RELATIONSHIPS OF MATHEMATICS ANXIETY,

MATHEMATICS SELF-EFFICACY AND MATHEMATICS PERFORMANCE

OF ADULT BASIC EDUCATION STUDENTS

by

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Abstract

Competent mathematical skills are needed in the workplace as well as in the college setting. Adults in Adult Basic Education classes and programs generally perform below high school level competency, but very few studies have been performed investigating the predictors of mathematical success for adults. The current study contributes to the literature on mathematics education of adults in Adult Basic Education by investigating the relationships among mathematics anxiety, mathematics self-efficacy, gender, and age and determining if any of the variables predict mathematics performance. Adult Basic Education students at two community colleges were given math anxiety and math self-efficacy rating scales and their placement test scores were used as the math performance values. Multiple variable analyses were performed and the study found that age, mathematics anxiety, and mathematics self-efficacy were related but mathematics self-efficacy was the only predictor of math performance. Implications for future mathematical instruction in Adult Basic Education and ideas for future research were discussed as a result of this study.

Dedication

This dissertation is dedicated to my wonderful parents and heroes, Paul and Janet Kinsey. This research was only possible because of their love, support, encouragement, and generosity. I love you, Mom and Dad.

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CHAPTER 1. INTRODUCTION

Many adults who did not complete high school or have lost their jobs are enrolled in Adult Basic Education (ABE) classes through their local community college or JobLink. ABE classes are filled with adults obtaining a General Educational Development (GED) diploma or trying to improve skills that are needed to obtain new employment. In 2005, more 18- to 25- year-olds enrolled in ABE classes than ever before due to the poor economic conditions in the United States (The American Institutes for Research, 2006). Economic conditions in the United States have not improved, and ABE classes continue to overflow with students. Many of these adult students, as well as older adults, lack the sufficient mathematical skills needed in higher education mathematics courses or in technical employment (The American Institutes for Research).

Introduction to the Problem

Mathematics anxiety and mathematics self-efficacy may impact students' success in mathematical performance on the GED standardized test or in other ABE mathematics courses and may prevent these adults from pursuing higher education or employment in a technical field. Adult students enrolled in ABE mathematics courses generally did not complete or perform well in higher level mathematics courses in high school (The American Institutes for Research, 2006). This may be due to high mathematics anxiety or low mathematics self-efficacy levels usually acquired during the elementary or secondary education years (Tobias, 1976; van Groenestijn, 2001). Many ABE students have negative feelings towards mathematics which developed during their elementary and secondary schooling. This trepidation is detrimental because competent mathematical skills are necessary in college math courses and in most jobs, especially technical jobs. A research study should be performed to determine the relationship between the emotions involved with mathematics, namely mathematics anxiety and mathematics self-efficacy, and the mathematics performance of ABE students. Recommendations could then be made to the ABE mathematics faculty concentrating on mathematical teaching techniques in order to reduce mathematics anxiety and increase mathematics self-efficacy. These techniques could also improve mathematics performance both in the classroom and in the workforce.

Background of the Study

Research in mathematics education suggests that mathematics anxiety, beliefs about mathematics, and mathematics self-efficacy are variables contributing to or hindering success in mathematics (Walsh, 2008). The term mathematics anxiety entered the social world during the 1970's largely due to the women's movement (Schneider & Nevid, 1993). In the early 1970's, two independent studies were conducted on entering freshmen at universities. The studies determined that mathematics anxiety caused mathematically underprepared college students from choosing any math or science related majors (Ernest, 1976; Sells, 1973). In the studies, it was found that mathematics anxiety related more to women than men, but both genders were affected. Mathematics anxiety was determined to be the cause of "math avoidance" which kept high school students from taking advanced mathematics courses and therefore, the students were underprepared for college level mathematics (Tobias, 1976). More adults are entering Adult Basic Education (ABE) classes and programs than ever before because of job losses or for the opportunity to earn a General Educational Development (GED) diploma to obtain employment. Many of these adults are underprepared in mathematics and this can be attributed to the lack of higher level mathematics courses completed in high school. The lack of completing advanced mathematics courses in high school may be a result of mathematics anxiety, but that is not known at this time (The American Institutes for Research, 2006).

Self-efficacy represents the confidence that one has in performing a task successfully (Bandura, 1986). Academic self-efficacy focuses on coursework, assessments, and course completion in the educational setting while mathematics self-efficacy deals specifically with mathematics. Studies have been conducted showing that mathematics self-efficacy is a predictor of mathematics success (Ferrari & Parker, 1992; Lindley & Borgen, 2002). Other studies have found that mathematics anxiety and mathematics self-efficacy are negatively related indicating that as mathematics anxiety levels increase mathematics self-efficacy decrease (Pajares & Kranzler, 1995). Mathematics self-efficacy has been found to have a positive correlation with mathematics performance while having a negative correlation with mathematics anxiety indicating that mathematics self-efficacy and performance rise and fall together while mathematics anxiety and mathematics self-efficacy levels rise and fall in opposite directions (Cooper & Robinson, 1991). Mathematics anxiety and mathematics self-efficacy have also been correlated individually with the gender or age of students, but no definite conclusions have been found (Gupta, Harris, Carrier, & Caron, 2006). The studies involving mathematics anxiety, mathematics self-efficacy, and mathematics performance have been performed with children, high school students, and college undergraduate students. None of the studies included Adult Basic Education students.

Tobias (1976) gave recommendations to educators for decreasing mathematics anxiety levels while increasing mathematics self-efficacy and mathematics performance among students. These recommendations have not been applied to the ABE mathematics classrooms nor have universal standards been developed for ABE mathematics courses or instruction. Studying the relationships among mathematics anxiety, mathematics self-efficacy, mathematics performance, gender, and age will provide the information necessary to make proper recommendations for improving mathematics education and instruction in the ABE classroom.

Statement of the Problem

There is a gap in the literature regarding Adult Basic Education (ABE) students and whether these students' mathematics anxiety levels, mathematics self-efficacy, and mathematical performances, along with gender and age, are related. The previous research studies focused on children and undergraduate students but did not include ABE students. This study focused on ABE students enrolled at two community colleges located in the western area of a South Atlantic state and gathered information regarding mathematics anxiety and self-efficacy levels, as well as mathematical performances on the Comprehensive Adult Student Assessment Systems (CASAS) or the Tests of Adult Basic Education (TABE) placement tests. This study addressed previously unknown relationships among mathematics anxiety, mathematics self-efficacy, mathematical performance on the CASAS or TABE placement tests, gender, and age of ABE students. To address this problematic educational gap, information was gathered that will be useful in assisting ABE mathematics faculty in providing proper mathematics instruction to ABE students thus ensuring that anxiety levels will be lowered, mathematics self-efficacy will be enhanced, and mathematical skills will be performed with accuracy and confidence.

Purpose of the Study

The purpose of this quantitative study was to determine if mathematics anxiety, mathematics self-efficacy, gender, or age were predictors of mathematical performance for Adult Basic Education (ABE) students. This study determined if mathematics anxiety, mathematics self-efficacy, and mathematics performance differed between gender and age. Investigation into possible correlations among mathematics anxiety, mathematics self-efficacy, and mathematical performance, gender, or age was also included in this study.

Rationale

It is unknown what level of mathematics anxiety or mathematics self-efficacy Adult Basic Education (ABE) students possess when they enroll in ABE classes or programs and this lack of knowledge hinders the mathematics instruction of ABE learners. Most of the research on mathematics anxiety and self-efficacy has been centered on children and undergraduate college students. Strategies such as implementing relaxation techniques and conducting open discussions about math anxiety have been recommended to improve mathematics instruction to reduce anxiety and increase self-efficacy. Would the same strategies instituted with children and undergraduate students work with ABE students in reducing math anxiety and increasing self-efficacy? If information about anxiety and self-efficacy levels of ABE students was known and then shared with ABE mathematics faculty, then mathematics instruction could be supplemented and enhanced to assist ABE students. This restructured instruction would reduce mathematics anxiety, increase mathematics self-efficacy levels, and increase mathematical performance on assessments, problem-solving, and course assignments. Results of this study were shared with ABE faculty to encourage mathematics instruction structured to meet the needs of adult students. Ultimately, ABE students will receive more focused instruction in mathematics and will therefore gain the confidence to take higher level mathematics courses beneficial for career advancement or employment in a technical area.

Research Questions

In order to obtain the information required to address the problem presented in this study, a quantitative methods research study was performed. Quantitative data were collected and analyzed using multiple variable analyses in order to provide the most accurate information about how and to what extent mathematics anxiety, mathematics self-efficacy, gender, and age predicted mathematics performance on the Comprehensive Adult Student Assessment System (CASAS) or the Tests of Adult Basic Education

(TABE) placement test of Adult Basic Education (ABE) students. The quantitative methods study answered the following questions:

1. What are the relationships among mathematics anxiety, mathematics self-efficacy, mathematical performance, gender or age among ABE students?

2. Are the relationships among mathematics anxiety, mathematics self-efficacy, mathematical performance, and age the same for men and women?

3. Do math anxiety, math self-efficacy, age, and gender predict math performance?

4. Do math anxiety, math self-efficacy and gender predict math performance, controlling for age?

Definition of Terms

The following definitions were used in this study:

Adult Basic Education students. This label included adult students who were enrolled in ABE classes or programs and were working to obtain their GED diploma or improving their job skills. These students may continue taking courses at the community college or seek new employment.

Math Anxiety. The level of math anxiety determined by the score that was received on the Math Anxiety Rating Scale – Short Version (MARS-S), (Suinn, 2003).

Math Self-Efficacy. The level of math self-efficacy determined by the score that was received on the Math Self-Efficacy Scale (MSES), (Betz & Hackett, 1993).

Mathematical Performance. The score obtained on the standard Comprehensive Adult Student Assessment Systems (CASAS) appraisal test or the Tests of Adult Basic Education (TABE) that all students completed before entering ABE classes and programs.

Assumptions and Limitations

It was assumed that all the participants in this study answered the questions truthfully on the mathematics anxiety scale and the mathematics self-efficacy scale. This type of self-reporting classified as a limitation in the study. It was also assumed that the ABE students were able to accurately read and understand the questions on the scales even though English was not the native language for some of the students. In addition, the research sample was drawn from volunteer ABE students attending classes at two community colleges in the western area of a South Atlantic state during a single semester. The results of the study can only be generalized to a population following the sample composition.

Nature of the Study

Adult Basic Education (ABE) students participating in the research study from the two selected community colleges were given surveys that measured mathematics anxiety and self-efficacy levels and the students provided their gender and birth date. Along with this information, the students' mathematical scores from either the Comprehensive Adult Student Assessment Systems (CASAS) or the Tests of Adult Basic Education (TABE) placement test, which is administered prior to enrollment in ABE classes and programs, were collected. Quantitative methods were used to analyze the data on mathematics anxiety, mathematics self-efficacy levels, and mathematical performance of the ABE students. Several multiple regression analyses were executed to determine if there is a correlation between mathematics anxiety, mathematics self-efficacy, and mathematical performances, with additional regressions being performed to include gender and age attributes. These analyses will assist ABE mathematics educators in meeting the needs of their students by providing a more complete understanding of the emotions and beliefs concerning mathematics that their students possess upon entering ABE classes and programs.

CHAPTER 2. LITERATURE REVIEW

There is an increasing need for strong mathematical abilities in all realms of adult life and adults, aged 18 and older, are enrolling in Adult Basic Education (ABE) classes in order to increase their knowledge and skill levels in mathematics. ABE students function below a high school level and attend ABE classes in order to improve their writing, speaking, reading, problem solving, or computation skills to function more effectively on a job, in society, in a postsecondary classroom, or in the family (Whitfield, 2004). Knowledge of mathematics is a necessity in an increasingly technological society as well as in the business sector. It is important that ABE students improve their math skills and their understanding of mathematical concepts because as the students are encouraged to move beyond the General Educational Development (GED) stage and enter into postsecondary or technical education, the development of strong math skills and problem-solving will become vital for academic success. Many of these adults avoided taking higher level mathematical courses in high school and lack proficiency in mathematics which could limit their career options (Betz, 1978). Thirty-five percent of all United States students score at the "below basic" level on the National Assessment of Educational Progress (NAEP; National Center for Education Statistics, 2002). In addition, higher proportions of African American, Hispanic, and low-income students score "below basic" than any other category of U.S. student.

There is also an increase of 18- to 25-year-olds enrolling in the adult education programs and classes, and these are the very students who are lacking basic mathematical concepts and skills (The American Institutes for Research, 2006). These students bring with them past experiences and emotions that either hinder or enhance the learning process. The adult education programs are not properly equipped to provide mathematical education to a population that brings different skills, needs, behaviors, and attitudes toward mathematics (The American Institutes for Research). More research is needed to provide information to math instructors in the ABE program in order to assist in the improvement of math instruction for such a diverse population.

