS test, to draw insight on student's achievement in mathematics at a two-year community college.

Reliability of COMPASS Mathematics Exam

ACT, Inc. introduced the COMPASS set of exams. This test was the second most used test in the U.S. The mathematics test comprised six sections and 25 items on different mathematics subjects, including numerical skills, pre-Algebra, Algebra, College Algebra and Geometry. The questions had multiple choice response options. The reporting of scores were through raw score and scale scores. Raw scores indicated individual performance such as eighteen correct out of twenty items. Scale scores commonly ranged from 0 to 100 and provided comparison of individual scores or determined the weight of scores in a particular aspect of the test with the rest of the test items. According to the COMPASS manual, a thorough testing of the mathematics exam resulted in a reliability score ranging from .87 to .91 (ACT, Inc., 2006). This indicated a significant repeatability of results in using the test.

Brown and Niemi (2007) considered the inter-rater reliability of the COMPASS Mathematics test by focusing on twenty items independently evaluated by two analysts. This resulted in an agreement level of 95 percent, with agreement on 41 descriptions of the test items and two disagreements. This indicated a high inter-rate reliability for the different items on the test.

Validity of COMPASS Math Exam

According to ACT, Inc. (2006), the validity of the COMPASS Mathematics Exam was determined by the ability of the test to measure the knowledge in mathematics of students relative to placement in specific courses or continuation of a course. As such, those who had a sufficient level of knowledge in mathematics and could achieve satisfactory scores on the COMPASS test were given their course paths. Moreover, higher or lower levels of knowledge coincided with higher or lower test scores.

Two studies considered the predictive validity of the COMPASS Mathematic Exam. In the earlier study by Mzumara and Shermis (2001), the correlation coefficient between the COMPASS test scores and scores in the course final exam was .16, while the correlation coefficient between the COMPASS test scores and final grades was .11. These coefficients indicated low predictive validity of the test relative to final exam score and final grade. In a later study, Mellard and Anderson (2007) considered the predictive validity of the COMPASS mathematics test with grades higher or equal to C and found that scores in Arithmetic and grades above or equal to C had a .72 correlation coefficient, and scores in elementary Algebra and grades above or equal to C had a .63 correlation coefficient. Knowledge of basic mathematics had a positive relationship with grades. While several scholars noted that the differences in the predictive validity of the COMPASS mathematics test results and grades they recommended further research investigation in the empirical setting (Mzumara & Shermis, 2001; Mellard & Anderson, 2007).

Data Collection Procedure

Data collection took place during the 2012 Fall semester academic year. All research gathered was administered and handled by the research investigator and the community college

Mathematics Department Chair. Data were checked throughout and collected electronically using the two instruments, *Attitude Toward Mathematics Inventory,* ATMI along with Pre-college Algebra course results. The two instruments were administered to the class by mathematics professors via face-to-face in a computer lab.

First, a letter of introduction was sent to the administrative officer of the community college to seek approval to conduct the study. Upon receipt of approval, the same introductory letter was also provided to the Mathematics Department Chair. Upon approval, the researcher obtained research data from college officials regarding respondents who participated in the study. The community college mathematics faculty administered the e-COMPASS 4.0 Mathematics Exam as their standardized final assessment in Pre-college Algebra. The student's pass/fail results in the course and raw e-COMPASS scores as the final exam were obtained from the Mathematics Department Chair.

Next, the ATMI survey was conducted during the last three weeks prior to the end of the semester. The ATMI was coordinated between the researcher and the community college's Mathematics Department. The Mathematics Department Chair worked in conjunction with instructors teaching the courses to provide access to the students enrolled in Pre-college Algebra. The instructors received an instruction letter of how to administer the questionnaire. The respondents provided consent to take the questionnaire located in Appendixes A through D.

Finally, the researcher gathered research data at the conclusion of the remedial mathematics course from the Mathematics Department Chair. The ATMI questionnaire responses, pass/fail course results and the corresponding e-COMPASS 4.0 final test of each participating student was coded, by number to protect their identity. The research data were summarized into raw data for analysis utilizing SPSS statistical software.

Data Analysis

This non-experimental research study used inferential statistics to explore the relationship between and amongst the variables. A comparative approach was used to examine the specific research questions. The raw data were entered into the Statistical Package for Social Science (SPSS) for the analysis of the variables. Various forms of analysis were used to draw conclusions about the relationship between and amongst variables, mathematics achievement and students' attitude 1) motivation, 2) anxiety, 3) value, 4) enjoyment, and 5) self-concept toward mathematics.

According to Morgan et al. (2006) descriptive statistics helped to "summarize the variables from our sample in terms of frequency, central tendency, and variability" (p. 40). Descriptive statistics (frequency and mean) was used to summarize data collected from the research instrument, particularly the number of male and female respondents, scores in the five areas of attitude toward mathematics along with Pre-college Algebra course results.

The following statistical treatment was utilized to provide meaningful information in relation to the research questions.

Research Questions

Q1. Are there differences between male and female community college students on remedial mathematic achievement Pre-college Algebra assessment as measured by the COMPASS?

The results from the Independent Samples *t*-test answered this research question. The independent samples *t*-test was used to determine the statistical significance of the mean of male and female students' remedial mathematic achievement. Although SPSS did not provide the

Cohen *d* size in the data output the effect size was manually calculated to determine the magnitude of the differences between the nominal variables.

Q2. Are there differences between male and female community college students on attitudes toward mathematics (motivation, anxiety, value, enjoyment, and self-concept) as measured by the (ATMI) *Attitude Toward Mathematics Inventory* survey?

An Independent Samples *t*-test was used to determine statistical significant difference in the mean scores for male and female students' differences in their attitude toward mathematics using the ATMI, *Attitude Toward Mathematics Inventory*. The independent sample *t*-test was used on the two different (independent) groups of people (males and females), and compared their scores on attitude 1) motivation, 2) anxiety, 3) value, 4) enjoyment, and 5) self-concept. In this study, data were collected on only one occasion, but from two different sets of people.

Q3. How well does the combination of sex, community college students' attitudes (*motivation, anxiety, value, enjoyment and self-concept*) about mathematics predict remedial mathematic achievement results?

Multiple regression was employed to answer this research question. This associational statistical approach was most appropriate to address how the many independent variables when combined together could predict the dependent variable.

Q4. Is there an interaction between male and female community college students and remedial mathematic (pass/fail) achievement on (*motivation, anxiety, value, enjoyment, and self-concept*)?

Two-Way Factorial ANOVA was utilized to answer this research question to clarify whether there was an interaction, between male and female students' remedial mathematic

achievement on attitudes toward mathematics 1) motivation, 2) anxiety, 3) value, 4) enjoyment, and 5) self-concept). A means plot was conducted to visually confirm the interaction.

