ABSTRACT

Mathematics Anxiety and Attitudes towards Mathematics in Adult Developmental Learners: An Exploratory Examination of the Relationship between Mathematics Anxiety, Attitudes Towards Mathematics, and Successful Adult Developmental Learners

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According to Complete College America (2015), as many as 53.6% of learners may need developmental courses as they enter college or university programs, most commonly mathematics, and only 17.1% of these learners complete the developmental courses. Why are so many learners entering college underprepared and why do so few actually complete developmental coursework? Perhaps one of the contributing factors for low completion rates is mathematics anxiety. The purpose of this exploratory, correlational study was to examine the relationship between mathematics anxiety and successful adult developmental learners. In this study, 83 participants from a community college in central Texas took the revised Mathematics Anxiety Rating Scale developed by Alexander & Martray (1989) and the Mathematics Attitudes Scale developed by Aiken (1963) during week 16 of the spring semester. A questionnaire about strategies used during the semester was given the same week. Implications for higher education and further research will be discussed.

Mathematics Anxiety and Attitudes towards Mathematics in Adult Developmental Learners: An Exploratory Examination of the Relationship between Mathematics Anxiety, Attitudes Towards Mathematics, and Successful Adult Developmental Learners

by

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CHAPTER ONE

Introduction

Mathematics anxiety has been studied since the early 1950s and has been defined in a variety of ways. Perhaps the most recognizable definition is provided by Richardson & Suinn (1972), which states, “Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (p.551). Mathematics anxiety can be present in any learner at any age. Even though mathematics anxiety has not been found to relate to intelligence, it can affect mathematics achievement (Dreger & Aiken, 1957; Maloney & Beilock, 2012; Perry, 2004).

Many adult learners who choose to continue their education beyond high school find that they are not academically prepared for college level mathematics and will need to begin in developmental courses, which are not credit bearing towards a degree program or certificate. In the state of Texas, 53.6% of adult learners need developmental coursework (Complete College America, 2015). Most notably for adult learners, mathematics anxiety can affect decisions of choosing a major in college, types of technical training and ultimately, career choices. Unfortunately, adult learners who begin in developmental coursework, in particular in mathematics, are less likely to finish certificate and degree programs of study (Attewell, Lavin, Domina, & Levey, 2006). One vital question comes to mind: Why are so many learners entering college underprepared in mathematics and why do so few actually complete developmental coursework?

Perhaps one of the contributing factors for low completion rates is mathematics anxiety and learner beliefs about mathematics. Only 17.1% of adult learners complete developmental coursework, most commonly mathematics, and only 8.5% of these learners complete degree and certificate programs (Complete College America, 2015). Figure 1.1 demonstrates the progression of dwindling completion after beginning in developmental course(s) of community college learners in Texas in 2015.

What is happening to the other 36.5% of adult developmental learners who do not complete required coursework? In particular, what contributing factors are stopping completion in developmental mathematics courses? Could mathematics anxiety and attitudes toward mathematics be contributing factors to non-completion in developmental mathematics courses? Of those learners who are successful, are there study and support resources and strategies that are helping them to complete developmental mathematics coursework?