At this time, there is little known about the math anxiety and math self-efficacy levels and how these self-constructs relate to the mathematics performance of ABE students. Research that focuses on attitudes, beliefs, and anxiety of adults enrolled in ABE programs has been limited while research studies have been widespread for children and college undergraduates (The American Institutes for Research, 2006). Information about these emotions, attitudes, and needs is important in developing proper mathematical instruction that will ensure student success in ABE programs. Literature will be reviewed concerning math anxiety and mathematics self-efficacy, their relationship, and how they are related to mathematics performance.

Math Anxiety

According to Dirkx (2001), "emotions are important in adult learning because they can either impede or motivate learning" (p. 63). Math anxiety is such an emotion. It can motivate an adult learner to practice and solve many mathematical calculations and problems, or it can paralyze another such that he or she cannot perform even a basic addition problem. Math anxiety has been defined as an "inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (Buckley & Ribordy, 1982, 1). In a study performed by Burns (1998), it was determined that two thirds of U.S. adults "fear and loathe" math. Researchers have shown that students with proven math ability can experience math anxiety that impairs their short-term memory and causes them to struggle in performing mathematical tasks (Ruffins, 2007). Math anxiety becomes problematic for adults when they are exposed to any quantitative environment (Baloglu, 2002). Some adults who encounter or confront a mathematical challenge will rise to the occasion and solve the quantitative problem while others might resort to delay or even denial (Scott, 2003). Betz (1978) has suggested that math anxiety is a critical factor in the educational and vocational decisions that students make and may influence the achievement of a student's educational and career goals. Consequently, math anxiety can hinder a student from choosing a career in a math related occupation because of his or her fear of math.

Math anxiety has been studied for nearly forty years and appears to affect all ages, genders, races, and nationalities. Some of the studies have focused on analyzing the relationship between math anxiety and gender. Many studies have found that females have a greater incidence of math anxiety than males (Cook, 1997; Dew & Galassi, 1983; Ho et al., 2000; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Pajares & Kranzler, 1995; Zettle & Raines, 2000) while other studies have found that there were no significant differences in the math anxiety levels between genders (Betz, 1978; Cooper & Robinson, 1989; Haynes, Mullins, & Stein, 2004; Hendershot, 2000; Segal, 1987).

Betz (1978) designed a research project to estimate the levels of math anxiety in college students, to investigate the relationships of math anxiety with ability and other anxieties, and to determine if math anxiety levels differ among genders, prior math courses, or ages. Betz considered three different groups of students at Ohio State University: 122 students enrolled in the lowest math course at the university that reviewed basic algebra skills and was designed for students who scored poorly on the math placement test, 384 students enrolled in a Precalculus course who scored higher on the math placement test and had taken more high school math courses, and 182 students enrolled in an introductory psychology course that was required for most majors and the students had a diverse math background. Students were given a Mathematics Anxiety scale that was taken and revised from the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976). The Fennema-Sherman Mathematics Attitude Scales was designed to be administered to high school students, so Betz revised some questions to fit the college setting. In all three groups, there was a negative correlation between math anxiety levels and the number of years that a student completed high school math. This indicates that the more math preparation that a student receives prior to college, the less likely the student will report a high level of math anxiety. It was also found that there was a moderate association between math anxiety and other types of anxiety such as test anxiety. In the lowest math group and the precalculus group, it was found that older women in the age range of 17 to 34 had a greater math anxiety level than younger women. This may be due to the number of years that a student had been out of the school or if the student had not taken a math course for several years. Results of the study also indicated that higher scores on a mathematics achievement test related to lower math anxiety levels. No significant differences were found between males and females and the levels of math anxiety that they possessed.

Haynes, Mullins, and Stein (2004) also found that there was no significant difference in the math anxiety levels between male and female college students, but the researchers were surprised to find that math anxiety increased as math performance success increased for females. Another study performed by Bernstein (1992) found that at age 12, males had a higher math anxiety level than females; however, this trend flipped by age 14 and females had a higher math anxiety than males. This may be due to the fact that many people believe that men are better at math than females are, and that females "cannot do" higher level math (Crawford, 1980). Reilly (1992) found that females enrolled in the late junior high or early high school years had higher levels of math anxiety than their counterparts.

In contrast to Bernstein's (1992) results, girls have been found to have higher math anxiety than boys at the age of 12, even in several countries. Ho, Senturk, Lam, Zimmer, Hong, and Okamoto (2000) studied the relationship of math anxiety and math performance among sixth-graders in China, Taiwan, and the United States. The study population included 671 students from both rural and urban schools in order to receive a representative group from the different nations. The Math Anxiety Questionnaire (Wigfield & Meece, 1988) and two parallel forms of mathematics achievement tests that were developed for the study were given to the students in group settings. Using a Chi-square analysis of goodness-of-fit, the study found that the cognitive and math anxiety levels followed the results from a study performed by Wigfield and Meece. The results of the study generalized the negative effects of math anxiety on mathematics performance of students in all three nations. The fact that math anxiety has an effect on high-achieving Asian students was interesting and unexpected. The thought has been that if students can perform well in mathematical situations on a regular basis then the students would not exhibit high levels of math anxiety. There was no significant difference in mathematical achievement between boys and girls across all three cultures. Mathematical differences between genders have not been shown to be significant in the elementary or middle school grades, but it has been shown to become more prominent in high school (Hyde, Fennema, & Lamon, 1990). The girls showed a much higher math anxiety level than the boys in the United States and Taiwan but not in China. The math anxiety levels were essentially the same between the genders in China, and this is believed to be in part due to the one-child policy in that country. The researchers believed that when there is only one child in the family, which is the case in China's culture, academically focused parents stress the importance of education and give full support to the child's efforts, male or female, in all subjects including mathematics.

Anxiety, in general, can cause students to have trouble remembering learned concepts and focusing on the task at hand. A study performed by Altieri (1987) did not focus specifically on learning mathematics but focused on learning in general. Altieri surveyed a sample of 89 developmental studies students at a community college using Kolb's Learning Styles Inventory. Kolb's Learning Styles Inventory is designed to help students and their instructors identify how they learn from experiences. Kolb believes that experiences such as conflicts, differences, and disagreements help to drive the learning process (Kolb, 1984). After the survey was completed, Altieri interviewed 17 students and four faculty members from the college. The analysis revealed that mental recall inability and anxiety acted as barriers to learning for the students and that they may be connected with one causing the other. The students, as well as the faculty, stated that anxiety was the dominant barrier to learning causing students to struggle with remembering, testing, and pacing through their course work.

Math anxiety affects mental recall and can hinder working memory as problems are solved mentally. Ashcraft and Kirk (2001) studied the relationships among math anxiety, working memory, and mathematics performance. Sixty-six undergraduate college students enrolled in psychology classes were recruited to participate in a study that required the adult learners to complete math anxiety and working memory tests. The short Mathematics Anxiety Rating Scale (Alexander & Martray, 1989), a 25-item version of the longer Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972), was administered to rate the math anxiety levels of the students. Demographic information, as well as the number of math courses completed in high school and college along with the grades, was collected. The undergraduate students' working memories were determined using results from the Salthouse and Babcock's (1990) listening span and computation span. Sentences and math problems were read aloud, and students were required to answer questions about what they heard. The participants were also shown letters on a screen that were read aloud by the participants and then the screen was turned off. Next, the students were given a math problem to solve verbally and then they had to list the letters that had been shown to them on the screen. The participants were then given the math problems to solve using pencil and paper in order to minimize the math anxiety effect. The results showed that math anxiety slows down performance, decreases the accuracy in solving math problems, and disrupts the working memory processes. The study also found that students with fewer math classes completed, both high school and college, had a higher math anxiety level when performing math computations, and the math anxiety level increased when the computations became more difficult.

In response to the studies performed on math anxiety and the subsequent finding that it is a barrier to learning mathematics, educators and researchers have tried to determine how, when, and where students first acquired or realized that they had math anxiety. A research study was performed by Shields (2007) to help provide an understanding of what causes math anxiety from the students' perspectives. Shields included 91 college students who were enrolled in or had just completed a developmental Beginning Algebra class in the study. Students were given the Mathematics Anxiety Rating Scale – Short Version (MARS-S; Suinn, 2003), a 32-item questionnaire created by Shields, and some were interviewed after the completion of the surveys. The study found that the majority of the students believed that their lack of mathematical skills causes their math anxiety and believed that if they improved their mathematical skills, their math anxiety levels would be reduced. The results showed that 61% of the college students believed that teachers attributed to their math anxiety. The students believed that they began to show signs of math anxiety at different grades levels: 19% at ninth grade, 15% at seventh grade, 12% at fourth grade, and 11% at eighth and eleventh grade. Since students first encounter Algebra in the seventh, eighth, and ninth grades, it was not surprising that 51% of the students noticed that their math anxiety appeared during their Algebra experience. Society places great emphasis on proficiency in mathematical skills;

60% of the students believed that math was important to their future, but they did not know why. The participants also noted that they preferred working in small groups or with a partner instead of individually or competitively because these activities increased their anxiety levels.

Other researchers have tried to determine the best method or methods to use in the classroom to help deter the effects of math anxiety. One researcher who has conducted extensive research on math anxiety in adults, especially women, is Tobias. In her book, *Overcoming Math Anxiety*, Tobias (1993) explores how poor mathematical skills can affect the economic status of adults. Tobias studied "math-phobic" individuals and found several methods that help reduce math anxiety in adults. These methods enable the adults to overcome their anxiety and to consider instruction and occupations that require strong mathematical skills. A suggestion that Tobias (1993) gives for overcoming math anxiety requires students to take responsibility for their mathematics learning. Another suggestion requires them to talk and write about feelings toward math and what strategies they might use to create positive feelings toward math. Teachers must help students read math textbooks, create learning environments where the fear of math can be discussed openly, and should adjust their teaching styles in order to accommodate student differences and learning styles.

Higbee and Thomas (1999) found that spending time helping adult learners reduce math anxiety was time well spent in the classroom. Higbee and Thomas performed a study on 23 college freshmen who were placed in a two-quarter sequential developmental math course at the University of Georgia. The developmental math instructors administered several inventories and tests to the students, one of which included the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976). The Fennema-Sherman Mathematics Attitudes Scales pose questions that enable the student to explain his or her attitudes towards mathematics. The questions are divided into four subscales: confidence in performing mathematics, usefulness of mathematics, mathematics in a male domain, and a teacher's perception of how the student performs in the subject of mathematics. Half of the questions are posed in a positive manner and the other half are posed in a negative manner. The Fennema-Sherman Mathematics Attitudes Scales, inventories, and tests were given to the developmental math students at the beginning of the first quarter and also at the end of the two-quarter sequence. During the two-quarter time of the study, the developmental math instructors altered their traditional teaching styles and methods by having the students work on activities that promoted self-esteem, an improved attitude toward math, and a reduction in math anxiety. These activities included relaxation exercises, systematic desensitization, and metacognition prior to major exams. The results of the study indicated that there was a decline in mathematics test anxiety and that there was an increase in the students' confidence to be successful in learning mathematics (Higbee & Thomas, 1999). The researchers indicated that it was impossible to determine if there was a single activity that reduced the math anxiety level, and they believed that the levels were reduced by the combination of the activities and the instructors' personalities.

Another study by Peskoff (2000) also analyzed the relationship between math anxiety and the strategies or coping skills that college students employed to succeed in their courses. Using 279 community college developmental students for a correlation study of math anxiety, Peskoff used a multivariate statistical analysis process that related the effects of gender, math anxiety, and course enrollment on 10 coping skills or strategies that were rated for helpfulness and frequency of use. The ten coping skills or strategies included practicing relaxation techniques or participating in physical exercise, discussing difficulties with other students, discussing difficulties with a school counselor, using additional textbooks or review material, asking questions in math class, completing homework assignments on time, letting the instructor know if concepts are not understood, using the school's tutorial services, reminding oneself that he or she is a good student, and setting aside additional study time. The results of the study showed that the developmental students with low math anxiety valued and used a wider variety of strategies or coping skills than students with high math anxiety. Students with high math anxiety preferred using tutorial services and discussing their difficulties with a counselor even though these strategies were found to be among the least helpful by all students. In contrast, students with low math anxiety levels willingly asked questions in class, discussed their problems openly with the instructors and other students, completed their homework on time, spent extra time studying, and reminded themselves that they were good students. Using relaxation techniques or engaging in physical exercise was used more by males than females but was also found to be among the least helpful in coping with math anxiety by all students and faculty. Some strategies that proved helpful in lowering math anxiety for all students included asking questions in class, completing homework on time, studying more before exams, and letting instructors know if they did not comprehend the material or new math concepts.