Summary

This comparative investigative approach provided data for analyzing and understanding the differences between male and female students on academic achievement and attitude toward remedial mathematics at a two-year community college. This chapter provided an explanation of the structural framework, specifically on the research approach, rationale, participation, sampling, measurements, instruments, validity and reliability of measurements, data collection procedure, and data analysis. Guidelines developed by Morgan, Leech, Gloeckner, and Barrett (2007) on SPSS tools were used to answer the research questions and further analyze the data and findings presented in Chapter 4.

CHAPTER 4: RESULTS

The primary purpose of this chapter is to present a summary of the results from the data collection and statistical approach. This non-experimental quantitative research study served to explore sex differences between community college male and female students on mathematics achievement and attitudes toward remedial mathematics in a metropolitan community college setting in the Southeastern United States. Descriptive and comparative approaches were used to explore the relationship between and amongst the variables. This chapter provides comparative data and the statistical findings from each of the research questions.

Descriptive Statistics

The study consisted of (N = 154) students 62, males and 92 females enrolled in a 15-week remedial mathematics course (Pre-college Algebra) at a two-year community college during the Fall 2012 academic semester. Using SPSS, the data set measured the attribute independent nominal variable sex as (0 - males and 1 - females). The variable for remedial mathematic achievement was measured by Pre-college Algebra indicated by (0 - Failed, 36 and Below) and (1 - Passed, 37 and Higher). The primary dependent interval variable for remedial mathematic achievement was the COMPASS exam used as a final assessment in Pre-college Algebra indicated by the raw scores of (8 to 90). Pre-college Algebra course letter grades were not used as part of this research study. Students' attitudes toward mathematics were measured using a self-reported survey questionnaire entitled, The *Attitude Toward Mathematics Inventory* (ATMI) a 32-item Five-Point Likert Scale that ranged from (1 = *Strongly Disagree* to 5 = *Strongly Agree*). The ATMI research instrument contained five constructs: 1) motivation, 2) anxiety, 3) value, 4) enjoyment and 5) self-concept.

Normal Distribution

Prior to beginning the analysis there was an initial review of the raw data that was checked throughout for inconsistencies, double coding, missing data, outliers, or extreme scores in the data set. The minimum and maximum values for each variable was compared for the proper allowable range. The means and standard deviations were also examined. Normality was assessed by obtaining and reviewing the skewness in the data. The skewness for the variables in this study were within the "acceptable" range of -1 through +1 which indicated a normal distribution (Morgan, Leech, Gloeckner, & Barrett, 2013).

Missing Data

Morgan et al. (2007) noted that when conducting research, particularly with human subjects it is very rare to obtain complete data from every respondent. Therefore, it was suggested to inspect data file for any missing data using SPSS descriptive approach. It was duly noted that the respondents in this study completed all the study requirements including the questionnaire for the *Attitude Toward Mathematics Inventory* (ATMI) on computers located in the course computer lab for Pre-college Algebra. The 32-item survey questionnaire was administered under the direct observation of the course instructor and overseen by the Mathematics Department Chair. Therefore, there were no missing values in the data set. Table 4.1 shows the minimum and maximum scores of the participants in the study along with the means score for each variable.

Table 4.1: Descriptive Statistics of Sex, Mathematics Achievement, and Attitude Toward Mathematics Homogeneity

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness Statistics
Males / Females	154	0	1	.60	.492	-.401
COMPASS Final Exam	154	8	90	45.53	20.06	.053
Pre-college Algebra	154	0	1	.60	.491	-.429
Motivation	154	1.00	5.00	3.27	1.41	-.189
Anxiety	154	1.00	5.00	3.17	1.61	-.045
Value	154	1.00	5.00	3.42	1.44	-.486
Enjoyment	154	1.00	5.00	3.20	1.19	-.295
Self-Concept	154	1.00	5.00	3.10	1.17	-.249

Morgan et al. (2007) warned that if the variances (standard deviation squared) of the compared groups in the study were substantially different, both the *t* test and ANOVA may be affected. According to (Urdan, 2010) in SPSS the homogeneity of variance option provides the Levene's Test for Equality of Variances, which determines whether the variance in scores is the same for each of the groups. Urdan (2010), noted that the column of most importance in the Levene's test is the significance value (Sig.). If the (Sig.) level is greater than .05 (e.g. .08, .28) the assumption of homogeneity of variance has not been violated and therefore is not significant. However, a significance result of (Sig. value less than .05) suggests that the variance of the dependent variables are not equal across groups (Urdan, 2010).

Data Analysis and Interpretation

This non-experimental quantitative research study utilized descriptive and comparative statistical approaches to determine the differences between and amongst the variables in the research questions. The intent of the research questions was to determine the difference between male and female students' remedial mathematic achievement in Pre-college Algebra and their attitudes toward remedial mathematics. Table 4.2 provides the frequency distribution to measures of variables in the study. As noted earlier, both the nominal and scaled variables for remedial mathematic achievement were reported in this study.

Table 4.2: Frequency Distribution for Sex and Mathematic Achievement

	Frequency	Valid Percent	Cumulative Percent
Sex:			
Male	62	40.3	40.3
Female	92	59.7	59.7
Mathematic Achievement:			
36 or Lower (Failed)	61	39.6	39.6
37 or Higher (Passed)	93	60.4	60.4

Q1. Are there differences between male and female community college students on remedial mathematic achievement Pre-college Algebra assessment as measured by the COMPASS?

The Independent Samples *t*-test was used to investigate male and female students' differences in mathematics achievement as measured by the Pre-college Algebra course results. The mathematics achievement raw scores were obtained and reported in SPSS as the ordinal variable. Table 4.3 provides a comparison of the variables.

Table 4.3: Comparison of Males and Females on Mathematics Achievement Measured by Pre-college Algebra (n = 62 males and 92 = females)

Variable	*M*	*SD*	*t*	*df*	*p*
Mathematics Achievement:			3.45	152	< .001
Males	52.10	17.82			
Females	41.11	20.36			

The study revealed there was a statistically significant difference between male and female students as measured by mathematics achievement on Pre-college Algebra. The total participants (N = 154) of both males and females in the study 60% (93) passed the COMPASS while 40% (61) failed. The data revealed that slightly above 28% (43) of the females passed the COMPASS compared to 32% (50) of the males who passed. Furthermore, amongst the students who failed the COMPASS 32% (49) were females compared to 8% (12) of the males who failed. Chi Square revealed ($\chi^2 = 17.80$, $df = 1$, $N = 154$, $p \leq .001$). Phi is -.340 and thus, the effect size is considered to be medium to large according to Cohen, 1988.