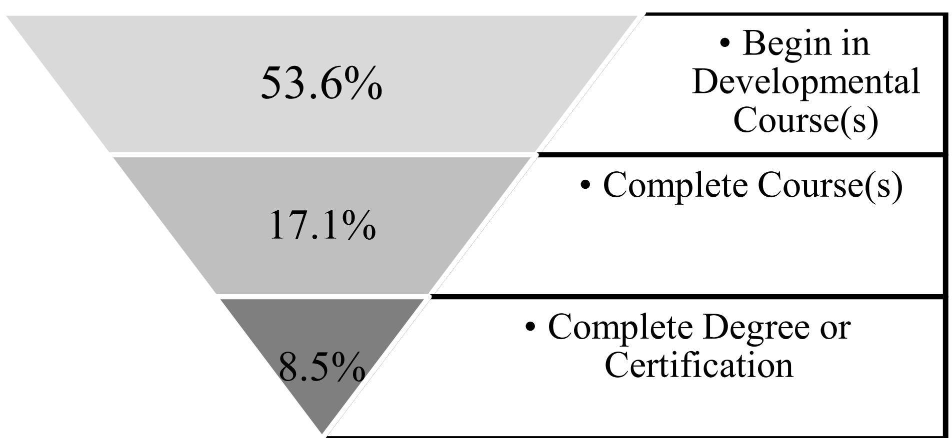


Figure 1.1: *College Readiness in Texas in 2015*

Children and adults alike often make such statements such as “Math is just a tough subject.” or “I don’t understand it because it’s math.” Though these words may seem harmless, some people may say or hear these statements often enough to develop negative feelings towards mathematics (Piercey & Tobias, 2012; Tobias, 1987). As a result, mathematics anxiety and/or negative attitudes may develop, which could lead one to avoid mathematics. Mathematics anxiety can affect any learner at any age (Richardson & Suinn, 1972; Ruedy & Nirenberg, 1990; Wigfield & Meece, 1988). Such anxiety may occur in learners solving a word problem or taking a test in a mathematics course, or adults may experience mathematics anxiety when balancing a checkbook or planning a budget.

In this exploratory, correlational study, the relationship between mathematics anxiety, attitudes toward mathematics and successful adult developmental learners in mathematics was examined. Through examination of this relationship, mathematics educators have gained a deeper understanding of mathematics anxiety, attitudes towards mathematics, and what adult developmental learners are experiencing when studying mathematics. Resources and strategies that are available and used by adult learners were also examined to determine if they were supportive towards a successful completion of developmental coursework. By understanding this relationship, mathematics educators may be able to help adult developmental learners succeed in completing coursework and progress towards the learners’ goal of completing a certificate or degree program.

Focus on Community Colleges

According to the American Association of Community Colleges, community colleges are defined as a place of higher education that is located in a community, publicly funded, and inclusive for all learners with varied academic and life experiences (American Association of Community Colleges, 2016a). Community colleges have existed and thrived since 1901 and began in Joliet, Illinois when the first community college was opened (American Association of Community Colleges, 2016b).

Community colleges offer a variety of developmental coursework in reading, writing and mathematics. They also offer freshman and sophomore level coursework that can be applied towards certificates, degree programs at the community college or transfer a four-year institution (Homeland Security, 2012). Due to the inclusive nature of community colleges, low cost, and locality, 46% of all adult learners choose to attend a community college to obtain a certificate, associates degree or transfer to a four-year institution (American Association of Community Colleges, 2015).

In order to apply for entrance into community colleges, adult learners must have a high school diploma or a General Educational Development (GED) certificate, and take a college entrance exam (College Board, 2016). In Texas, any student enrolling in a community college is required to take the Texas Success Initiative, or TSI, which is a college placement exam. The TSI has been in effect since August of 2014 in all public colleges and universities in the state of Texas (College Board, 2014).Unfortunately, many who take the TSI will not be considered college ready for mathematics coursework.

The 2015 Complete College America statistics for the state of Texas revealed that 53.6% of freshmen were placed into a developmental course in mathematics or reading/writing, with the most common being mathematics. As a result of very poor performance on the TSI, these adult learners could be required to take up to two developmental mathematics courses before they could enroll in mathematics classes required by the certificate or degree program. To further exacerbate this problem, many of these adult learners do not complete the required developmental mathematics sequence to continue with their degree program (Perry, 2004). According to Complete College America for the state of Texas (2015), only 17.1% of adult learners are projected to complete their developmental track within 2 years. The state faces a formidable challenge to improve instruction and enable these adult learners to succeed.

Problem

Echoing these statistics is a community college located in central Texas. On average, this community college enrolls about 9,000 adult learners during a typical spring semester. The enrollment statistics were provided by the participating college. After taking the TSI, approximately 63.4% of learners need developmental mathematics courses. Of those adult learners, only 25.9% complete them in 2 years. These are alarming statistics. What is contributing to the 37.5% of adult learners who fail to complete their developmental mathematics courses within 2 years?

Contributing Factors

Literature suggests that two possible contributing factors for the adult learners' failure to complete their developmental mathematics courses may be mathematics anxiety and learners' attitudes toward mathematics. Mathematics anxiety is an "extremely common phenomenon" for adult learners (Perry, 2004). Poor attitudes towards mathematics can also be common in adult learners and many times it begins when the learner is a child (Maloney & Beilock, 2012).