Mathematics Self-Efficacy

A definition for self-efficacy has been offered by Bandura (1986), and most educators would agree that the definition can be applied to adult learners. Bandura (1986) defined self-efficacy as “people’s judgment of their capabilities to organize and execute courses of action required to attain designated types of performances” (p. 391). Self-efficacy can be thought of as the amount of confidence one has to succeed in performing a task. These judgments or beliefs have been documented as being predictors of academic performance and career choice decisions (Bandura).

A large body of research indicates that there is a positive relationship between academic self-efficacy and college grades (Bong, 2001; Brown, Lent, & Larkin, 1989: Hackett, Betz, Casas, & Rocha-Singh, 1992; Lent, Brown, & Larkin, 1984; Multon, Brown, & Lent, 1991; Wood & Locke, 1987). Academic self-efficacy has also been shown to be a better predictor of grades and persistence in college than general self-efficacy (Ferrari & Parker, 1992; Lindley & Borgen, 2002). General self-efficacy can be thought of as a person’s belief or confidence that he or she will be able to complete a task while academic self-efficacy is the belief that one will succeed in enrolled courses and school.

Bong (2001) performed a study to determine if self-efficacy beliefs predict course achievement and future course enrollment. The participants for the study included 168 college students enrolled in a teacher credential course in the School of Education in a women’s university in Seoul, South Korea. Eight different surveys or measures on self-regulated learning, academic achievement, course-specific, content-specific, problem-specific self-efficacy and course values, along with course performance, were given to the students. The surveys included questions such as “I can finish course assignment by deadlines,” and “I believe that I can do an excellent job on the problems and tasks assigned for the courses I’m taking this semester.” Also on the surveys were 30 midterm problems which asked students to rank their confidence on solving types of problems on a scale from 0 to 100 with 0 meaning not confident at all and 100 meaning that the student was very confident of solving the problem. Bong found that self-efficacy was a predictor for academic performance for both midterm and final scores for the course.

A study performed by Paulsen and Betz (2004) was designed to evaluate the relationship between self-efficacy in academic areas, including mathematics, and career decision-making self-efficacy. Participants of the study included 627 undergraduate students who were enrolled in introductory psychology courses and majoring in liberal arts or general studies from a large Midwestern university. The sample consisted of 55.5% women, 44.5% men, 80% Caucasian, 9% African American, 6% Asian American/Pacific Islander, 2% Latino/Hispanic, 1% multiracial, and 1% Native American. The African American subgroup was the only subgroup that was large enough to analyze separately in the statistical analysis. The participants were given the 5-point scale Expanded Skills Confidence Inventory (Betz et al., 2003) which focused on six of the Basic Confidence Scales: Mathematics, Science, Writing, Using Technology, Leadership, and Cultural Sensitivity. They were also given the short version of the Career Decision Self-Efficacy Scale (CDMSE-SF; Betz, Klein, & Taylor, 1996) to measure the students’ self-efficacy expectations for completing requirements or tasks in making career decisions. Leadership confidence was considered to be a predictor of career decision-making self-efficacy for all groups. Secondary predictors varied among all other groups. It was found that self-efficacy in mathematics, science, and using technology were predictors in making career decisions for all the undergraduate students, especially African Americans (Paulsen & Betz, 2004). However, it was found that science self-efficacy related negatively with mathematics self-efficacy for African Americans. The results also showed that mathematics self-efficacy was more important to women than men.

Another study of 230 undergraduate students at a southeastern university who were enrolled in four general education classes found that there were no gender differences in self-efficacy. The participants consisted of 62% White, 34% Black, 1% Hispanic, 1% Asian, and 2% other with approximately 56% female and 44% male. Choi (2005) measured general self-efficacy using a subscale of the Self-Efficacy Scale (Sherer et al., 1982); academic self-efficacy was measured using the College Academic Self-Efficacy Scale (Owen & Froman, 1988); task-specific self-efficacy was measured using a modified scale from another study performed by Wood and Locke (1987); academic self-concept was measured using the Academic Self-Concept Scale (Reynolds, 1988) and modified items from a study performed by Marsh (1992). The Self-Efficacy Scale poses questions about failures and successes and how these instances attribute to the participant's composition of self-efficacy. The Self-Efficacy Scale does not measure task-specific efficacy but rather includes questions such as "When I make plans, I am certain I can make them work." The participants indicate the level of self-efficacy on a five-point Likert-type scale with a higher score indicating a higher level of self-efficacy. The College Academic Self-Efficacy Scale also uses a five-point Likert-type scale and measures the confidence that college students have in performing typical academic behaviors such as "taking well organized notes." Specific self-efficacy was determined by asking participants their level of self-efficacy while completing tasks for a specific course that included class concentration, understanding the content, and note-taking. Academic self-concept was measured using the Academic Self-Concept Scale, which used a five-point scale and consisted of 40 questions such as "I consider myself a very good student." Academic self-concept was also determined by using a course specific self-efficacy survey that asked participants to answer questions such as "I learn things quickly in this type of course." The results of the study indicated that there was no significant difference between genders in self-efficacy and self-concept. This study also found that specific self-efficacy is a predictor of term grades while general and academic self-efficacy were not significant factors in academic performance.

Math self-efficacy has been studied to determine if it can be a predictor of mathematics performance. Gupta, Harris, Carrier, and Caron (2006) surveyed 451 entry-level college math students to determine predictors of student success at the University of Southern Maine. The University offers 50 majors and serves a diverse population from suburban and rural areas of the state. A questionnaire was given to selected math classes during the last few weeks of the semester and asked the students to volunteer to be participants of the study. Previously validated questions from a study by Stratford and Finkel (1996) were included in the questionnaire in order to assess students' attitudes toward mathematics. The questionnaire included questions on student demographics (gender, age in years, and college major), factors that could hinder study time (number of work hours, other coursework, and the number of children at home), the number of remedial math courses completed at the high school and college level, the number of years that had lapsed since taking the last math course, the total number of freshman level math courses taken, college math course attendance, and the number of hours the student received mathematics tutoring. The researchers found that the students made higher grades if they had a more positive attitude towards mathematics, had a good attendance record, and did not use tutorial services. A significant difference was not found between males and females in attitudes towards mathematics. The results also showed that older students and male students tended to receive higher grades. Surprisingly, students who were enrolled in majors that required strong mathematical skills did not receive significantly higher grades than students in other majors. The number of math courses taken in high school and remedial math courses taken did not have a significant impact on the students' grades.

In 2003, the Organization for Economic Co-operation and Development (OCED) conducted a Program for International Student Assessment (PISA) survey to assess the knowledge and skills of 15-year-old students in participating international countries (OCED, 2003). The large scale PISA survey is administered every three years to 15-year olds in all the 41 OCED countries and assesses student literacy in one of three cognitive areas: reading, mathematics, and science. In 2003, the PISA survey focused on mathematics literacy. The PISA survey included a math test as well as questions regarding math self-concept and math self-efficacy that required participants to respond using a four-point Likert-type scale. Math self-concept is a person's attitude about mathematics in general, and math self-efficacy is a person's confidence that he or she will succeed in the math course or successfully complete a mathematics task. The math self-concept questions included "I have always believed that mathematics is one of my best subjects," and "I learn mathematics quickly." The math self-efficacy questions had the participants rate their confidence in solving six different mathematical tasks using a four-point Likert-type scale. Math anxiety levels were determined by answering questions using a four-point Likert-type scale which included "I get very nervous doing mathematics problems," and "I often worry that it will be difficult for me in mathematics classes." Ferla, Valcke, and Cai (2009) conducted a study on the results of the PISA survey for Belgian students to determine if there was a difference between academic self-efficacy and academic self-concept, in particular math self-efficacy and math self-concept, and if either or both constructs affected mathematics performance. It was found that a student's math self-concept, the belief that he or she has the ability to achieve in mathematics, strongly influences his or her math self-efficacy but not vice versa. It was also found that math self-efficacy independently predicts math scores and that math self-efficacy levels had no or little effect on math interest and math anxiety.

Also using the data and results from the 2003 PISA survey, Lee (2009) studied the specifics of math self-efficacy, math self-concept, and math anxiety across the 41 participating countries including the United States. The purpose of the study was to determine if the self-constructs could be differentiated from one another across diverse cultural groups. Each self-construct was analyzed within each country and the results showed that math anxiety showed a stronger correlation with the math scores than did math self-efficacy and math self-concept. Also, math self-efficacy and the math scores had a positive relationship which means that if a student has a high math self-efficacy level, the student will have a higher math score. It was interesting that the United States had the highest math self-concept and a high math self-efficacy yet scored in the lower half of the countries on the math score. In contrast, participants in Japan scored the lowest among the 41 countries in math self-concept and math self-efficacy and was in the top five for high math anxiety levels while scoring high on the math test.

The differences between the mathematics self-efficacy of college freshmen enrolled in Calculus I and freshmen enrolled in developmental or remedial Intermediate Algebra were studied by Hall and Ponton (2005). The researchers used the Mathematics Self-Efficacy Scale (MSES) developed by Betz and Hackett (1983) which helps to determine a student's confidence in successfully completing tasks in mathematics and helps to determine a student's belief that he or she will receive at least a B in a particular mathematics course. The results of the study showed that the Calculus I students possessed a higher mathematics self-efficacy than the remedial Intermediate Algebra students. The results of the study also indicated that there were no differences in the mathematics self-efficacy levels between genders in both the Calculus I and Intermediate Algebra courses. Hall and Ponton believe that "exposure to mathematics with positive outcomes increases mathematics self-efficacy, whereas exposure to mathematics with negative outcomes decreases self-efficacy" (1983, p. 28). They also suggested that teachers of developmental or remedial courses create a learning environment that fosters positive math self-efficacy while keeping the standards of the course comparable to more difficult college courses.

Relationships Among Math Anxiety, Self-Efficacy, and Math Performance

According to Pajares and Kranzler (1995), math self-efficacy and math anxiety are negatively correlated which means that a high math self-efficacy relates to a low math anxiety and a high math anxiety level indicates a low math self-efficacy. Using a joint-path analysis to compare math self-efficacy and math anxiety in high school students, only math self-efficacy was found to be predictive of math performance. Studying undergraduates, researchers Siegel, Galassi, and Ware (1985), were surprised to find that math self-efficacy was more predictive of mathematics performance than math anxiety.

Cooper and Robinson (1989) performed research at a Midwestern university that emphasized science and engineering to determine if there is a relationship among math self-efficacy, math anxiety, and math performance. Correlation tests were calculated with the results showing that mathematics self-efficacy had a negative correlation with mathematics anxiety while having a positive correlation with mathematics performance.

A few studies about math anxiety, math self-efficacy, and math skills used in performing drug dosage calculations have been conducted in the nursing field at the college level. In a static group comparison designed study performed by Hodge (2002), 44 out of 122 undergraduate nursing students, including students completing prerequisites to obtain admission into the nursing program, were selected to determine if there was a connection or relationship between math anxiety, self-efficacy, instruction, and dosage calculation performance. The 44 students were enrolled in Math Topics for Nurses, an introductory course for nursing students as well as potential nursing students. The students were administered the Math Anxiety Scale and the Math Self-Efficacy Scale at the beginning of the course. All of the students received didactic instruction in the classroom, but a sample of 21 students received computer-assisted instruction following the classroom instruction. The remaining 19 attended another lab where they were given a short review and worksheets to complete (Hodge). The Math Anxiety Scale, the Math

Self-Efficacy Scale, and a 25-item dosage calculation test were given at the end of the semester to determine if there was indeed a relationship among math anxiety, math self-efficacy, math performance, and computer-assisted instruction. The results showed that there was a relationship between math self-efficacy and dosage calculation ability. However, math anxiety was not a significant factor in the students' abilities to calculate dosages. Students who received the computer-assisted instruction scored an average of 9.52 points higher on the 25-item dosage calculation test than the students who received the "traditional" instruction.

Kathleen Walsh (2008) performed a mixed-method study in order to explain the relationship among math anxiety, beliefs in mathematics, mathematics self-efficacy, and mathematical performance on a drug dosage test with third-semester nursing students enrolled in an associate degree program. The nursing students were given a survey that included ten dosage calculation problems and concluded with open-ended questions about how the students felt about the mathematical affective factors being studied. Another survey that contained 50 items combining the Mathematics Anxiety Scale (Betz, 1978), the Indiana Mathematics Belief Scale (Kloosterman & Stage, 1992), and the Mathematics Self-Efficacy Scales (Betz & Hackett, 1993) was administered to the students. The results of the study indicated a slight inverse relationship between math anxiety and the students' beliefs about mathematics. The majority of the students possessed confidence that they were able to perform basic and complicated mathematical operations, and a positive correlation was found between the test scores and the Mathematics Self-Efficacy Scales results (Walsh, 2008). The qualitative data that was gathered in this study indicated that while the nursing students possessed low math anxiety levels, they did experience mathematics test anxiety. Responses to the open-ended questions offered valuable insight for future nursing education pedagogies. Walsh recommended that nursing educators develop strategies that will support the nursing students in their efforts to improve their math skills and to accurately perform dosage calculations. Some options of this support may include tutoring, mentoring, offering courses outside the nursing department, and computer-assisted instruction. Walsh also recommended that medication mathematics skills should be introduced early in the nursing program, and it would be helpful to use one method when performing dosage calculations so that nursing students will not become confused by the use of different calculation methods.