The research showed males were different from females on mathematic achievement ($p \leq .001$), which was statistically significant. The means scores of the two groups indicated that the average male students scored (M = 52.10) while the female students scored significantly lower at (M = 41.11). The effect size was .6, which according to Cohen (1988) is medium to typical in

this discipline. So, this study found that there was a statistically significant difference between males and their female counterparts as measured by the remedial mathematic achievement in Pre-college Algebra. Therefore, the male students performed higher than the females on mathematics achievement.

Q2. Are there differences between male and female community college students on attitudes toward mathematics (motivation, anxiety, value, enjoyment, and self-concept) as measured by the (ATMI) *Attitude Toward Mathematics Inventory* survey?

Using Independent Samples *t*-test this study found mixed results regarding differences between male and female community college students' attitudes toward mathematics. Table 4.4 showed that males were different from females on motivation ($p = .005$), anxiety ($p = 0.15$) and self-concept ($p \leq .001$), which were all statistically significant. An inspection of the means indicated that the average motivation score for male students ($M = 3.65$) was significantly higher than females ($M = 3.01$). The difference between the means was .64. The effect size *d* for Motivation was .5, which was medium or typical in this discipline (Cohen, 1988). The research found that females scored higher on Anxiety ($M = 3.42$) than their male counterparts ($M = 2.80$). The means difference was .62. The effect size for Anxiety was .4, which according to (Cohen, 1988) was medium or typical in the behavioral sciences. Self-concept revealed a means score of ($M = 3.55$) for males students which was higher than females students ($M = 2.79$). The difference between the means was .76. The effect size *d* for Self-Concept was large or larger than typical for this discipline (Cohen, 1988). However, male students did not differ from females students on two of the attitude variables value ($p = .288$) and enjoyment ($p = .111$). The means score on value for males was ($M = 3.57$) and ($M = 3.32$) for females. The effect size *d* for both Value .2 and Enjoyment .3 was small or smaller than typical (Cohen, 1988).

The Levene's *F* test for assumptions was statistically significant (Sig. <.05) for both anxiety and enjoyment which indicated that the assumption of equal variances were violated. Therefore, the Equal Variances Not Assumed analysis was used.

Table 4.4: Comparison of Males and Females on ATMI Attitude Toward Mathematics Inventory (N = 62 males and 92= females)

Variable	*M*	*SD*	*t*	*df*	*P*	*d*
Motivation			2.85*	130	.005	.5
Males	3.65	1.39				
Females	3.01	1.37				
Anxiety			2.45*	152	.015	.4
Males	2.80	1.43				
Females	3.42	1.68				
Value			1.06	138	.288	.2
Males	3.57	1.38				
Females	3.32	1.49				
Enjoyment			1.60	152	.111	.3
Males	3.40	1.31				
Females	3.07	1.08				
Self-Concept			4.02**	152	<.001	.7
Males	3.55	1.22				
Females	2.79	1.03				

Q3. How well does the combination of sex, community college students' attitudes (*motivation, anxiety, value, enjoyment and self-concept*) about mathematics predict remedial mathematic achievement results?

Simultaneous multiple regression was utilized to explore the best predictor of mathematics achievement. Table 4.5 provides the means, standard deviations and inter-correlations of the data. The results showed that the combination of sex and student's attitudes (*motivation, anxiety, value, enjoyment and self-concept)* to predict remedial mathematics achievement from the COMPASS final was statistically significant, $F(6, 147) = 8.80$, $p < .001$. The effect size was large or larger than typical (Cohen, 1988).

Table 4.5: Means, Standard Deviations, and Inter-correlations for Mathematics Achievement and Predictor Variables (N = 154)

Variable	*M*	*SD*	Motivation	Anxiety	Value	Enjoyment	Self-Concept	Sex
Mathematics Achievement	45.5	20.06	.369	-.193	.048	.321	.218	-.269
Predictor Variables								
1. Motivation	3.27	1.41	---	.132	.489	.142	.538	-.225
2. Anxiety	3.18	1.61	.132	---	.123	-.320	.127	.190
3. Values	3.42	1.44	.489	.123	---	-093	.434	-.086
4. Enjoyment	3.20	1.19	.142	-.320	-.093	---	.193	-.134
5. Self-Concept	3.10	1.17	.538	.127	.434	.193	---	-.320
6. Sex	.60	.492	-.225	.190	-.086	-.134	-.320	---

The Beta coefficients are presented in Table 4.6. The Model Summary in SPSS showed that when using all the predictors simultaneously, the multiple correlation of coefficient R was .51 and the adjusted R^2 was .23, indicating that 23% of the variance in the COMPASS final mathematics achievement can be predicted from the combination of (*motivation, anxiety, vales, enjoyment and self-concept*). This indicates a large or larger than typical effect size (Cohen, 1988). Only Motivation and Enjoyment significantly contributed to the equation. However, all of the variables were combined together to obtain these data.

Table 4.6: Simultaneous Multiple Regression Analysis Summary for Attitude Predicting Mathematics Achievement (N = 154)

Variable	*B*	*SE B*	ßeta	*t*	*p*
Motivation	5.50	1.28	.38	4.26	<.001
Anxiety	1.73	.98	.14	-1.78	.077
Values	1.61	.1.19	.12	1.35	.177
Enjoyment	3.22	.1.33	.19	2.41	.017
Self-Concept	-.078	1.57	-.05	-.049	.961
Sex	-5.75	3.16	-.141	-1.81	.071
Constant	31.99	7.24		4.41	.000

NOTE: $R^2 = .26$; $F(6, 147) = 8.80$, $p < .001$.

The following equation provides a formula for using motivation to predict mathematics achievement. From the Correlation table in SPSS the motivation variable appeared strong enough to create a prediction equation at .369. The Coefficient Table provided a Constant of 28.41 and Motivation at 5.23. Therefore, as one example of how to use regression to predict test score; if motivation was approximately 3.5, then the formula for using Motivation in a Prediction Equation would be as follows:

Y = 5.23x + 28.41 = 46.71

Q4. Is there an interaction between male and female community college students and remedial mathematic (pass/fail) achievement on (*motivation, anxiety, value, enjoyment, and self-concept*)?

Two-way/Factorial ANOVA was conducted to measure the interaction between the independent and dependent variables in this research question. The General Linear Model, GLM

in SPSS provided the cell means, standard deviation, effect size (eta²) and plots for each subgroup representing the interaction between the variables. An inspection of the data in the Descriptive Statistics table was checked for accuracy. The ANOVA Tests of Between-Subjects Effect table provided data for interpreting and explaining the results of the test for interaction.