Even though mathematics anxiety and attitudes towards mathematics have been studied for many ages and learners (Ashcraft, 2002; Richardson & Suinn, 1972), a limited number of studies have been conducted for postsecondary adult developmental mathematics learners. Jameson and Fusco (2014) have called for additional research in adult learners' mathematics attitudes, mathematics anxiety and achievement and the relationship between these. This study will contribute to a growing body of research about adult learner attitudes toward mathematics, mathematics anxiety and achievement and the relationship between them.

Adult Learner Consequences

Particularly in adult learners ages 18 and older, mathematics anxiety causes serious, long-term consequences. If postsecondary adult learners enrolled in mathematics courses experience anxiety and do not successfully complete the course with a letter grade of A, B, or C, they may not continue their education. Not completing a certificate or degree program could limit career choices for these adult learners for the rest of their lives.

Even if such students complete their mathematics classes with a letter grade of A, B, or C, they may still struggle on the job with tasks involving mathematics and perform their jobs poorly. For such adults, even everyday tasks such as grocery shopping or balancing a checkbook pose serious challenges (Allen, 2011; Frankenstein, 2014). Moreover, these adults could also continue the negativity towards mathematics when their children or peers ask for help with the subject (Ruedy & Nirenberg, 1990).

Alleviating Mathematics Anxiety and Improving Attitudes

Mathematics anxiety and poor attitudes towards mathematics should not be ignored by educators of adult learners; it does not simply disappear on its own. When adult learners overcome their mathematics anxiety and improve their attitudes about mathematics, they become more confident in their degree programs, careers, and futures (Allen, 2011; Frankenstein, 2014; Krantz, 1999).

Fortunately, mathematics anxiety can be alleviated and attitudes towards mathematics improved if educators address it on a personal level with the learner (Allen, 2011; Piercey & Tobias, 2012). Alleviating mathematics anxiety and improving attitudes towards mathematics for adult learners can begin in developmental mathematics and/or introductory mathematics classes at a community college where these classes are more likely to be offered.

Strategies

While a high percentage of developmental learners are unsuccessful and many do have high math anxiety and poor attitudes towards mathematics, some are able to cope with the anxiety, improve attitudes and successfully complete all the needed developmental courses to move on to credit-bearing courses. What strategies do they use to cope with the anxiety and improve attitudes?

Seeking help from various resources can alleviate mathematics anxiety and improve attitudes. These resources and strategies include, but are not limited to, the instructor of the mathematics class, on-campus lab tutoring centers, textbooks, and study groups (Dahlke, 2008; Piercey & Tobias, 2012; Smith & Hageman Smith, 2006). When learners utilize these resources and strategies, they are encouraged to persevere and reinforce what they have gained in their mathematics classes. Dahlke (2008) states, "Receiving help is a sign of strength, regardless of the difficulty you want to overcome" (p.487).

Purpose of this Study

Even though mathematics anxiety and attitudes towards mathematics have been studied for many ages and learners (Ashcraft, 2002; Maloney & Beilock, 2012; Richardson & Suinn, 1972), very few have been conducted for post-secondary adult developmental mathematics learners. Recall in Figure 1.1: *College Readiness in Texas 2015*, only 8.5% of those who begin in developmental course(s) complete degree or certificate programs.

Why are only 8.5% completing certificate or degree programs? This is most definitely a problem that needs to be examined (Complete College America, 2015). The purpose of this exploratory, correlational study is to examine the relationship between successful adult developmental learners' attitudes toward mathematics and their levels of mathematics anxiety in relation to their use of available resources and strategies. According to Jameson and Fusco (2014) successful adult developmental learners have low mathematics anxiety, have a positive attitude towards mathematics, have a high motivation to complete a mathematics course, and have coping strategies to alleviate mathematics anxiety.

Jameson and Fusco (2014) have also called for additional research in adult learners' mathematics attitudes, mathematics anxiety, achievement in mathematics and the relationship between these. This study will contribute to a growing body of research about adult learner attitudes toward mathematics, mathematics anxiety and achievement and the relationship between them.

Research Questions

For the purpose of this study, there is a main research question and seven sub-questions. The main research question is: Are mathematics anxiety and attitudes toward mathematics contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study? The seven sub-questions are:

1. Is there a relationship between the learners' mathematics anxiety and the strategy/strategies utilized by the learners?
2. Is there a relationship between the learners' attitudes towards mathematics and strategy/strategies utilized by the learners?