Summary

The literature that has been reviewed offers information indicating that there is a relationship among math anxiety, mathematics self-efficacy, and mathematical performance for children and college students. However, there is no general consensus from one research project to the next about these relationships. There is no clear conclusion on whether males or females have the highest math anxiety levels. Several research projects found that females had a higher math anxiety level than males while others found that there was no difference between genders. A few studies showed that math anxiety levels were higher for males at age 11 and then switched to higher levels for females at age 14. The literature has also suggested that several teaching techniques and methods can be used in order to reduce math anxiety levels. A gap in the literature was found because no studies were performed on ABE students about math anxiety.

Several research studies found that math self-efficacy levels were not the same between genders. If students make good grades in mathematics, they tend to have higher math self-efficacy levels than students who make poor grades. The same appears to be true for students who are enrolled in higher level mathematics courses as opposed to those who are enrolled in remedial mathematics courses. Math self-efficacy has been found to be predictive of math performance in several studies. Again, no studies were conducted on ABE students to determine their math self-efficacy levels.

There are only a few studies that researched the relationship among math self-efficacy, math anxiety, and math performance. It was found that if students have a high math self-efficacy level, then they possess a low math anxiety level, and the reverse was found to be true. Math self-efficacy was a better predictor of good mathematics grades with math anxiety appearing to have no effect on mathematics performance. These studies were performed on children and college students, but there were no studies performed on ABE students.

In this study, the ABE students' math anxiety, mathematics self-efficacy, and mathematical performances, along with gender, were measured to determine if there is a relationship among these factors. The results of the proposed study were added to the existing literature by providing information on math anxiety, mathematics self-efficacy, and mathematical performance of ABE students who are pursuing a GED or are enrolled in ABE classes. This information can be used to assist educators in setting mathematics teaching methods that will reduce math anxiety and increase math self-efficacy and mathematics performance.

CHAPTER 3. METHODOLOGY

This study attempted to determine how and to what extent mathematics anxiety, mathematics self-efficacy, gender, and age affected mathematics performance in Adult Basic Education (ABE) students. This chapter describes in detail the research design, the population and sample selected for the study, the instruments used for data collection, the statistical methods that were used, and the research procedures implemented for the study. In addition, ethical issues concerning this study and expected results of the data analysis are discussed briefly.

Introduction and Overview of Research Design

A quantitative research design was used to measure how and to what extent mathematics anxiety, mathematics self-efficacy, gender, and age were related for Adult Basic Education (ABE) students. The purpose of this study was to determine the levels of mathematical anxiety and mathematical self-efficacy of ABE students and how these self-constructs, along with gender and age, affected or predicted mathematical performance. A quantitative research design was appropriate for this study because quantitative research is used to describe trends or explain the relationship among variables (Creswell, 2008).

Reviewing the literature revealed the lack of information about ABE students and their mathematics anxiety and self-efficacy levels and how these self-constructs affected their mathematics performances. In addition, it has not been determined what levels of mathematics anxiety and mathematics self-efficacy that ABE students possess. This information was gathered using established reliable and valid scales that produced numerical values that were used in a quantitative research study. Quantitative methods research designs use statistical data analysis which is used extensively in research studies when the data are numerical or can be converted to numerical measures. Statistical data analysis can be used to test hypotheses to determine if data are significant and if explanatory variables have an effect on the response variable. Statistical data analyses were performed to determine the relationships among mathematical anxiety, mathematical self-efficacy, gender, age, and mathematics performance and to determine if the self-constructs, along with gender and age, predicted mathematical performance. The levels or influence of these self-constructs could have been explored using qualitative methods; however, there would be room for subjectivity, and the results of a qualitative analysis would not provide accurate measures. In contrast, quantitative research methods provide objectivity and unbiased results. The study was not designed to explain how or why the ABE students acquired mathematics anxiety or mathematics self-efficacy, and further qualitative research studies could be performed to determine this. Therefore, quantitative methods were used to answer the research questions and hypotheses for this research study.

In order to use quantitative methods, numerical data were collected from ABE students in two different community colleges. Mathematics anxiety and mathematics self-efficacy levels, along with mathematical performance, were measured numerically and gender and age were also given numerical values.

Students were given the Comprehensive Adult Student Assessment Systems (CASAS) or Tests of Adult Basic Education (TABE) placement test after attending an orientation session and before entering the ABE classes. The CASAS or TABE provided a score in mathematics and determined the mathematical concepts that needed to be reviewed in the ABE classes. The score that the adult learners received on the math portion of the CASAS or TABE assessment was used as the mathematics performance level for the research study. In addition, a student's age and gender were gathered on the personal data sheet during the orientation, but the researcher asked for these again on the background information form that was included in the packet along with the consent form and scales. In order to use quantitative statistical methods, a male student was assigned a 1 for the gender value while a female student was assigned a 2. The age of a student was given a decimal value. The mathematics anxiety level was measured using the Mathematics Anxiety Rating Scale-Short Version (MARS-S) which is a 30-question, self-reporting test found to be reliable and suitable for adult learners. The mathematics self-efficacy level was measured using the Math Self-Efficacy Scale (MSES) that consists of 34 questions designed to measure one's belief about his or her own ability for performing math-related tasks. The MARS-S and MSES scales, used with permission, were given to the adult learners after they began ABE classes but before they completed their math classes.

The data were analyzed using multiple variable analysis techniques with math anxiety, math self-efficacy, gender, and age as independent or explanatory variables while keeping the math performance as the dependent or response variable.

Research Questions and Hypotheses

In this research study, the following questions were answered:

1. What are the relationships among mathematical performance, mathematics anxiety, mathematics self-efficacy, gender, or age among ABE students?
2. Are the relationships among mathematical performance, mathematics anxiety, mathematics self-efficacy, and age the same for men and women?
3. Do math anxiety, math self-efficacy, age, and gender predict math performance?
4. Do math anxiety, math self-efficacy, and gender predict math performance, controlling for age?

In order to answer these questions, the following testable null hypotheses were used to lead the multiple variable and correlation statistical analysis of the data:

1. There is no relationship among mathematical performance, mathematics anxiety, mathematics self-efficacy, gender, or age among ABE students.
2. There is no difference among mathematical performance, mathematics anxiety, mathematics self-efficacy, and age for men and women.
3. Math anxiety, math self-efficacy, age, and gender do not predict math performance.
4. Math anxiety, math self-efficacy, and gender, controlling for age, do not predict math performance.

These hypotheses were considered as null hypotheses and were tested to determine if they could be rejected at a significance level of 0.05 ($\alpha = 0.05$) using multiple variable analysis.

Population and Sample

At two different public community colleges in the western area of a South Atlantic state, ABE students who were completing courses towards earning their General

Educational Development (GED) diplomas or taking courses to improve skills needed for new employment were the participants of the study. One of the community colleges served a rural county that had a population of about 50,000 while the other community college served a more populated area of approximately 90,000 residents. Both counties had an unemployment rate over 15% leading to a record high number of adults entering into the ABE classes in 2009 (Economic Time Series, n.d.).

Before entering into the ABE classes or programs, the adult learners attended an initial three-hour orientation session that served as a student success and study skills class. Upon completion of the orientation, the adult learners took the CASAS or TABE assessment to determine their placements in the ABE classes. Adult learners enrolled in the ABE courses took the CASAS or TABE and scored below high school level in one or more areas of the test. At one community college, the ABE students were able to enter into classes at any time and advance in a self-paced manner towards completion of the courses by successfully passing posttests. At the other community college, the ABE students were enrolled in a more traditional classroom setting and worked together toward a goal.

The ABE students who were enrolled in the ABE classes were age 18 years of age and older and considered as adult learners in this study. Some studies have defined the adult learner as someone who is 25 years or older who are involved or enrolled in postsecondary learning activities (Voorhees & Lingenfelter, 2003). According to the U.S. Department of Education, the adult learner is one who is acquiring information, knowledge, and the skills necessary to be successful in the workplace, earn credentials or certifications, or learn basic skills through instruction or an educational activity (National

Center for Education Statistics, 1999). In this study, the U.S. Department of Education definition of the adult learner was used. If students younger than 25 were excluded from this study, the sample size would be limited and the sample would not be a true representation of the ABE populations in the two community colleges that were involved in this study. In addition, many studies have been performed on students in middle school, high school, and colleges, but very few studies have been performed on ABE students. This study assisted in providing additional information on this group of learners. This information will be invaluable because the ABE population is expected to increase due to rising dropout rates and high unemployment rates (Hayes, 1999; Rachel & Bingham, 2004).

The researcher contacted the directors or coordinators of the Adult Basic Skills classes at the two public community colleges to determine which ABE classes would be presented with the opportunity to join the research study. Classes were chosen that included students who had not taken any ABE math classes, or who had just started an ABE math class. The researcher recruited assistants at each community college who presented the research study to the students in the appointed classes. The researcher assistants, under the direction of the researcher, also presented the methods that would be used to ensure confidentiality and anonymity. The students were informed of the option to participate, or refrain from participating, in the study. Any student who was younger than 18 years old was informed that he or she would not be included in the study because of the adult learner definition. Participants were recruited in this manner during a one month period or until at least 75 students from each college completed the self-construct scales. At least 75 students were needed for this study because five variables were included in the statistical analysis, and at least 15 participants were needed per variable.

Instruments

All ABE students at the two community colleges complete a Comprehensive Adult Student Assessment System (CASAS) appraisal test or the Tests of Adult Basic Education (TABE) for proper placement into ABE classes. The CASAS appraisal test assesses adult basic writing, listening, reading, speaking skills, and mathematics. The CASAS is the only assessment system "that has been approved and validated by the U.S. Department of Education and the U.S. Department of Labor to assess both native and non-native speakers of English" (Comprehensive Adult Student Assessment System, n.d.). In addition, the CASAS has field tested and validated its assessments and instruments to measure functional critical thinking skills, mathematics, and communication skills for both native and non-native speakers of English. The mathematics portion of the CASAS can usually be completed in 60 minutes with paper and pencil even though the appraisal test is not timed (Comprehensive Adult Student Assessment System). The appraisal test includes the basic mathematical concepts of fractions, decimals, whole numbers, percentages, and signed numbers. The Tests of Adult Basic Education (TABE) is a diagnostic test that is used to determine an adult's skill level in reading, English, and mathematics. The mathematics section consists mostly of basic math skills including fractions, percentages, and decimals, but there are a few pre-algebra questions (Tests of Adult Basic Education, 2000). The TABE tests are published by McGraw-Hill and the TABE developers met with expert educators to determine the common educational goals and the knowledge and skills that should be emphasized in adult curricula (Tests of Adult Basic Education). After the meetings, the TABE questions or items were then designed to measure the knowledge and skills that should be included in adult curricula. The TABE tests are statistically correlated to the GED tests (Tests of Adult Basic Education). The TABE tests have been found to be reliable and valid, and the supporting data can be found in the TABE Technical Report (Tests of Adult Basic Education).

The Mathematics Anxiety Rating Scale-Short Version (MARS-S) survey is a 30-item, Likert scaled self-reporting questionnaire that is used to accurately measure mathematics anxiety levels with the adult student rating his or her anxiety level. The MARS-S was developed by Suinn (2003) because he believed that the original 98-item Mathematics Anxiety Rating Scale (MARS) that was developed by Richardson and Suinn in 1972 was too long. According to Suinn, the original MARS is very reliable with an internal reliability coefficient of 0.97, and the shortened version MARS-S has an internal reliability coefficient of 0.96. Correlation tests between the MARS and MARS-S scales showed a correlation of 0.92 and 0.94 one week later with $p < 0.001$ (Suinn). The shortened version MARS-S is believed to be equivalent to the original MARS and is more user friendly for adults to rate their anxiety levels (Suinn).

The Mathematics Self-Efficacy Scale (MSES) was developed by Betz and Hackett in 1983 and contained 75 items but was revised in 1993 to contain 34 items. The MSES is used to measure an adult student's confidence in his or her ability to correctly perform everyday tasks while the Mathematics Tasks subscale and the Mathematics Courses subscale measure the student's ability to perform well in subsequent college courses that require mathematical skills (Hall & Ponton, 2005). The content validity of the MSES has been confirmed through research studies that demonstrate the validity of each area of the MSES instrument (Betz & Hackett, 1993).