This study found that male and female students did not interact on the COMPASS final differently in regards to their attitude toward mathematics (motivation, anxiety, value, enjoyment, and self-concept). A profile plot was conducted to provide a visual confirmation of the data results. Table 4.7 Two-Way ANOVA – Dependent Variable: *Motivation* indicated that there was not a significant interaction between sex, mathematics achievement on motivation (p = 429). However, there was a statistically significant main effect of the COMPASS final on motivation $F(1, 150)= .24.98$, $p < .001$. Eta for motivation was .38, large or larger than typical effect size (Cohen, 1988).

Table 4.7: Two-Way ANOVA – Dependent Variable: Motivation

Variable and Source	*Df*	*MS*	*F*	*p*	ŋ²
Sex	1	2.32	1.47	.227	.010
COMPASS Final	1	39.39	24.98	<.001	.143
Sex * Achievement	1	.994	.630	.429	.004
Error	150	1.57			

Table 4.8, Two-Way ANOVA – Dependent Variable: *Anxiety*, showed that the interaction effect between sex, COMPASS final on anxiety (p = .165) was not statistically significant. It was duly noted that there was a statistically significant main effect for the COMPASS final on

anxiety $F(1, 150) = 5.42$, $p < .001$. The eta squared accounts for about 3 to 5% of the shared variance. Eta for anxiety was .19, which is considered small or typical effect size (Cohen, 1988).

Table 4.8: Two-Way ANOVA – Dependent Variable: Anxiety

Variable and Source	*df*	*MS*	*F*	*p*	ŋ²
Sex	1	1.96	.798	.373	.005
COMPASS Final	1	13.35	5.42	.021	.035
Sex * Achievement	1	4.80	1.94	.165	.013
Error	150	2.46			

Table 4.9 Two-Way ANOVA - Dependent Variable: *Value,* revealed that there was not a statistically significant interaction effect between sex, COMPASS final on value ($p = .504$). Furthermore, there was not a statistically significant main effect for the COMPASS final on value (p = .411). Eta for value was .07, smaller or smaller than typical (Cohen, 1988).

Table 4.9: Two-Way ANOVA – Dependent Variable: Value

Variable and Source	*df*	*MS*	*F*	*p*	ŋ²
Sex	1	.424	.201	.655	.001
COMPASS Final	1	1.43	.679	.411	.005
Sex * Achievement	1	.949	.449	.504	.003
Error	150	2.11			

As illustrated in Table 4.10 Two-Way ANOVA - Dependent Variable: Enjoyment, there was not a statistically significant interaction between sex, COMPASS final on enjoyment ($p = .177$). Yet, there was a statistically significant main effect for the COMPASS final on enjoyment $F(1, 150) = 19.06$, $p < .001$. The eta was about .34, which is medium effect size, explaining 11% of the variances (Cohen, 1988).

Table 4.10: Two-Way ANOVA – Dependent Variable: Enjoyment

Variable and Source	*df*	*MS*	*F*	*p*	ŋ²
Sex	1	.238	.202	.654	.001
COMPASS Final	1	22.53	19.06	<.001	.113
Sex * Achievement	1	2.17	1.83	.177	.012
Error	150	1.18			

Table 4.11 Two-Way ANOVA – Dependent Variable: *Self-Concept* provided data that showed there was not a statistically significant interaction between sex, COMPASS Final on self-concept ($p = .332$). Thus, there was a statistically significant main effect for the COMPASS final on self-concept $F(1, 150) = 10.87$, $p < .001$. The eta of .26 provided a medium or typical effect size and 7% of the variance is explained (Cohen, 1988).

Table 4.11: Two-Way ANOVA – Dependent Variable: Self-Concept

Variable and Source	*df*	*MS*	*F*	*p*	ŋ²
Sex	1	6.14	5.23	.024	.034
COMPASS Final	1	12.77	10.87	.001	.068
Sex * Achievement	1	1.11	.947	.332	.006
Error	150	1.17			

Summary

This chapter used comparative statistics to summarize of the findings from each of the four research questions. The attribute independent variable (male and female students) provided the focus of this investigation along with the COMPASS and the ATMI, *Attitude Toward Mathematics Inventory* instrument.

CHAPTER 5: DISCUSSION

This chapter serves as the discussion, conclusions and recommendations section for this non-experimental quantitative research study. This investigation utilized the comparative approach to answer the research questions using the *Attitude Toward Mathematics Inventory* (ATMI) survey, Pre-college Algebra course and the COMPASS assessment instrument as the course final exam. This dissertation was designed to expand upon existing but limited body of work on the differences between male and female community college students' academic achievement and their attitudes toward remedial mathematics. This chapter is divided into two major sections. The first major section, presents a discussion of the critical areas of the differences between sex, remedial mathematics achievement and attitudes toward the subject from this study. The second major section provides implications for practice along with policy change and recommendations for future research.

Discussion

This section of the study is divided into three parts and provides a discussion of the findings along with how they relate to the literature in the field. First, a discussion regarding sex differences in mathematics achievement as measured by the (Pre-college Algebra) and the COMPASS assessment instrument as a final exam in the course. Second, the study provided a discussion of the differences between sex and students' attitudes toward mathematics as measured by the *Attitude Toward Mathematics Inventory* (ATMI) survey. Third, the research examined predictive variables of mathematics achievement and the interaction between male and female students' achievement and attitudes toward mathematics.

Sex Differences in Remedial Mathematic Achievement

Research question number one explored whether there were sex differences in remedial mathematics achievement Pre-college Algebra as measured by the COMPASS as a final assessment in the course. The research found that there was a statistically significant difference between male and female community college students who participated in this study on remedial mathematic achievement. The male students performed higher than female students in Pre-college Algebra remedial mathematics.

The results of this dissertation supports earlier research findings in the literature that boys perform better than girls on standardized tests (Wainer & Steinberg, 1992). However, this dissertation study does not substantiate the findings that males and females are substantially equal in mathematics achievement (Else-Quest, Hyde, & Linn, 2010). Kimball (1989) cited many studies that showed boys in high school achieve consistently higher scores than girls on standardized math tests. Over the past forty years several studies concurred that on average boys' mathematics achievement was superior to that of their female counterparts on standardize test (SAT) Scholastic Aptitude Test but lower on course grades in mathematics (Wainer & Steinberg, 1992). Later studies (Hedges & Nowell, 1995; Randhawa, 1994) confirmed these findings. However, more recent literature in the field found a narrowing in the gap of differences between male and female students on mathematic achievement (Lloyd, Walsh, & Yailagh, 2005; Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006). Several studies indicated mathematical skills of boys and girls, men and women, were notably equal (Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Lloyd, Walsh, & Yailagh, 2005; Santos, Ursini, Ramirez, & Sanchez, 2006). The findings from two landmark studies, *Trends in International Mathematics and Science Study* (TIMSS, 2003) and *Programme for*

International Student Assessment (PISA, 2003) studies conducted between 1990 and 2007 found that males and females had shown to be substantially equal in mathematics achievement (Else-Quest, Hyde, & Linn, 2010). These team of researchers compiled and examined data including SAT results and mathematic scores from 7 million students in K-12 tested in accordance with the No Child Left Behind Act (Else-Quest, Hyde, & Linn, 2010). The researchers found that mathematics performance of females measured up to their male counterparts.