3. Is there a relationship between the resources and strategies utilized and successful completion of developmental mathematics?

4. Is there a relationship between learners' mathematics anxiety and biological gender?

5. Is there a relationship between the learners' attitudes towards mathematics and biological gender?

6. Is there a relationship between the learners' mathematics anxiety and ethnic origin?

7. Is there a relationship between the learners' attitudes towards mathematics and ethnic origin?

Knowing the answers to these questions could be beneficial for community colleges in addressing the need to increase the completion rate among adult learners in developmental mathematics courses.

Research Hypothesis

It was hypothesized that when adult developmental learners utilize various resources and strategies to cope with their mathematics anxiety, their mathematics anxiety levels would be lower, their attitudes toward mathematics would be more positive and they would be more likely to successfully complete a developmental mathematics course with a letter grade of A, B or C.

CHAPTER TWO

Literature Review

Literature about mathematics anxiety and attitudes towards mathematics began to appear in the 1950s. Mathematics anxiety has been defined overall as an aversion towards mathematics. Attitudes towards mathematics have been defined as a positive or negative feeling towards mathematics. Many studies have been conducted on mathematics anxiety and attitudes towards mathematics and they have revealed that both can affect learners of all ages and can develop at any time during one's academic career. Most notably for adult learners, literature suggests that mathematics anxiety and poor attitudes towards mathematics can affect decisions of degree plans, certificates and ultimately, career choices.

Currently, in the state of Texas, 53.6% of adult learners need developmental coursework and only 17.1% of these learners finish (Complete College America, 2015). Fortunately, literature suggests strategies that can be utilized to alleviate mathematics anxiety. By alleviating mathematics anxiety and increasing positive attitudes towards mathematics, adult learners would be able to complete certificates and degrees and continue with careers.

Mathematics Anxiety Defined

Literature suggests that mathematics anxiety can be defined in a variety of ways. Maloney and Beilock (2012) suggest it is "an adverse emotional reaction to math or the prospect of doing math" (p. 404).

Mathematics anxiety can also be described in a physiological way as well. According to Krantz (1999), “outward symptoms of math anxiety are physiological … the sufferer has sweaty palms, is nauseous, has heart palpitations, and experiences paralysis of thought” (p. 100). Perhaps the most recognizable definition is provided by Richardson & Suinn (1972), which states, “Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (p.551).

For the purpose of this study, mathematics anxiety is defined using the definition provided by Richardson & Suinn (1972). Mathematics anxiety can be present in any learner at any age. Even though mathematics anxiety has not been found to relate to intelligence, it can affect mathematics achievement (Dreger & Aiken, 1957; Maloney & Beilock, 2012; Perry, 2004).

Mathematics Anxiety and Poor Attitudes at Any Age

Mathematics anxiety and poor attitudes towards mathematics can be experienced by many learners of all ages. Such anxiety may occur in learners solving a word problem or taking a test in a mathematics class, or adults may experience mathematics anxiety at home when balancing a checkbook or planning a budget. Poor attitudes towards mathematics could be rooted in past experiences, poor experiences in the classroom, or even lack of understanding.

Unfortunately, if mathematics anxiety or poor attitudes towards mathematics is not addressed, learners will carry it throughout their personal, academic and professional lives (Piercey & Tobias, 2012; Shodahl & Diers, 1984). It can develop in children, teens and adults, and the anxiety builds or continues until it is addressed.

Children

While mathematics anxiety or poor attitudes towards mathematics can develop at any age, both often begins when the learner is a child. Studies about children and mathematics anxiety began in the late 1980s. A study about children in grades 4 to 6 (ages 9 to 12) and mathematics anxiety was conducted by Suinn, Taylor and Edwards in 1988. The subjects, 1,119 children, were from six different schools. These children were given an adaptation of the MARS for elementary students (see *Adaptions of MARS*). The study revealed that children ages 9 to 12 can and do display worry in mathematics class, especially when trying to find the correct answer. However, in this study, young learners did not let their worries stop them from performing well in mathematics.