Statistical Methods

Research question one was answered by testing hypothesis one using a correlation matrix generated using SPSS software. In addition to the correlation matrix, Pearson *r* correlations were calculated among the variables math anxiety, math self-efficacy, gender, and age with the dependent variable math performance to determine how strong the linear correlation was between each pair. The closer the *r* value was to ±1, the stronger the correlation. The correlation matrix and the Pearson *r* calculations determined if there were relationships and how strong the relationships were among the five variables.

Research question two was answered by testing hypothesis two by using a correlation matrix for men and women separately. Pearson *r* values were calculated to determine the strength of the relationships among math anxiety, math self-efficacy, math performance, and age while keeping the gender constant. *T* tests were performed on the *r* values to compare men and women in terms of correlation among variables.

Research question three was answered by testing hypothesis three using a multiple regression analysis. Math anxiety, math self-efficacy, gender, and age were considered the explanatory variables while math performance was considered the response variable. The multiple regression analysis constructed a least-squares equation that followed the pattern $y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4$ where *y* was the response variable, x_i represented the explanatory variables, b_0 was the constant, and b_i represented the regression coefficients (Sullivan, 2010). The equation that was created can be used to predict math performance using a combination of the values of math anxiety, math self-efficacy, gender, or age. The significance of explanatory variables in the presence of other variables in the equation was determined by p values. The explanatory coefficients in the least-squares equation were examined to determine the extent of prediction that each explanatory variable had on the dependent variable. The F test was used to determine if the set of explanatory variables predict the response variable. R^2 was calculated to determine the proportion of variation in the response variable that was due to the variation in the explanatory variables. The R^2 values assisted in determining how strongly math anxiety, math self-efficacy, gender, and age influenced math performance. Math anxiety, math self-efficacy, gender, and age were studied separately and thoroughly using descriptive statistics and simple linear regression analysis.

Research question four was answered by testing hypothesis four by using multiple regression analysis methods similar to those described in answering research question three. However, the tests were conducted without the age explanatory variable to determine if math performance was predicted without regard to a student's age.

The assumptions of normality were tested for each variable by calculating skewness and kurtosis values using the SPSS software. Results from the purchased MARS-S and MSES scales were assumed to be normally distributed, but they were still tested for normality. Scatter plots were created in order to test for linearity and homoscedasticity or constant variance. Linearity and homoscedasticity are required assumptions of any regression analysis. Linearity indicates that the explanatory variables and the response variable follow a linear relationship in the scatter plot. Homoscedasticity indicates that the dispersion of data points is uniform about the regression line in the scatter plot.

There were limitations in the data analysis of this quantitative study. It was assumed that the participants honestly answered the questions on the MARS-S and MSES scales. Data from this study may not be generalizable to other populations or be consistent with other research studies in which the explanatory and response variables are defined differently. There may be other types of stress or anxiety possessed by the ABE participants that were not considered in this study and this anxiety also could have influenced a participant's answers on the MARS-S and skewed the results. Quantitative analyses study relationships between variables but do not necessarily determine cause and effect. Another limitation of the quantitative study is that the participants were not allowed to provide insights into their thinking concerning the possible relationships among mathematics anxiety, mathematics self-efficacy, gender, age, and mathematical performance.

Research Procedures

The research assistants, employees of both community colleges, helped in identifying ABE students who should be invited to participate in the study. The ABE students who were asked to contribute to the study were those who had taken the CASAS or TABE test but had not finished working on their mathematical skills. Packets were assembled that included the student consent form, the background information form, and the MSES and MARS-S scales. The MSES and MARS-S scales were purchased and permission was granted to use them in the study, and a background information form was designed to collect a student's gender and race, and his or her age was indicated by his or her month and year of birth. The packets were numbered using codes to identify the community college and the student such as AB1, AB2, and so on. All pages in each packet had the identifying code. A large brown envelope was provided to each participant so that the completed forms and scales could be placed into the envelope and sealed by the participant.

If the student agreed to participate in the study, the student was given a packet that included a consent form, a background information form, a math anxiety scale (MARS), and a math self-efficacy scale (MSES). Once the student completed the packet, the student sealed it in a plain brown envelope and put his or her assigned code on the seal for security and to ensure confidentiality. Data were collected for a period of one month or until at least 75 students participated in the research study from the two community colleges. The researcher collected the sealed envelopes and then removed the consent form from each packet after all participants had completed the scales and forms.

The analysis process began by removing the consent form and storing it securely. The rest of the packet contained the information and data needed to complete the study. Students were not able to be identified by the instructors or the researcher throughout the data collection and analysis process. In this way, confidentiality and anonymity were ensured. The MARS and MSES scales were scored following the instructions in the manuals for the scales. The scores from the MARS and MSES scales, gender, and birthdates were analyzed using the SPSS software program. Correlation matrices were calculated between the variables to answer research questions one and two. A multiple regression analysis was performed on the data in order to answer research questions three and four. The results of the study were shared with the ABE directors at the two community colleges. If they chose to know the results of the MARS and MSES scales, students were informed of their mathematics anxiety and mathematics self-efficacy levels. The directors of the ABE programs at the community colleges plan to use the information to improve instruction and provide additional support for the ABE adult learners.

Ethical Issues

The researcher designed procedures that minimized risks for the students during the course of the research study. Permission to conduct the research study was obtained from the directors of the ABE programs or the Institutional Review Board at the two community colleges chosen for the study and from the researcher's university. Permission to use the MSES and MARS scales was also obtained. Consent forms were developed that gave students the opportunity either to join or decline participation in the research study.

ABE students filled out a consent form before they were considered to be participants of the study. Confidentiality and anonymity were ensured by using codes instead of names on the surveys to identify students, using envelopes in which to seal the forms and documents, and immediately sealing the consent forms in an envelope by the researcher so that names were not visible throughout the analysis process. The consent forms will be stored in a locked file cabinet for three years after the completion of the study. Students were allowed to withdraw at any time during the study, and they were able to request their math anxiety and math self-efficacy levels from the completed surveys. The students' grades were not affected in their ABE classes, and the participants were informed of this at the beginning of the study. The instructors, directors, and coordinators of the ABE classes did not have access to the individual data values, but they received an overall view of the math anxiety and math self-efficacy levels; however, the information provided did not identify individuals or their scores. The researcher also safeguarded the collected data and consent forms and ensured that an accurate account of the information was provided in the analysis and interpretation.

The researcher did not use any of her own students in the study and she did not know any of the participants, therefore eliminating any conflict of interest. In addition, coding the responses and using SPSS software eliminated researcher bias.

Expected Results

The researcher expected to find that the ABE students had high math anxiety levels because the ABE student typically does not take higher level math courses in high school and is anxious about completing mathematical tasks or mathematics courses. A high math anxiety level could lead to low math performance while a high math self-efficacy level could lead to higher math performance. The researcher expected to find no differences in math anxiety and math self-efficacy levels between genders; however, it was believed that the math anxiety levels would be higher for older ABE students while math self-efficacy levels would be lower for older students. Older students were expected to perform better on the math performance indicators because they are more dedicated and serious about performing well in school than younger students.

CHAPTER 4. DATA COLLECTION AND ANALYSIS

This quantitative study researched how and to what extent mathematics anxiety, mathematics self-efficacy, gender, and age affected mathematics performance in Adult Basic Education (ABE) students. This chapter describes the research results including the research procedures implemented for the study, the demographics of the research sample selected for the study, the instruments used in the data collection, the statistical methods that were used to analyze the data, and the results of the analyses.

The purpose of this study was to determine the levels of mathematical anxiety and mathematical self-efficacy of ABE students and how these self-constructs, along with gender and age, affected or predicted mathematical performance. The information will be used to aid Basic Skills instructors in learning more about their students. It will also be useful in helping instructors enhance their teaching methods in order to address low confidence and high anxiety levels in math classes. This study was based on information gathered from students enrolled in Adult Basic Skills courses in two community colleges in the western area of a South Atlantic state during the last two months of 2010. Some of the students may have started their math courses but they had not yet completed their math courses in the ABE program when the data was collected.

Research Participants and Sample Demographics

This research study focused on adult learners in the Adult Basic Education (ABE) programs. The definition of adult learners that was used in this study limited adult learners to those who were at least 18 years old. For this study, a sample of participants was gathered from Adult Basic Education programs in two community colleges in the western area of a South Atlantic state with the help of research assistants. The research assistants entered classrooms at their colleges, introduced the research project, and asked for volunteers to join the study. About one-fourth of the students in the classes were younger than 18 years old and they were not invited to join the study because they did not meet the definition of adult learner. This process continued until a total of 110 participants was recruited to join the study. The participants completed a consent form, a demographic form, a Mathematics Self-Efficacy Scale (MSES), and a Mathematics Anxiety Revised Scale (MARS). The completed forms were sealed in brown envelopes and the researcher picked them up from the research assistants. The research assistants obtained the math placement scores for the project participants from their respective colleges.

A total of 110 sealed envelopes was collected from the two community colleges. Three volunteer participants were eliminated from the research project because one did not sign the consent form, another one did not complete the MARS survey, and a math placement score could not be found for the third. Therefore, a total of 107 participants formed the sample for this research project.

The participants indicated their race on the background information data sheet in order to determine the demographics of the sample and the results are shown in Table 1. The “other” category included one participant who indicated that he or she was Mayan Indian and another participant who indicated that he or she was Native American.

The participants also indicated their gender on the demographic data sheet and the results are shown in Table 2. In addition to gender and race, participants also provided their age in terms of month and year of birth. The researcher then calculated the ages relative to November 2010. No one under age 18 was included in the study. The youngest participant was 18 years and one month old or approximately 18.1 years while the oldest participant was 74 years old. The average or mean age was 35 years old and the median age was 32.6 years old.

Table 1 *Sample Distribution by Race*

Race	# of Participants	%
Caucasian	72	67.3
African American	14	13.1
Latino/Hispanic	8	7.4
Asian	4	3.7
Other	9	8.4

Table 2 *Sample Distribution by Gender*

Gender	# of Participants	%
Male	66	61.5
Female	41	38.5

Instruments and Collected Data

The participants completed the short version of the Mathematics Anxiety Rating Scale (MARS) in the classroom setting. The MARS scale included 30 items that asked students to rate their anxiety levels when they encountered tasks or instances that required math skills or thinking about math. Some of the tasks or instances included "taking an examination (final) in a math course", "being given a 'pop' quiz in a math class", and "picking up the math text book to begin working on a homework assignment" (Suinn, 2003). Responses to the items were not at all, a little, a fair amount, much, and very much. Responses were assigned a value from 1 to 5, respectively. Then the researcher scored the completed the MARS scales according to the publisher's instructions. The higher the MARS score, the higher the self-reported mathematics anxiety level of the student. A normative table was provided with the purchase of the MARS for determining if a person has a high anxiety level. For example, if an individual scores 90 on the MARS, then the math anxiety level falls in the 85th percentile indicating that the individual has a high amount of math anxiety (Suinn). In this study, the lowest MARS score was 30 and the highest score was 150 while the mean score was 82.4 with a standard deviation of 29.18 and the median was 83. The mean score of 82.4 falls into the 80th percentile which indicates that the average ABE student participating in this study has a moderately high mathematics anxiety level. The lowest MARS score of 30 belonged to a man aged 20.75 years and the highest score of 150 belonged to a woman aged 51 years.

The participants also completed the Mathematics Self-Efficacy Scale (MSES) using responses of no confidence at all, very little confidence, some confidence, much confidence, and complete confidence. The responses were assigned a value from 0 to 9 respectively, with multiple numbers assigned to a particular level of confidence. This allowed the student to choose if he or she was as the lower end or upper end of that confidence level. Participants were asked to indicate how confident they were in successfully accomplishing a task that related to mathematics. Some of the tasks included "multiply two large numbers in your head", "determine the amount of sales tax on a clothing purchase", and "balance your checkbook without a mistake" (Betz and Hackett, 1993). In addition, participants had to indicate their confidence in successfully completing 16 different college courses with some, but not all, relating to mathematics. The MSES contained 34 items, and the MSES score was still valid if at least 31 items were rated (Betz and Hackett). The MSES was scored by adding all the circled answers and dividing the sum by 34 or by the number of circled answers. The lowest score could be 0, which would indicate no confidence at all in completing mathematical tasks and the highest score could be 9, which would indicate that a participant has complete confidence in completing mathematical tasks. In this study, the lowest score on the MSES was 1.0882 and the highest was 8.5882. The average or mean score on the MSES in this study was 4.444 with a standard deviation of 1.91 and the median, which was very close to the mean, was 4.412. A score of four on the MSES indicates that the participants have "some confidence", at the lower end of that level, in completing mathematical tasks or successfully completing college courses. This confidence level is midway between the lowest and highest confidence levels on the MSES scale.