There may be several explanations for the differences between male and female mathematics performances in this dissertation study. It is noteworthy to reiterate that the methodology used in this study was non-experimental and therefore did not lend itself to causation. However, there may be various reasons why males in this study outperformed their female counterparts on remedial mathematics achievement. The first explanation may be attributed to past research studies that utilized such standardized measures as the SAT, Scholastic Aptitude Test and did not particularly address remedial mathematics in their results (Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006). Second, many of the study participants from the previous researchers (Lloyd, Walsh, & Yailagh, 2005; Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006) primarily examined mathematics achievement of students in grades K-12 and did not explore community college students. Third, unlike the previous studies (Else-Quest, Hyde, & Linn, 2010) this dissertation explored community college students whose average age was 28 and often worked full-time or part-time and also had to balance, parenting and family life while attending college. In addition to the reasons stated earlier, perhaps males in this dissertation had more mathematical oriented experiences than their female counterparts.

Sex Differences in Students' Attitudes Toward Mathematics

Research question number two examined sex differences in students' attitudes toward mathematics (*motivation, anxiety, value, enjoyment, and self-concept*) as measured by the *Attitude Toward Mathematics Inventory* (ATMI) survey. Overall, the research found that there was a statistically significant different between male and female community college students' attitude toward mathematics in regards to *motivation, self-concept* and *anxiety*. More specifically, males in the study scored higher than females on *motivation* and *self-concept* however, females scored higher on *anxiety* than males in the study. There was not a statistically significant difference between male and female students on *enjoyment* and *value*. However, males had a higher means score than females on both *enjoyment* and *value* attitude variables. This could suggest that neither male nor female participants in this study who took remedial mathematics may actually enjoy mathematics. However, perhaps both male and female students see the value of mathematics in their lives.

The results of this dissertation supported several past studies on sex differences regarding attitudes toward mathematics. Much of the literature in the field supported the assumption that males and females had different attitudes toward mathematics (Asante, 2012; Tapia & Marsh, 2000). Analysis of the findings throughout the literature linked sex differences in mathematics through attitudes (Di Martino & Zan, 2007; Hannula, 2002).

One reason for the findings regarding sex differences in attitudes toward mathematics may be due to the lack of clarity in the definition of attitude. There were numerous studies that did not provide a clear theoretical framework regarding the issue because of differences in the definitions of attitude toward mathematics. Most definitions of attitude toward mathematics emerged from studies, or came about after the development of attitude assessment instruments

(Di Martino & Zan, 2007; Hannula, 2002). In support of the literature, the definition of attitude in this dissertation study was derived from the development of an attitude assessment instrument entitled, *Attitudes Toward Mathematics Inventory*, ATMI containing five dimensions (*motivation, anxiety, value, enjoyment,* and *self concept*), which originated from the (Tapia & Marsh, 2004) study.

A second reason for sex differences in students' attitude toward mathematics could be linked to academic performance. This dissertation study found that males scored higher than females on motivation and self-concept. Male students also performed better than females in their academic performance. Therefore, these findings may suggest that better attitude may lead to higher academic performance. These findings mirror the results in the Tapia and Marsh, (2004) study which revealed that males had higher scores on self-confidence than females who received a failing grade and scored lower on self-confidence. As mentioned earlier, this dissertation study, revealed that females scored lower on self-concept and performed lower on remedial mathematics achievement in comparison to males in the study.

A third reason for the sex differences in attitude toward mathematics perhaps could be due to limited exposure to the subject and may suffer from higher levels of anxiety toward mathematics. The females in this dissertation study had a higher means score on *anxiety* than male students. The Ashcraft, Kirk, and Hopko, (1998) and the Hembree, (1990) studies found that mathematics *anxiety* in the adult learner is linked to limited exposure to mathematics and limited enjoyment. This dissertation concurred with some researchers that investigated sex differences in terms of mathematics anxiety that showed that females experienced mathematics anxiety more than males (Zettle & Houghton, 1998).

Prediction of Students' Attitudes on Mathematics Achievement

Research question number three explored how well the combination of sex and students' attitudes about mathematics predict remedial mathematics achievement. The research found that the combined relationships between sex and attitude (*motivation, anxiety, value, enjoyment, and self-concept*) can predict mathematics performance in Pre-college Algebra. However, the primary factors in the prediction of mathematic achievement were motivation and enjoyment. These findings could suggest that community college students' with better attitudes toward Pre-college Algebra may achieve better mathematics learning outcomes. Thus, students who are highly motivated and enjoy mathematics may be more likely to achieve higher academic performance in remedial mathematics.

The results of this dissertation support much of the literature in the field on predictors of students' attitudes toward mathematics related to achievement. Several mathematics educators, scholars and researchers have established the importance that predictors of attitudes toward mathematics have on achievement (Singh, Granville & Dika, 2002; Webster & Fisher, 2000). Student achievement in the study of mathematics has been linked to attitudes toward the subject and influenced by many variables including success and perseverance (Webb, Lubinski, & Benbow, 2002). However, attitude is one of the variables that has been shown to be the most important factor that relates to mathematics achievement (Ma & Kishor, 1997). Therefore, most of the researchers in the field agreed that students' attitude plays a critical role in predicting their outcome in mathematics (Mueller, Yankelewitz, & Maher, 2011; Meelissen & Luyten, 2008; Siskandar, 2013).

One reason for the findings regarding students' attitude and achievement could be due to a link between classroom environment and a student's motivation to succeed. This dissertation

study did not explore factors that influenced enjoyment and motivation in a classroom environment. However, in contrast, Meelissen and Luyten (2008) reported that good classroom environment and feeling safe in class were positively linked to liking mathematics. Nonetheless, it is worth noting that the participants involved in this dissertation study were taught in a self-directed learning, SDL classroom environment using the computer software *Assessment Learning Knowledge Space,* ALEKS in which students were placed at the center of the learning experience. This dissertation supports the findings on motivation found in the (Howard & Whitaker, 2011) study. Their qualitative research study regarding developmental students' perception and experiences in mathematics indicated students' motivation was fueled by feeling power over their own learn experience. The researcher's investigation indicated that motivation was the common theme that determined the students' unsuccessful and successful experience in mathematics (Howard & Whitaker, 2011).