Another study that included 6th grade students and mathematics anxiety was also conducted by Wigfield and Meece in 1988 (see *Teens*). The 564 children were followed from the 6th grade for two years and were given the Student Attitude Questionnaire (SAQ) (see *Attitude Scales*) and the Math Anxiety Questionnaire (MAQ) (see *Adaptations of MARS Scales*). Wigfield and Meece also concluded from the longitudinal study that the 6th grade students were not affected by mathematics anxiety, but they were successful because of fewer evaluations of mathematics skills and lack of pressured learning environments (Wigfield & Meece, 1988).

Since Suinn, Taylor and Edwards's (1988) and Wigfield and Meece's (1988) studies, other relationships of mathematics anxiety in children ages 5 to 12 have been explored. A more recent study was conducted by Galla and Wood in 2012. Galla and Wood gave 139 children (ages 5 to 12) three separate instruments that measured mathematics anxiety (Multidimensional Anxiety Scale for Children), emotional self-efficacy, and mathematics performance within a single school year. In this study, emotional self-efficacy is defined as "confidence in one's ability to regulate negative emotions" (p.118). Table 2.2: *Other Mathematics Anxiety Scales* provides a summary for the MASC.

The study revealed that children with higher self-efficacy did not have anxiety-related performance issues when taking a standardized mathematics test. Those with lower self-efficacy did have anxiety-related performance issues. The following year, a cross-sectional study about mathematics anxiety in younger learners in first and second grades was conducted by Ramirez, Gunderson, Levine and Beilock in 2013.

The 154 children, ages six and seven, were given four separate instruments measuring working memory, reading performance, mathematics achievement and mathematics anxiety (Child Math Anxiety Questionnaire) (see *Adaptations of MARS Scales*). Table 2.1: *MARS Adaptations* provides a summary for the CMAQ. The results of the study showed that if the young children had high working memory, then there is a negative effect on the their mathematics performance (Ramirez, Gunderson, Levine, & Beilock, 2013). The topic of mathematics anxiety in children is continuously being researched and the findings are ongoing.

Teens

Studies have been conducted for mathematics anxiety in teens (ages 13-19) as well. In the longitudinal study conducted by Wigfield and Meece (1988), that was mentioned previously, teen learners were also asked to complete the Math Anxiety Questionnaire (MAQ) (see *Adaptations of MARS Scales*) and Student Attitude Questionnaire (SAQ) to determine if there was a significant relationship between attitudes and mathematics anxiety (see *Mathematics Attitude Scales*). Table 2.2: *MARS Adaptations* provides a summary for the MAQ. Table 2.3: *Mathematics Attitude Scales* provides a summary for the SAQ. The results of the longitudinal study revealed that teens were more likely to be negatively affected by mathematics anxiety than their younger counterparts were.

A comprehensive review of literature which compiled 151 studies about mathematics anxiety for all ages and learners was conducted by Ray Hembree (1990). Through his research, Hembree concluded that mathematics anxiety peaks for teenagers during the ninth and tenth grades and that more research needed to be conducted in mathematics anxiety and separated from the more general test anxiety. Ashcraft & Krause (2007) utilized Hembree's study by reviewing literature about working memory, mathematics anxiety, and mathematics performance. They concluded and that teens who exhibit symptoms of mathematics anxiety will avoid taking more mathematics classes other than those required for a high school diploma. On the other hand, another comprehensive study reviewing 26 studies about mathematics anxiety and mathematics achievements in all ages by Ma (1999) found that grade levels and mathematics anxiety did not have a significant correlation. This area of research is ongoing.

Adults

Once mathematics-anxious learners with poor attitudes towards mathematics have entered into post-secondary education, they continue to avoid taking more mathematics classes beyond those required by their degree programs. Unfortunately, this anxiety in mathematics has caused some students to change majors and even careers entirely. LeFevre, Kulak and Heymans in 1992 conducted a study about factors that influenced choices of college majors with varying mathematics requirements.

The 126 participants were freshman of a liberal arts college who were enrolled in an introductory psychology course. They were given a 14-item questionnaire about their personal mathematics experience and demographics and a four item open-ended scale that questioned confidence and interest in mathematics. Both of the instruments were developed by the authors. The results revealed that learners who were more anxious avoided majors with many mathematics requirements. On the other hand, learners who enjoyed arithmetic were more likely to choose majors with many mathematics requirements (LeFevre, Kulak, & Heymans, 1992). In a more recent study by Jameson and Fusco (2014), they discussed how adult learners, male and female, avoid mathematics in the college setting.