The math placement scores were retrieved from the participants' college records by the research assistants from each college. One college used the Comprehensive Adult

Student Assessment Systems (CASAS) placement test and the other college used the Tests of Adult Basic Education (TABE) placement test. These placement tests used different scales which made it necessary for the researcher to normalize the scores in order to use them in the study. If the obtained scores followed a normal distribution then *z*-scores could be calculated for all the test scores and they would then be normalized. In addition, multiple variable correlation statistical analysis requires that the datasets be approximately normal or the analysis results will not be valid.

A normal probability plot was developed for the CASAS and TABE scores in order to determine if the obtained scores followed a normal distribution. To draw a normal probability plot, the test scores were placed in ascending order from lowest to highest and then the expected proportion of observations that were less than or equal to the *i*th data value was calculated using the formula $f_i = (i - 0.375)/(n + 0.25)$ where i is the position of the data value in the ordered list and n is the number of observations in the list (Sullivan, 2010). Then the *z*-scores that corresponded to the f_i values were found using a standard normal distribution table. Lastly, the normal probability plot was made using the placement test scores on the horizontal axis and the *z*-scores on the vertical axis, forming a scatter plot. If the normal probability plot is approximately linear, than the sample data set is normally distributed. The normal probability plot for the CASAS scores is shown in Figure 1. The normal probability plot of the CASAS scores is approximately linear so the data set was considered to be normal. A normal probability plot was also created for the TABE scores and it was found to be approximately linear as shown in Figure 2 so that data set was also considered to the normal.

Figure 1. Normal probability plot of CASAS raw scores and the calculated z-scores.

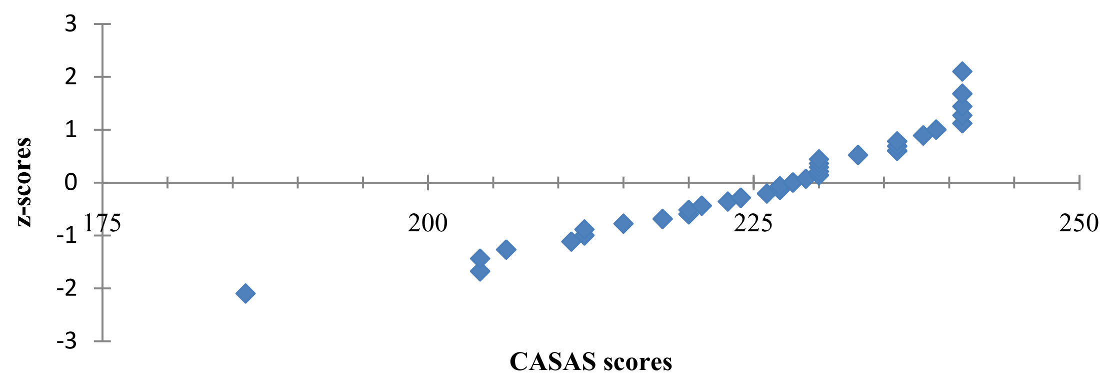
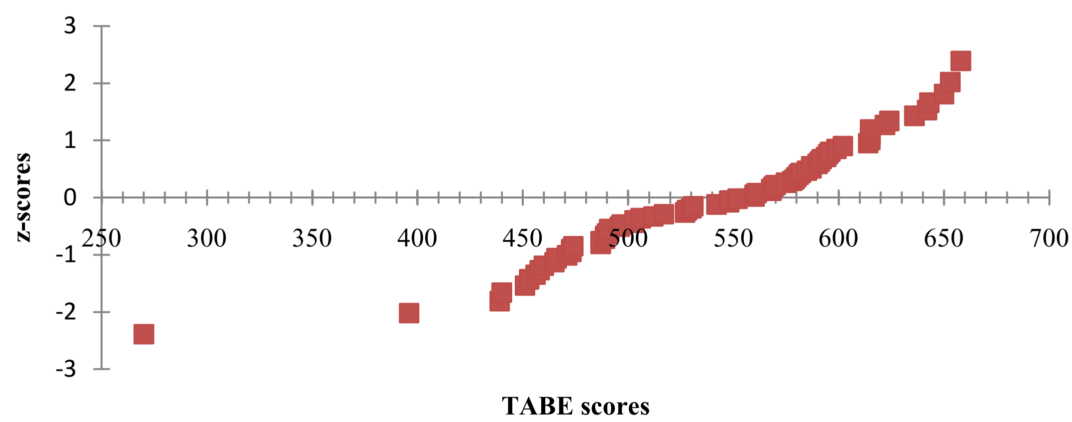


Figure 2. Normal probability plot of TABE raw scores and the calculated z-scores.



The correlation between the CASAS scores and the respective *z*-scores was calculated to be $r = 0.96$ and the correlation between the TABE scores and their respective *z*-scores was calculated to be $r = 0.97$. These correlations are very close to 1.00 and indicate that the normal probability plots were approximately linear. Therefore, it was assumed that both the CASAS and TABE datasets were normal and *z*-scores were calculated for all the scores and were placed into one dataset.

The MARS, MSES, and age datasets were also tested for normality by finding the skewness and kurtosis values using the SPSS statistical software program. The skewness and kurtosis values should be close to zero if a dataset is approximately normal (Brown, 1997). A positive skewness value of a dataset indicates the dataset has more values bunched together at the low end of the dataset while a negative skewness value means that more values would be bunched at the upper end of the dataset (Brown). The kurtosis value indicates if the graph of the dataset is more peaked or flat-topped compared to the normal distribution which is bell shaped. A positive kurtosis value indicates that the dataset distribution is relatively peaked while a negative kurtosis value indicates that the dataset distribution is relatively flat. The MARS dataset had a skewness value of 0.178 and a kurtosis value of -0.748. The MSES dataset had a skewness value of 0.063 and a kurtosis value of -0.792. In addition, the age dataset had a skewness of 0.711 and a kurtosis value of -0.326. All of the values were close to zero so it was assumed that the MARS, MSES, and age datasets followed a normal distribution.

Research Question 1

The first research question addressed the relationships among mathematical performance, mathematics anxiety, mathematics self-efficacy, gender, and age for ABE students. In order to answer this question, the null hypothesis that there was no relationship among mathematical performance, mathematics anxiety, mathematics self-efficacy, gender, and age was tested. This was accomplished by creating a correlation matrix and calculating the Pearson *r* correlation coefficients using the SPSS statistical software program. The results are shown in Table 3.

Table 3 *Correlation Results of Gender, Age, Math Scores, MSES, and MARS*

Variable × Variable	*r*	*p*
Gender × Age	-0.088	0.365
Gender × Math scores	0.000	0.996
Gender × MSES score	0.134	0.168
Gender × MARS score	-0.044	0.649
Age × Math scores	-0.209^{*}	0.031
Age × MSES score	-0.351^{**}	0.000
Age × MARS score	0.099	0.313
Math scores × MSES score	0.463^{**}	0.000
Math scores × MARS score	-0.197^{*}	0.042
MSES score × MARS score	-0.270^{**}	0.005

Note: * indicates that the correlation is significant at the $p = 0.05$ level (2-tailed).
** indicates that the correlation is significant at the $p = 0.01$ level (2-tailed).

According to Table 3, the correlations between the gender of a student and his or her age, math placement scores, MSES scores, or MARS scores are weak and not significant. There is a weak statistically significant negative correlation between a student's age and his or her math placement scores meaning that the older a student is, the lower his or her math placement score tends to be. There is also a statistically significant and stronger, but still weak, negative correlation between a student's age and his or her MSES scores. This indicates that a younger student has higher mathematics self-efficacy than an older student. There is a moderately strong statistically significant positive correlation between the math placement scores and the MSES scores. According to these results, students who have a high mathematics self- efficacy also have higher math variable placement test scores. The correlation matrix also indicates that there is a statistically significant weak negative correlation between the MSES and MARS scores. This result implies that students who have higher levels of mathematics self-efficacy will have lower levels of mathematics anxiety. In addition, students who have higher levels of mathematics anxiety will tend to have lower levels of mathematics self-efficacy. The Pearson *r* coefficients show that the strongest statistically significant correlation is found between mathematics self-efficacy and the variables age, math placement test scores, and mathematics anxiety. Therefore, the null hypothesis was rejected. It was found that there is indeed a relationship, although weak, among age, math placement test scores, mathematics self-efficacy levels, and mathematics anxiety levels but not with the gender

Research Question 2

The second research question addressed the relationships among mathematical performance, mathematics anxiety, mathematics self-efficacy, and age separately for men and women. This question was answered using the null hypothesis that there is no difference in the relationships among mathematical performance, mathematics anxiety, mathematics self-efficacy, and age for men and women. In order to answer this question, separate correlation matrices were created for men and women and tests on the correlation *r*-values were calculated. The correlation *r*-values and significant values for men and women are shown in Table 4.

The results for the men in Table 4 show that there is a statistically significant weak negative correlation between age and math placement test scores which implies that the older male students tend to have lower math placement test scores. This also means that younger male students tend to have higher math placement test scores. There is also a statistically significant moderate negative correlation between age and mathematics self-efficacy indicating that the younger a male student is the higher his mathematics self-efficacy tends to be. This indicates that older male students tend to have lower mathematics self-efficacy levels. The correlations between a student's math anxiety level and a student's age, math performance, or math self-efficacy were not statistically significant according to the correlation results.

Table 4 *Correlation Results of Age, Math Scores, MSES, and MARS Between Genders*

	Men		Women	
Variable × Variable	*r*	*p*	*r*	*p*
Age × Math score	-0.325**	0.008	-0.009	0.956
Age × MSES score	-0.410**	0.001	-0.256	0.106
Age × MARS score	0.183	0.142	-0.029	0.858
Math score × MSES score	0.468**	0.000	0.480**	0.002
Math score × MARS score	-0.124	0.320	-0.334*	0.033
MSES score × MARS score	-0.106	0.399	-0.487**	0.001

Notes: * indicates that the correlation is significant at the $p = 0.05$ level (2-tailed).
** indicates that the correlation is significant at the $p = 0.01$ level (2-tailed).

The correlation results for women in Table 4 show there is a statistically significant moderate positive correlation between math placement test scores and mathematics self-efficacy. This indicates that as a female student ages, her confidence in performing mathematical tasks tends to increase. The results also show a statistically significant moderate negative correlation between female's math placement test score and her math anxiety level. This result implies that as a female's math anxiety level increases, her math placement test score tends to decrease. In addition, the correlation values indicate that there is a statistically significant moderate negative correlation between a female's mathematics self-efficacy level and her math anxiety level. As a result, this implies that as a female's confidence in successfully completing mathematical tasks increases her mathematics anxiety tends to decrease and vice versa.

In order to determine if the correlation *r*-values are statistically significantly different between men and women, tests of independence were performed on the *r*-values. The results of the tests of the differences between genders, shown in Table 5, gave a *z*-score using Fisher's *r*-to-*z* transformation and then *p*-values are calculated for both 1-tail and 2-tail tests (Cohen & Cohen, 1983). For this study, these calculations were performed using a calculator on a Website by Preacher (2002) where the *r*-values were entered into an interactive calculator and the *z*-scores, along with the corresponding *p*-values, were calculated.

The only correlation that is statistically different between men and women is the correlation between the mathematics self-efficacy level and the mathematics anxiety level. There was a weak negative correlation between mathematics self-efficacy and mathematics anxiety levels for males but there was a statistically significant moderate negative correlation between the mathematics self-efficacy and anxiety levels for women.

Table 5 *Tests of Independence Between Men and Women for Correlations Among Math Scores, Age, MSES, and MARS*

	Men	Women		1-tail	2-tail
Correlations	*r*	*r*	*z-score*	*p*	*p*
Math score × Age	-0.325	-0.009	-1.598	0.055	0.110
MSES score × Age	-0.410	-0.256	-0.846	0.199	0.397
MARS score × Age	0.183	-0.029	1.042	0.149	0.297
MSES × Math score	0.468	0.480	-0.075	0.470	0.940
MARS score × Math score	-0.124	-0.334	1.084	0.139	0.278
MSES score × MARS score	-0.106	-0.487	2.073*	0.019	0.038

Note: * indicates that the *z*-score is significant at the $p < 0.05$ level.