A second reason for the studies' findings regarding students' attitude and achievement could be due to the students' ability to regulate their own learning. This dissertation study did not qualitatively examine the role of regulated learning on motivation and enjoyment. The dissertation, however, supports the finding in the (Howard & Whitaker, 2011) study which found that students were motivated by the ability to regulate the way they studied and the resources used such as mathematics lab and tutors. Motivation may have been a contributing factor in this dissertation due to the student's ability or inability to work at their own pace due to the learning regulations set by the computer software, *Assessment Learning Knowledge System*, ALEKS. Students were taught in a mathematics lab and were allowed to progress and learn at their own pace without the threat of trying to keep up with other students. This approach enabled students to customize their approach to learning tasks, combine the development of skills with the

development of character and prepare for learning throughout their lives. The Mathematics department at the community college called this teaching strategy, '*The Guide on the Side*.' Both male and female students were taught to not only work at their own pace, but to learn their own way, choose their own goals, and apply concepts to real world problems. Additionally, (Howard & Whitaker, 2011) noted the importance of using learning strategies effectively merged as a factor in motivating student success. The study noted students' past beliefs about mathematics led to unsuccessful experiences (Howard & Whitaker, 2011). Since many of the participants in this dissertation were adult remedial mathematics students perhaps their past beliefs about mathematics or their ability to self-regulate their learning led them to an unsuccessful outcome.

A third reason for the findings regarding students' attitude and achievement could be due to the attitude, achievement and the role of parents. Although this dissertation did not examine grade school students or the role of parents as predictors of mathematics outcomes, the research partially supports a quantitative study conducted on 294 elementary schools in Indonesia that examined the relationship between motivation and achievement on mathematics (Siskandar, 2013). The Siskandar (2013) study used questionnaires to collect data on attitude, perception and motivation of learning. The research revealed attitude and achievement on mathematics had a positive relationship, which indicated better attitudes gave higher achievement (Siskandar, 2013). The results also showed that there was a positive significant relationship between attitude of the students toward learning mathematics, motivation and role of parents related to mathematics learning along with achievement on mathematics (Siskandar, 2013). This dissertation concurred with the findings from the (Siskandar, 2013) study in regards to there being a relationship between motivation and mathematics achievement.

Interaction Between Sex and Mathematics Achievement on Attitude

Research question number four clarified whether there was an interaction, among male and female students', remedial mathematic achievement on attitude (*motivation, anxiety, value, enjoyment, and self-concept*). This study found that there was not a significant interaction between sex and mathematics achievement on all five attitude variables, (*motivation, anxiety, value, enjoyment, and self-concept*). However, there was a statistically significant 'main effect' of the pass/fail COMPASS as a final exam on *(motivation, anxiety, enjoyment, and self-concept).* Yet, the *value* attitude variable was not statistically significant. This may mean that male and female community college students do not differ in terms of their attitude (*motivation, anxiety, value, enjoyment, and self-concept*) toward mathematics but there is a difference for those who pass/fail remedial mathematics on (motivation, anxiety, enjoyment, and self-concept) but not regarding their perceived value of mathematics.

This dissertation study supported the findings in the literature on the interaction between sex, students' attitude and achievement particularly regarding the relationship between self-concept and achievement in mathematics. Researchers in an earlier study noted that there was a positive interaction between mathematics attitude and achievement (Ma & Kishor, 1997). The researchers additionally, stated there was a positive relationship between self-concept about mathematics and achievement in mathematics. In general, mathematics attitude, mathematic achievement and self-confidence in mathematics had been well documented in the literature for a positive relationship particularly for problem solving. In regards to the *Trends in International Mathematics and Science Study* (TIMSS, 2003) research, a positive association was found not only between mathematics attitude and achievement but also between self-perceived competence in mathematics and mathematics achievement (Kadijevich, 2008).

In contrast, this non-experimental investigation did not examine the degree of positive or negative attitudes toward mathematics instruction in a classroom environment. This investigation cannot explain causation regarding the variables and is therefore cautious about the 'interaction effect' and the 'main effect' of the data. However, there may be several reasons for the findings in this study regarding the interaction between sex, mathematics achievement on attitude.

One reason for the interaction between sex, mathematics achievement on attitude could be related to the pedagogy instructional method. The participants in this dissertation were taught remedial mathematics using the *Assessment Learning Knowledge Space* (ALEKS, 2001) learning pedagogy. These findings could suggest that the method of technological instruction i.e. *Assessment Learning Knowledge Space* (ALEKS, 2001) may be linked to students' attitude and achievement in the course. For example, while the use of technology in the classroom may increase enjoyment, self-concept and motivation in mathematics for some students, however, it may cause anxiety for other students and therefore may impact mathematics achievement. Taylor (2008) stated that a computer-mediated curriculum improved academic performance for some students but not for other students in remedial mathematics. Furthermore, Taylor (2008) revealed that anxiety was reduced by the use of technology in solving mathematics problems for some remedial mathematics students but not for other students.

Another reason for the interaction between sex, mathematics achievement on attitude may linked to classroom interaction. As mentioned earlier, the student participants in this study were taught in a self-paced learning environment. These finds may suggest however, that there may have been some interaction in the classroom i.e. perhaps student to student engagement, or student to instructor relationship among students who did not differ in their attitude toward mathematics. It could be speculated that students possibly worked in small peer-led groups or

some sort of collaborative learning environment may have taken place in the classroom. Past researcher (Hooker, 2011) surveyed remedial mathematics students and found that when students worked together there was the notion that mathematics was more fun, more motivational and more satisfying than working alone. In the (Hooker, 2011) study students felt that by working together to learn mathematics they would earn a better grade than working alone. One might speculate that students who have higher self-concept, motivation, and enjoyment toward mathematics may potentially earn higher grades in the course.