These learners often wait until the last semester to take mathematics classes needed to fulfill university requirements. Unfortunately, adult learners who delay or avoid mathematics courses because of their anxiety will negatively impact their ability to obtain a degree and a satisfying career. Nevertheless, competence in mathematics for men and women is more essential than ever.

Careers that were once void of mathematics are now including it as a job requirement. Kasi Allen, who has 25-years of experience in the field of mathematics education, is an active advocate of the importance of mathematics in the future careers of college learners. Allen (2011) stated, “In nearly every arena, from personal finance to health care, navigating life in the 21st century requires mathematical thinking, particularly problem solving. Society is increasingly complex and global in nature” (p.3). Allen encourages educators to create “communities of learners”, which help learners take an active part in understanding mathematics in their world (p.3).

Consequently, college learners need strategies to cope with their mathematics anxiety and improve their attitudes’ towards mathematics. On the other hand, college mathematics educators also need to know the essential elements: access and equity, curriculum, tools and technology, assessment, and professionalism, in order to create an effective developmental mathematics course (NCTM, 2014). It is very important to college learners, their careers, their families and ultimately, their futures (Allen, 2011; Piercey & Tobias, 2012).

Contributing Factors and Myths Related to Anxiety and Attitudes towards Mathematics

There are many possible factors that contribute to mathematics anxiety and poor attitudes towards mathematics such as, the myth that mathematics is only procedural and it does not apply to real world applications, or the lack of motivation, or one’s own negative emotions towards mathematics. All of these can heighten the development of mathematics anxiety (Allen, 2011; Brahier & Speer, 2011; Piercey & Tobias, 2012; Ruedy & Nirenberg, 1990).

Children, teens and adult learners alike face many of these inhibiting factors: myths, negative emotions, and a lack of motivation. Myths about mathematics are perpetuated when learners hear their peers, instructors/teachers and parents repeat negative and discouraging statements such as "I hate math" or "Math is just really hard and is for geniuses only," or "Some people just can't learn math" (Ruedy & Nirenberg, 1990; Tobias, 1987). These negative and demotivating statements could also be a product of previous experiences, which could affect the way that learners view mathematics (Bobis & Cusworth, 1994; Sanchez, Zimmerman, & Ye, 2004).

Myths

Unfortunately, societal influences have caused myths about who can learn mathematics and why. These myths include, but are not limited to, biological gender, ethnicity, and intelligence. As a result, negative views and emotions about math are developed (Piercey & Tobias, 2012; Ruedy & Nirenberg, 1990; Tobias, 1990). Learners of all ages need to be informed that they can understand mathematics no matter the circumstances.

Biological Gender. One myth is that males are superior in mathematics and females are not as good (Cheryan, 2011; Tobias, 1978, 1987). In 1978, Sheila Tobias wrote a pivotal book called, *Overcoming Math Anxiety*. In her book, she discussed the current research of the decade and revealed that girls were just as capable in learning mathematics, but that girls were taught to dislike mathematics by parents and teachers.

Tobias (1978) concluded that "the most important elements in predicting success at learning math are motivation, temperament, attitude and interest" (p. 95). Since 1978 her first book, Tobias has been publishing more literature about mathematics anxiety, attitudes towards mathematics and biological gender differences. Ten years later, Sheila Tobias followed her first book with *Succeed with Math* (Tobias, 1987). In this book, she offered a solution to both men and women to alleviate their mathematics anxiety.

The solution followed steps that included "active thinking", "self monitoring", "giving yourself permission", and "self mastery" (p. 7-11). Tobias defined "active thinking" as keeping thoughts moving and not allowing emotions to stop the student's thought processes (p 7-8). Next, she defined "self monitoring" as being able to self identify feelings of panic by taking notes as a problem was worked (p. 8-9).

Next, Tobias defined "giving yourself permission" as exploring student's own thoughts and confusion within them (p. 9-10). Finally, she defined "self-mastery" as understanding the confusion in the mathematics problems and working through them (p.10-11). By following these solution steps, any man or woman could alleviate their mathematics anxiety and possibly improve their attitudes towards mathematics. Since Tobias's work, many studies about mathematics anxiety, attitudes towards mathematics and biological gender have been conducted.