Research Question 3

Correlation matrices have been constructed in order to determine the correlation between the age, gender, mathematics performance, mathematics self-efficacy level and mathematics anxiety level of ABE students. However, the question remains if math performance can be predicted by any of these variables. Therefore, the next question addressed in this study was whether or not math anxiety, math self-efficacy, age, and gender predicted math performance. The null hypothesis formulated to answer this question stated that math anxiety, math self-efficacy, age, and gender do not predict math performance for ABE students. In order to answer this question, a multiple regression analysis was performed on the datasets using SPSS software. As shown in Table 6, the significant F statistic was 7.486 and suggests that math placement scores can be predicted using a combination of a student's gender, age, MSES levels, and MARS levels.

Table 6 *Multiple Regression Analysis Using Math Scores as the Dependent Variable*

Model	*df*	*F*	*p*	*r*	r^2
Regression	4	7.486**	0.000	0.476	0.227

Notes: Predictors are gender, age, MSES score, MARS score, and the constant value.
** indicates the F-test is significant at the $p < 0.01$ level.

In Table 6, the r-value indicates that the least-squares line is a weak, moderate fit for the data. In addition, the r^2 value indicates that 22.7% of the variation in the math performance on the math placement test is due directly to the variation in the other variables which include age, gender mathematics self-efficacy levels, and mathematics anxiety levels. This indicates that 87.3% of the variation in the math performance is due to other variables that have not been accounted for in this study such as test anxiety. The MSES variable is most significant in predicting math performance among the other variables according to the results in Table 7.

Regression analyses were also performed individually with each of the independent variables and the dependent variable math performance or math scores as it is coded in the SPSS software analysis. The results of these analyses are shown in Table 8. The results of the linear regression analysis using math scores as the dependent variable and gender as the independent variable shows that math scores are not predicted by gender. However, the results indicate that age does predict math scores when tested at the 0.05 level of significance. In addition, the results show that MSES scores, as well as MARS scores, predict math scores when tested at the 0.05 level of significance. Overall, the linear regression analysis shows that mathematics self- efficacy levels predict math performance to a greater extent than any of the other independent variables when analyzed separately. According to the results, gender does not predict math performance in this study.

Table 7 *Multiple Regression Model Using Independent Variables Gender, Age, MSES, and MARS*

Regression Model	B	*t*	*P*
Constant	-0.563	-1.150	0.253
Gender	-0.134	-0.760	0.449
Age	-0.004	-0.597	0.552
MSES	0.222	4.468**	0.000
MARS	-0.003	-0.861	0.391

Notes: Dependent variable is math scores. B represents the coefficients of each term in the multiple regression model.
** indicates the *t* test is significant at the $p = 0.01$ level.

Table 8 *Simple Linear Regression Models with Math Scores as the Dependent Variable*

Model	B	*t*	*P*
Gender	-0.001	-0.005	0.996
Constant	-0.010	-0.67	0.947
Age	-0.014	-2.188*	0.031
Constant	0.494	1.984	0.050
MSES score	0.238	5.356**	0.000
Constant	-1.068	-4.974**	0.000
MARS score	-0.007	-2.058*	0.042
Constant	0.535	1.902	0.060

Notes: * indicates the *t* test is significant at the $p < 0.05$ level.
** indicates the *t* test is significant at the $p < 0.01$ level.

Research Question 4

It was found that gender did not significantly predict mathematics performance in answering research question three. Would these results change if the age variable was held constant in the regression analysis? This led to research question four which addressed the possibility of determining math performance using math anxiety, math self-efficacy, and gender variables while controlling for age. A multiple regression analysis was performed using a two-step forced entry process with age in the first step followed by the other variables in the second step. The results are shown in Table 9. The results show that the regression model using only the age variable and the regression model using all the variables both predict the math scores at different significance levels. The Durbin-Watson test statistic was found to be 2.035 using the SPSS program. This value indicates that there is no significant difference between the regression models.

Table 9 *Multiple Regression Analyses Using Math Scores as the Dependent Variable*

Model	*df*	*F*	*p*	*r*	r^2
Regression with only age	1	4.787*	0.031	0.209	0.044
Regression with all variables	4	7.486**	0.000	0.476	0.227

Notes: Predictors are age, gender, MSES score, MARS score, and the constant value.
* indicates the *F*-test is significant at the $p < 0.05$ level.
** indicates the *F*-test is significant at the $p < 0.01$ level.

The coefficients of each multiple regression model are shown in Table 10. The first regression model uses only the age variable and the second model uses all the variables. The only variable that is statistically significant in predicting math performance is mathematics self-efficacy. This indicates that mathematics self-efficacy is the explanatory variable. If the MSES variable is present in the regression model, then the variables age, gender, and MARS are not significant predictors. This leads to the conclusion that if age is a predictor of math performance by itself, then it is because the variables MSES and age are correlated. When the MSES score is included in the prediction of math performance, age is no longer a predictor of math performance.

Table 10 *Multiple Regression Models Using Independent Variables Age, Gender, MSES, and MARS*

Regression Model	B	t	p
Constant	0.494	1.984	0.050
Age	-0.014	-2.188	0.031
Constant	-0.563	-1.150	0.253
Age	-0.004	-0.597	0.552
Gender	-0.134	-0.760	0.449
MSES	0.222	4.468^{**}	0.000
MARS	-0.003	-0.861	0.391

Notes: Dependent variable is math scores.
** indicates the t test is significant at the $p < 0.01$ level.

Summary

The results show that gender does not significantly affect math placement test scores, mathematics self-efficacy levels, and mathematics anxiety levels. However, age does affect math placement test scores and mathematics self-efficacy levels according to the results of this statistical analysis. There is a statistically significant weak negative correlation between an adult student's age and his or her math placement test scores.

Younger students tend to perform better on math placement tests while older students tend to make lower scores on math placement tests. These results suggest that older students have less confidence in performing mathematical tasks than younger students. It was found that a student's age and mathematics anxiety level are not significantly related.

According to these results, a student's confidence in performing mathematical tasks affects the student's math placement test scores. The results show that there is statistically significant moderate positive correlation between a student's mathematics self-efficacy level and his or her performance on the math placement test. As suggested by these results, a student who has a higher mathematics self-efficacy level tends to perform better on the math placement test than a student who has a lower mathematics self-efficacy level.

The results also indicate that students with higher math anxiety levels have less confidence in performing mathematical tasks while students who possess lower levels of math anxiety have more confidence in performing mathematical tasks. Among these findings, there was a statistically weak negative correlation between a student's math anxiety level and his or her math performance and math self-efficacy levels.

There were some differences in the correlations of age, mathematics self-efficacy levels, and math anxiety levels for males and females. There was a statistically significant weak negative correlation between age and performance on the math placement test as well as mathematics self-efficacy levels for males. There was no statistically significant correlation between age and math placement test scores, mathematics self-efficacy levels, or math anxiety levels for females. There was a statistically significant moderately positive correlation between a student's mathematics self-efficacy level and his or her performance on the math placement test for both males and females. Math anxiety did not significantly affect a male's math placement test performance or his mathematics self-efficacy levels. In contrast, females had statistically significant moderately negative correlations between math anxiety and both math placement test performance and mathematics self-efficacy.

When the correlations were statistically compared between genders, the correlation between mathematics self-efficacy and math anxiety levels was found be to significantly different between males and females. The males had a weak, negative insignificant correlation between MSES and MARS scores while females had a statistically significant moderate negative correlation between the same variables.

It was shown by multiple variable regression analysis that performance on the math placement test can be predicted by a student's gender, age, mathematics self-efficacy level and math anxiety level. Individually, the variables age, MSES, and MARS predicted math performance using simple linear regressions while gender did not significantly predict math performance. When all the variables were used in the multiple regression analysis, the only significant predictor of math performance was a student's mathematics self-efficacy level.

In addition, a multiple regression analysis was performed in order to determine if age was a significant predictor of math performance. This analysis used a two-step forced entry process where age was entered first followed by the other variables. When age was used in the regression by itself, age was a significant predictor of math performance. However, when all the variables were used, along with age, in the regression analysis the only significant predictor of math performance was a student's mathematics self-efficacy level. When mathematics self-efficacy is used to predict math performance, it overrides the age, gender, and MARS variables. Therefore, according to the results of this study, the most significant explanatory variable in predicting math performance is mathematics self-efficacy.

CHAPTER 5. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Chapter two reviewed research studies about mathematics anxiety and mathematics self-efficacy levels, gender, age, and mathematics performance that focused on undergraduate students at both two and four-year colleges as well as children in elementary and secondary schools. A gap was found in the literature regarding Adult Basic Education (ABE) students and the relationships of mathematics anxiety and mathematics self-efficacy levels, mathematical performances, gender, and age. To address this educational gap, this study investigated possible correlations among mathematics anxiety, mathematics self-efficacy, mathematical performance, gender, and age. This quantitative study determined if mathematics anxiety, mathematics self-efficacy, gender, or age were predictors of mathematical performance for ABE students. This study also determined if mathematics anxiety, mathematics self-efficacy, and mathematics performance varied depending on gender and age.

ABE students enrolled at two community colleges located in the foothills of Western North Carolina were the participants in this study. Information was gathered from the participants regarding their mathematics anxiety and mathematics self-efficacy levels, as well as mathematical performances on the Comprehensive Adult Student Assessment Systems (CASAS) or the Tests of Adult Basic Education (TABE) placement tests. Participants completed the Mathematics Anxiety Rating Scale (MARS) to determine their anxiety levels when they encountered situations involving mathematics. The participants also completed the Mathematics Self-Efficacy Scale (MSES) to determine their level of confidence in performing mathematical tasks. Participants also gave their age and gender on a data information form. Their math placement test scores were obtained from their student records with the help of research assistants at each college.

Using quantitative statistical analysis procedures, correlation matrices were developed to determine if strong, moderate, or weak correlations existed among mathematics anxiety levels, mathematics self-efficacy levels, performance on a math placement test, gender and age. In addition, correlation matrices were developed separately for both men and women. *T* tests were performed to determine if there were significant gender differences in mathematics anxiety levels, mathematics self-efficacy levels, and performances on math placement tests. Multiple regression analyses were performed to determine if the performance on the math placement test could be predicted by mathematics anxiety levels, mathematics self-efficacy levels, gender, or age.

Conclusions

Discussion of the results or conclusions from the analyses completed in this study will be presented in this section. Mathematics anxiety, mathematics self-efficacy, and mathematics performance will be addressed first. In addition, the relationship between mathematics anxiety and mathematics self-efficacy with the gender and age of the ABE students will be discussed. Basic descriptive statistics will be given for the different variables and correlations between the variables will be shown. The relationships among mathematics anxiety, mathematics self-efficacy, and mathematics performance will then be discussed. The conclusions of this study will potentially impact the curriculum, teaching strategies, and teaching techniques that are used in the ABE classroom.

Mathematics Anxiety Levels

In this study, there was a slight negative correlation between math anxiety levels and the genders of the ABE students. This correlation was not statistically significant and there does not appear to be a difference between genders and their mathematics anxiety levels. These findings support the results from other research studies reviewed in chapter two (Betz, 1978; Cooper and Robinson, 1989; Haynes, Mullins, and Stein, 2004; Hendershot, 2000; Segal, 1987) while conflicting with the results from other studies that women have a higher incidence of math anxiety than men (Cook, 1997; Dew and Galassi, 1983; Ho et al., 2000; Hyde, Fennema, Ryan, Frost, and Hopp, 1990; Pajares and Kranzler, 1995; Zettle and Raines, 2000).

The mean math anxiety level measured in this study was 82.4 and fell at approximately the 80th percentile. This indicates that overall, both genders have a fairly high mathematics anxiety level. ABE students, male or female, have not traditionally attended school past their high school years and carry with them the emotions and beliefs that they learned in elementary and secondary school. As Burns (1998) discovered, about 67% of U.S. adults fear or dislike mathematics and that fact was supported in this study.

There was a slight positive correlation, although not statistically significant, between a student's age and his or her mathematics anxiety levels as shown in Table 1. Results from research question two in this study showed a slight positive correlation between the male student's age and his math anxiety levels. In addition, there was a slight negative correlation between the female student's age and her math anxiety levels.

However, the statistics were not significantly different between genders so it can be assumed that in this case an ABE student's age has no affect on his or her math anxiety levels. This conclusion does not support the findings from Betz (1978) where it was shown that older women had higher math anxiety levels than younger women students. Shields (2007) found that over 25% of college students had established their math anxiety levels prior to completing seventh grade. In addition, 51% of the students experienced math anxiety during their first encounter with Algebra. Therefore, it appears that many students have already established math anxiety levels in their elementary and secondary school years. ABE students generally have not encountered additional math courses past Algebra I and carry established math anxiety levels into the ABE classes.

Mathematics Self-Efficacy Levels

In Table 1, the correlation matrix results show that there is a slight, not statistically significant, positive correlation between gender and mathematics self-efficacy. Therefore, it cannot be assumed that there is a difference in mathematics self-efficacy levels between men and women. These results support those found by Choi (2005) when undergraduate students at a southeastern university were studied.