Implications for Practice

The results of this investigation provided valuable insights into male and female community college students' differences on achievement and attitudes toward remedial mathematics. Given the accountability demands of remedial education placed on community colleges to provide evidence of student learning outcomes to internal and external stakeholders (Cohen & Brawer, 2003), the implications for practice in this investigation could prove useful. Many scholars and researchers have agreed that, students' attitude toward mathematics influenced success in academic achievement (Chang, 1990; Ma, 1997; Thorndike-Christ, 1991; Webb, Lubinski, & Benbow, 2002). Students' academic achievement and attitude toward remedial mathematics has been an important area of assessment in community colleges with a limited body of research conducted in this area (Cohen & Brawer, 2003; Di Martino & Zan, 2011; Georgiou, Stavrinides, & Kalavana, 2007; Hyde, 2008; Santos, Ursini, Ramirez, & Sanchez, 2006). Information obtained from this study could be useful in constructing strategic plans and policy changes that may provide meaningful opportunities to assist both male and female community college students in achieving academic success, specifically in remedial

mathematics. The following four implications could provide valuable insight for thought and practical implementation:

The first implication for practice is based on the research findings regarding sex differences in remedial mathematics achievement. The research found that male community college students performed better than females in remedial mathematics. The reason for this outcome might imply that males in the study had prior mathematical experience that was helpful in their success e.g. environment, past experiences with mathematics either socially, academically or culturally. Additionally, females in the study may have had only limited exposure to mathematics either from their high school mathematics experience or their environmental as well as from the influence of family and friends. However, it may serve community colleges well to explore an initial assessment of a students' work, life and academic experiences to determine the best path for achieving academic success, especially related to mathematics.

Community colleges may also have to re-think or contemplate new ideas to meet the academic challenges of remedial mathematics assessment for both male and female students. To help ensure females advance in their academic and work endeavors and males continue to grow and expand to reach new levels of success community colleges might contemplate exploring new assessment instruments to measure academic achievement among remedial mathematic students. One suggestion may be for community colleges to re-evaluate the future validity and reliability in the use of the COMPASS as an assessment instrument to ensure it meets the needs of today's adult community college learner. Nevertheless, sex differences in remedial mathematics must continue to be closely re-examined in community colleges.

The second implication for practice is based on the research findings regarding sex differences in students' attitudes toward mathematics. As noted earlier, the study found that male community college students scored higher than females on motivation, self-concept, and enjoyment. However, females scored higher on anxiety and value than their male counterparts. This could indicate that the attitude components of motivation, self-concept and enjoyment toward mathematics in males could be linked to their performance in the subject i.e. better attitudes may be linked to a more successful outcome. This could also imply that while females may tend to understand mathematics worth to their everyday lives or its importance in terms of their academic journey, females may not necessarily like taking remedial mathematics.

However, if females do not possess self-concept, motivation and enjoyment toward mathematics this could pose a serious problem for institutions since all three of these attitude variables have been shown to link to success in academic performance. Additionally, remedial mathematics serves as a prerequisite for entrance into college and various professions. Therefore, community colleges may consider some kind of program of engagement to help improve female students' attitude toward mathematics. Nonetheless, in an effort to improve remedial academic performance community colleges must explore ways to assess and improve the attitude toward mathematics by both males and females. For example, perhaps a 'Women's Mathematics Expo' facilitated by women from various industries to inform, uplift and empower female community college students who struggle with remedial mathematics. Bryk and Treisman (2010) explained that there needs to be an integrated academic support system as well in remedial mathematics. “We need to strengthen the connections of students to successful peers, to their institutions, and to pathways to occupations and education” (Bryk & Treisman, 2010, p. 20).

The third implication for practice is based on the research findings regarding the prediction of students' attitudes on remedial mathematics achievement. As mentioned earlier, the study found that the combined relationships between sex and attitude (*motivation, anxiety, value, enjoyment, and self-concept*) for participants contributed to predicting mathematics performance in Pre-college Algebra. However, the primary attitude variables in the prediction of mathematics achievement were motivation and enjoyment. Therefore, these findings could suggest that community college students' with better attitudes toward Pre-college Algebra might achieve better academic success. Thus, students who are highly motivated and enjoy mathematics may be more likely to achieve high academic performance in remedial mathematics. One could also speculate whether students who enjoy mathematics and are highly motivated are influenced from their past high school mathematics experience or family influenced mathematic experiences. To address motivation and enjoyment as possible contributors of students' academic success in remedial mathematics, community colleges may consider the pedagogical framework from which students learned mathematics and add elements that focus on motivation and enjoyment as part of the teaching and learning process.

The fourth implication for practice is based on the research findings regarding interaction between sex and remedial mathematics achievement on attitude. This study found that male and female community college student participants did not differ in terms of their attitude (*motivation, anxiety, value, enjoyment, and self-concept*) toward mathematics but there was a difference for those who pass/fail remedial mathematics on attitude (motivation, anxiety, enjoyment, and self-concept) but not on the value attitude variable. This could imply that students who pass remedial mathematics may have more motivation, self-concept and enjoyment towards mathematics than students who failed remedial mathematics. Additionally, students who

failed remedial mathematics may also experience more anxiety than students who passed the course. Institutions may consider providing a pre-screening of cognitive behavioral for females in remedial mathematics. Since psychological literature noted the impact Cognitive Behavioral Group Therapy (CBGT) has on effectively reducing mathematics anxiety in students (Karimi & Venkatesan, 2009), institutions may consider this strategy as their first-line defense to resolve females' anxiety in remedial mathematics.

Recommendations for Future Research

In conducting this research, a variety of additional unanswered questions emerged along with suggestions and recommendations that could be noteworthy for future investigations. The following are some suggested approaches for future research.

First, future researchers could further examine the interaction between how both male and female community college students learn remedial mathematics differently using the *Assessment Learning Knowledge Space*, (ALEKS) form of teaching pedagogy. Taylor (2008) agreed, that future researchers need to be diligent about finding what methods (i.e. computer algebra or lecture) will help underprepared students succeed in remedial mathematics. Additionally, there has been limited empirical research on the study of remedial instructional pedagogies in mathematics (Kilpatrick, Swafford, & Findell, 2001).

Second, future researchers could expand this investigation particularly addressing male and female community college students' attitudes toward mathematics but exploring different geographical areas both domestic and international using the same *Attitude Toward Mathematics Inventory* (ATMI) instrument and standardized testing via mixed method research design. Tapia and Marsh, (2004) concurred stating that there were limited studies regarding college students' attitudes toward mathematics because most research primarily focused on students in K-12.

Third, future researchers could explore the relationship between anxiety and sex stereotypes among female community college students in remedial mathematics. Using a mixed-method approach, researchers may consider examining how and to what extent does sex stereotypes influence attitudes and mathematic achievement outcomes. Future investigations may particularly explore additional variables quantitatively such as mathematics instructors, counselors, a students' ethnicity, age and/or parental educational background on anxiety and sex stereotypes in community colleges. Several scholars in the field agreed that sex stereotypes in community colleges was an unexplored area of research particularly in mathematics education (Hyde & Linn, 2006; Kiefe & Sekaquaptewa, 2007; Beilock, Gunderson, Ramirez, & Levine, 2010).

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APPENDIX A: RESEARCH INSTRUMENT

ATTITUDES TOWARD MATHEMATICS INVENTORY

The following statements are about the study of attitudes toward mathematics. Please read each statement carefully and decide whether it describes the way you feel about mathematics. Then find the number of the statement that best describe your feelings at the present time. Be sure to answer every question. Mark the response for each statement that is closest to your view/opinion.

1 – Strongly Agree **2** - Agree **3**- Neutral **4** - Disagree 5– Strongly Disagree

Self-concept in mathematics

Place an X on the number that most represent your opinion.

1.I feel at ease in a mathematic class	5	4	3	2	1
2.Mathematics is easy for me	5	4	3	2	1
3.I usually understand what we are talking about in mathematics class	5	4	3	2	1
4.No matter how hard I try, I cannot understand mathematics	5	4	3	2	1
5.I often think, "I can't do it," when a mathematics problem seems hard	5	4	3	2	1
6. I am good at working mathematics problems	5	4	3	2	1
7. I remember most of the things I learn in mathematics	5	4	3	2	1
8. I don't do well in mathematics	5	4	3	2	1
9. I have a good feeling toward mathematics	5	4	3	2	1

Anxiety toward mathematics

Place an X on the number that most represent your opinion.

10. When I hear the word mathematics, I have a feeling of dislike	5	4	3	2	1
11. I feel tense when someone talks to me about mathematics	5	4	3	2	1
12.It doesn't disturb me to work mathematics problems	5	4	3	2	1
13.Working numbers upsets me	5	4	3	2	1
14.It makes me nervous to even think about doing mathematics	5	4	3	2	1
15.It scares me to have to take mathematics	5	4	3	2	1

Enjoyment toward mathematics

Place an X on the number that most represent your opinion.

16. Mathematics is something which I enjoy very much	5	4	3	2	1
17. I enjoy talking to other people about mathematics	5	4	3	2	1
18. Mathematics is more of a game than hard work	5	4	3	2	1
19. I like the easy mathematics problems the best	5	4	3	2	1
20. I would like to spend less time in school doing math	5	4	3	2	1
21. I don't like anything about mathematics	5	4	3	2	1
22. I like to play games that use numbers	5	4	3	2	1
23. I would like to do some outside reading in mathematics	5	4	3	2	1

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1 – Strongly Agree **2 -** Agree **3-** Neutral **4 -** Disagree **5** – Strongly Disagree

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Motivation in Mathematics

Place an X on the number that most represent your opinion.

24. Sometimes I read ahead in our mathematics book	5	4	3	2	1
25. Sometimes I work more mathematics problems than are assigned in class	5	4	3	2	1
26. I have a real desire to learn mathematics	5	4	3	2	1
27. The only reason I'm taking mathematics is because I have to	5	4	3	2	1
28. I would rather be given the right answer to a mathematic problem than to work it out myself	5	4	3	2	1

Value of Mathematics

Place an X on the number that most represent your opinion.

29. Mathematics is important in everyday life.	5	4	3	2	1
30. Mathematics is one of the most important subjects for people to study.	5	4	3	2	1
31. Mathematics courses would be very helpful no matter what I decide to study.	5	4	3	2	1
32. Mathematics is a very worthwhile and necessary subject.	5	4	3	2	1

(Tapia & Marsh, 2004).

APPENDIX B: COVER LETTER

Date:

Dear Participant,

My name is Susan Hughes-Isley and I am a doctoral student from Colorado State University in the School of Education. We are conducting a research study exploring the relationship between male and female community college students' academic achievement and attitude toward mathematics. The title of our project is ' 'Differences Between Male and Female Community College Students in Achievement and Attitude on College Remedial Mathematics.' I am the Principal Investigator and the Co-Principal Investigator is Dr. Linda Kuk in the School of Education.

We would like you to complete a survey questionnaire. This study will take place on the campus of a two-year institution located in southeastern United States. Student participants will take approximately 15-20 minutes to complete this process. Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participation at any time without penalty.

Any information obtained during this research study that could identify respondents will be kept strictly confidential. Careful preparation will be taken to maintain total anonymity of the institution and participants in the study. We will do everything we can to protect your privacy. While there are no direct benefits to you, we hope to gain more knowledge on students' academic achievement and attitude toward mathematics.

There are no known risks involved in participating in this study. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential unknown risks.

If you have any questions, please contact Susan Hughes-Isley at shughesisley@comcast.net or Dr. Linda Kuk at lkuk@cahs.colostate.edu. If you have any questions about your rights as a volunteer in this research, contact Janell Barker, Human Research Administrator, at 970-491-1655.

Sincerely,

Susan Hughes-Isley
Principal Investigator

Dr. Linda Kuk
Co-Principal Investigator

APPENDIX C: INSTRUCTIONS

PLEASE READ ALL OF THE FOLLOWING INSTRUCTIONS TO THE CLASS

1. Any information obtained during this evaluation that could identify you as a participant will be kept strictly confidential.
2. Please be honest, your answers will help the research better understand your perspective of this course.
3. It is very important that each student complete the form on an individual basis. Please do not discuss with your friends or classmates.
4. If you are taking this electronic follow the directions indicated on your screen. For manual administration, you must use pencil only! Darken the entire circle. Do not use checks or X's. Do not make any stray pencil marks on the answer sheet. Evaluations completed in ink cannot be processed. Be sure your voice is heard!
5. Please do not talk during the administration of the survey questionnaire.
6. If any irregularities occur such as group evaluations or students trying to make other students evaluate a certain way, report the irregularities to the person that receives the evaluation from you.

Thank you!

APPENDIX D: INTRODUCTION LETTER

Date:

Dear Participant(s):

My name is Susan Hughes-Isley and I am presently a doctoral student pursuing a Ph.D. in Community College Leadership at Colorado State University. Currently, I am conducting a research study for a dissertation in the area of mathematics education under the direction of university committee members.

The purpose of this study is the help better understand the relationship between male and female community college students' academic achievement and attitude toward mathematics. The dissertation is entitled, 'Differences Between Male and Female Community College Students in Achievement and Attitude on College Remedial Mathematics.'

An important part of this research involves allowing me, the student to increase competency and responsibility in original research. Therefore, your feedback to the survey questionnaire is very important. The perspective of students' enrolled in a remedial mathematics course is essential and necessary to guide and provide valuable feedback for research completion.

Your time and effort in completing this survey is greatly appreciated. If you have any questions or concerns, please do not hesitate to contact me at shughesisley@comcast.net or via telephone at 678-344-2169.

Regards,

Susan Hughes-Isley
Doctoral Student
Colorado State University
Fort Collins, CO