The results of this study showed that there was a statistically significant moderate negative correlation between an ABE student's age and his or her mathematics self-efficacy levels. When the genders were studied independently, the correlations between the age of the student and his or her mathematics self-efficacy were negative. The negative correlation for the male students was statistically significant but the independence test performed on the *r*-values indicated that there was statistically no difference between the male and female students. This indicates that older ABE students tend to have lower mathematics self-efficacy or confidence in performing mathematical tasks than younger students. Older students have been out of school longer and may not believe that they remember how to perform mathematical tasks accurately which leads to lower confidence in performing those tasks. In addition, younger ABE students may have taken more math classes than older ABE students because additional math courses are now required in secondary education than in previous years in North Carolina (Public Schools of North Carolina, 2010). Taking additional math courses provides opportunities to build more confidence in performing mathematical tasks.

Math Performance

There was a statistically significant weak correlation between the age of a student and the score achieved on the math placement test. The results also showed that there was a statistically significant weak negative correlation between age and performance on the math placement test for men when the genders were studied separately. However, the tests of independence performed on the *r*-values indicated that there was statistically no difference between the male and female students. Therefore, the results of this study show that an older ABE student would tend not to perform as well on the math placement test as a younger ABE student. Adult students who have been out of school for a longer period of time than younger students tend to forget mathematical concepts, both basic and advanced. This may be due to the fact that the older students may be out of practice in performing mathematical tasks that are found on math placement tests. In addition, more math courses are required for graduation than in previous years and many of the older students would not have been required to complete algebra courses in order to complete high school requirements (Public Schools of North Carolina, 2010).

Relationships Among Math Anxiety, Math Self-Efficacy, and Math Performance

Performance on the math placement test was significantly correlated with a student's math anxiety level in a weak, negative manner when genders were studied together. Students who showed a high level of math anxiety tended to perform with less accuracy on the math placement test. The results of this study support the findings of the study performed on undergraduate college students by Ashcraft and Kirk (2001). Ashcraft and Kirk found that math anxiety decreased accuracy in working memory and solving math problems. In agreement with Ruffins (2007), these results may be due to the belief that math anxiety can contribute to students going into a panic mode, thus causing students to forget basic and complicated math concepts and rules.

For female adult students, there was a significant moderate negative correlation between math anxiety levels and performance on the math placement test. For male students, the correlation between math anxiety levels and math performance on the placement test was not significant. In addition, there was not a significant difference between the correlations of the math anxiety levels and the math performance for men and women. These results support the results from several other studies reviewed in chapter two that found that women have a greater incidence of math anxiety than men (Cook, 1997; Dew and Galassi, 1983; Ho et al., 2000; Hyde, Fennema, Ryan, Frost, and Hopp, 1990; Pajares and Kranzler, 1995; Zettle and Raines, 2000) but conflicts with the results in the study by Betz (1978). Women may have a higher math anxiety level than men because women believe that they have less ability to perform mathematics than men. These feelings may come from within or from society in general even though it has not been shown that women are less capable of performing mathematical tasks than men

(Crawford, 1980). For ABE students in this study, both men and women who had high math anxiety levels performed with less accuracy on the math placement test which affirms the findings of Buckley and Ribordy (1982). Teaching techniques should be used on both male and female ABE students in order to reduce math anxiety.

The results of this study showed that there was a statistically significant positive moderate correlation between an ABE student's mathematics self-efficacy level and the student's math performance on the placement test. This indicates that a student tends to produce a higher score on the math placement test if he or she tends to have higher confidence in performing mathematical tasks as compared to someone who has a low mathematics self-efficacy level. The results of this study supported the findings of other studies on mathematics performance and mathematics self-efficacy that were reviewed previously in chapter two (Bong, 2001; Brown, Lent, and Larkin, 1989; Choi, 2005; Hackett, Betz, Casas, and Rocha-Singh, 1992; Lee, 2009; Lent, Brown, and Larkin, 1984; Multon, Brown, and Lent, 1991; Wood and Locke, 1987). An ABE student, whether male or female, will tend to perform better on a math test if he or she has more confidence in performing mathematical tasks. If a student has greater confidence in performing mathematical tasks then he or she has usually had more success in learning math concepts and rules during previous encounters with math problems

Mathematics anxiety was shown to have a weak significant negative correlation with mathematics self-efficacy. If a student is anxious about encountering situations with mathematics, then the student will tend to have less confidence in performing mathematical tasks. In addition, if the student has less confidence in successfully completing mathematical tasks, then the student is likely to have higher math anxiety levels. These findings support the results of the study performed by Pajares and Kranzler (1995) on high school students and the results of the study performed by Cooper and Robinson (1989) on university students.

When the genders were studied separately, women had a moderate statistically significant negative correlation between math anxiety levels and mathematics self-efficacy levels indicating that women who tend to have a high math anxiety level tend to have a low mathematics self-efficacy level. High math anxiety levels can cause students to forget rules and concepts and can cause students to become less confident in performing mathematical tasks.

A multiple regression analysis was performed on the data and it was found the mathematics self-efficacy was the only predictor of math performance on the math placement test from the variables tested. Even when age was held constant, the results of the multiple regression analysis essentially remained unchanged. Researchers Siegel, Galassi, and Ware (1985) studied undergraduates and also found that mathematics self-efficacy was more of a predictor of mathematical performance than other factors. Results of this study have consistently shown that mathematics self-efficacy significantly affects math performance and it would follow that mathematics self-efficacy would be more of a predictor of math performance than math anxiety, age or gender.

Limitations

This research project concentrated on the self-reported feelings toward math and the math performance of adult learners at two community colleges in western North Carolina. The sample used in this research project included ABE students who were at least 18 years old and were enrolled in Adult Basic Skills classes. Students enrolled in these classes who were younger than 18 years of age were not included in the study because they did not meet the operational definition of adult learner that was used in this study. In addition, Adult Basic Skills classes were also offered at local prisons near the participating colleges but students in these classes were not included. Results from this study cannot be generalized to Adult Basic Skills classes that include students less than 18 years old or students who are in prison. In addition, the results cannot be generalized to urban areas or to populations that do not have the majority as Caucasians.

Math performance was measured using only math placement test scores. The two colleges used in this study used different placement tests. The placement tests are taken on the computer and ABE students may be apprehensive about taking a test on the computer. In addition, the questions on the placement tests may cause additional anxiety. Therefore, other anxieties may influence a student's math performance on the math placement test. The ABE students also take a test at the end of their classes to assess their knowledge of topics that are covered during the class. This study did not consider the test scores at the end of the classes because the researcher desired to know how student math anxiety and math self-efficacy affected math performance as evidenced by the math placement test scores upon entering the Adult Basic Skills classes. Caution should be taken when generalizing these results to ABE students who are near completion of their math Adult Basic Skills courses.

Mathematics anxiety and mathematics self-efficacy rating scales were used to measure student anxiety and self-efficacy levels in this study. The Mathematics Anxiety Rating Scale (MARS) and Mathematics Self-Efficacy Scale (MSES) are widely used and have been found to be reliable and valid. The participants in this study completed the MARS and MSES scales and it was assumed that the participants were truthful in answering the questions. Both scales were administered at the same time and some students may have tried to complete them quickly without giving much thought to their answers. The rating scales gave the students' math anxiety and math self-efficacy level but did not reveal why, when, or how the students acquired their math anxiety or math self-efficacy levels.

Implications

The results of this study provide information that can be used to supplement or improve the curriculum and teaching methods that are used in the Adult Basic Skills classes. Results from this study indicate that mathematics self-efficacy and math performance are related, with mathematics self-efficacy acting as a predictor for math performance. Math anxiety and age affect math performance but when mathematics self-efficacy is included in the mix, math anxiety and age no longer appear to affect math performance according to this study. Therefore, including opportunities in the curriculum that focus on improving both students' mathematics self-efficacy levels and math performance would be ideal and would most likely produce positive effects on the students' learning and performance in mathematics.

Improving a student's mathematics self-efficacy does not necessarily mean that his or her math performance will increase. A student's mathematics self-efficacy may be increased by simply telling him or her that an answer or method is correct but this may not increase math performance. However, if a student's math ability or performance improves, then it would seem reasonable that the student's mathematics self-efficacy levels would increase.

Most ABE students take their math classes last because they lack confidence in performing mathematical tasks successfully. Modifying curriculum and instruction methods to include opportunities for ABE students to be successful in performing mathematical tasks early in their ABE classes would most likely improve math ability and build the students' confidence so that they are more willing to attempt more difficult mathematical tasks. Including applications that are based on students' past experiences would promote interest in attempting mathematical tasks and perhaps promote greater success in performing those mathematical tasks.

Standards have not been developed for ABE classes at this time and information from this study could be used to assist in the development of standards and objectives for ABE classes. Developing standards for the ABE program that include changes in the curriculum to increase mathematics performance may also help to increase student mathematics self-efficacy levels and reduce math anxiety levels. Teaching students how to take tests, read textbooks, take notes, and improve their study skills may improve mathematics performance. In addition, providing opportunities for small group activities may assist in increasing mathematics performance, math self-efficacy and reducing math anxiety (Shields, 2007). Math software programs that provide tutorial videos and additional help solving basic to more complicated math problems could be added to the curriculum. Students may be nervous using the software at first, but as they solve math problems correctly their confidence will increase.

Recommendations for Future Studies

The age, gender, and math anxiety levels of an ABE student have been shown to have some influence on math performance. However, when mathematics self-efficacy is taken into account, the other variables appear to have minimal, on math performance. It is not known if improving mathematical abilities and skills improves mathematics self-efficacy or if improving mathematics self-efficacy levels improves math ability. It is highly likely that it is a student's math ability, as indicated on the CASAS or TABE placement tests, which actually influences a student's math anxiety and mathematics self-efficacy levels. Therefore, more research is needed that explores in more detail the relationships among mathematics self-efficacy, math anxiety, and math performance. For example, research may determine the initial level of math at which students are unsuccessful; at that point additional instruction would be given to improve math ability and performance. The instruction would be gradual so that students would reach mastery level of new concepts. Mathematics self-efficacy and math anxiety levels would be measured at the beginning of the research process and would be measured periodically during instruction until the math performance and mathematics self-efficacy levels reached desired levels. It is reasonable to predict that not only would math performance and mathematics self-efficacy improve, but math anxiety levels would be reduced as well.

This research project found significant correlations between the levels of math anxiety and math self-efficacy that ABE students possess, especially among women. Future research projects or studies that include surveys would be beneficial in investigating why, when, and how students acquire their mathematics anxiety and mathematics self-efficacy levels. These studies could be conducted at different age and school levels in order to obtain a better understanding of the dynamics of math anxiety and math self-efficacy. The information gathered could be analyzed to determine when, how, and why the differences between men and women first appear. This information would be valuable to educators and decision makers who are entrusted with the responsibility of creating standards, learning objectives, curriculum, and teaching methods for courses in mathematics at all levels, including ABE courses. The results of future research studies may indicate that changes need to be made at the secondary or perhaps even the elementary school level in order to increase math self-efficacy levels or reduce math anxiety levels before a student reaches adulthood. Additional instructional efforts may be needed that allow women more success in performing mathematical tasks in order to improve math performance while increasing mathematics self-efficacy and reducing math anxiety.

Summary

Results and information from this study indicate that mathematics self-efficacy is the most important self-construct that impacts the math performance of ABE students. Adult learners who have been out of school for a long period of time struggle to perform mathematical tasks partially due to low mathematics self-efficacy levels. Implementing teaching methods that improve the students’ mathematics performance with frequent successes would most likely increase the mathematics self-efficacy levels of all their students. However, more research is needed to determine what level of math performance will improve the students’ mathematics self-efficacy levels to the extent that math anxiety is reduced. It is not known which instructional methods or techniques work the best to accomplish this feat and more research is also needed in this area.

The results of this research project suggest that ABE students enter the classroom with established math anxiety and math self-efficacy levels. It is not known at this time when ABE students acquire these self-constructs and additional research is required to determine if educators at lower grade levels should employ instructional methods that will enable students to reduce their math anxiety and increase their math self-efficacy at an earlier age. The results of this study indicated that women are affected more than men by mathematics self-efficacy and math anxiety. It would be reasonable for educators to encourage women to perform well in mathematics classes and enroll in more math classes as they progress through their secondary education.

The outcomes of this research project assist in providing important information that is needed for ABE educators and curriculum designers. It has been shown that an ABE student's mathematics self-efficacy and math anxiety levels, along with age, impact his or her math performance with mathematics self-efficacy being the most significant variable. More research is needed to determine how improved math abilities and performance affect mathematics self-efficacy and math anxiety and what instructional methods should be used to improve math performance and increase mathematics self-efficacy while reducing math anxiety in ABE students.

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