In 2004, Haynes, Mullins and Stein conducted a study about differential models for mathematics anxiety in college students. The authors collected a stratified random sample of 159 undergraduate participants from Tennessee Technological University. The instruments used in the study were the Math Anxiety Scale subset of the Fennema-Sherman scale and the 20-item Test Anxiety Inventory (TAI).

The authors also developed 46 additional questions about demographics, level of mathematics, confidence in mathematics, and ability in mathematics. The results revealed that there are different factors that predicted male mathematics anxiety and female mathematics anxiety. For males, the predicting factors were low ACT scores and high scores in general test anxiety. For females, the predicting factors were high ACT scores, low mathematics ability, poor attitudes towards mathematics by previous high school teachers, and high scores in general test anxiety. Haynes et al. (2004) concluded that more instructors need to break down the stereotypes and gender socialization that women face in mathematics (p.313).

In a more recent review of literature, Cheryan in 2011, reviewed gender gaps in mathematics within the last 30 years. Through her research, she revealed empirical evidence of women's attitudes towards mathematics were a deciding factor for them avoiding a heavy course load in mathematics while in college. The negative implications of the avoidance directly affected mathematics-heavy majors in college and careers. Cheryan (2011) also commented on how stereotypes about women in mathematics overtime have resulted in women staying away from mathematics courses in college even though women are equally capable.

Ethnic Origins. Another societal myth is that learners must be of a certain ethnic background in order to learn and understand mathematics. A longitudinal study conducted by Crumb and Grodsky in 2010 examined the racial/ethnic differences in mathematics achievement.

The authors began in 2002 with a representative sample of 4,070 high school sophomore students and followed up on them in 2004 and again in 2006. Data about the students' parents, demographics, and achievement tests scores in reading and mathematics. The results revealed that black and Hispanic students did not have high percentages in completing a higher level mathematics course. The authors discussed that life at home, money, or social pressures could be affecting mathematics achievement in ethnic groups. Even though there has been more achievement in minorities in higher mathematics courses in recent years, there is still a gap in achievement between ethnic origins and many more studies need to be conducted.

Intelligence. Other myths are that mathematics ability is related to intelligence, that learning mathematics requires the learner to have a perfect memory, or that there is only one method to get the right answer (Ruedy & Nirenberg, 1990). These are simply not true. An article written by Chapin and Eastman in 1996 discussed the importance of educators' role in encouraging learners that mathematics is creative. Educators should emphasize that mathematics is an ever changing subject with many applications, not a "fixed body of knowledge" (Chapin & Eastman, 1996).

Unfortunately, some educators treat mathematics as a stagnant knowledge base. This reflects in the educator's instruction and affects how the student views mathematics. Both learners and educators need to be a part of the process of developing mathematical ideas and reasoning.

According to many studies, every learner, male or female, of any ethnic group, of any level of intelligence, is capable of achieving in mathematics classes. Learners should not be caught in stereotypes that were created about mathematics by society.

Lack of Motivation

Some learners lack motivation, which is crucial to learning mathematics. An article written by Jansen and Middleton (2011) discussed the definition of motivation. Motivation is defined as a personal desire to pursue goals set by the learner, such as graduation (Jansen & Middleton, 2011). When high motivation of learning mathematics is occurring, it is learned and an understanding is gained; it is not just memorized.

Unfortunately, mathematics can be portrayed as a fixed set of rules, particularly when learners enter secondary education and beyond (Chapin & Eastman, 1996; Jang, 2008; Jansen & Middleton, 2011). Learners need relevance in order to motivate themselves to understand mathematics. In particular, adult learners want to know why the content is required, whether it is in mathematics, science or any subject. They like discussion and engaging in the material, especially if the knowledge is needed for careers (Jang, 2008; Piercey & Tobias, 2012; Tobias, 1990).

When adult learners believe that mathematics is a set of memorized rules and procedures, they become disinterested or bored in mathematics and develop negative views. On the other hand, if adult learners know why they need mathematics, then they may be more motivated to learn it. Once general motivation is present, interest returns and aids in learning (Jang, 2008).

Negative Attitudes Towards Mathematics

Negative attitudes could be rooted in past experiences, poor experiences in the classroom, or even lack of understanding. A study about overcoming past experiences in mathematics courses was conducted by Taylor and Galligan in 2002. Taylor and Galligan designed a video for adult learners in mathematics to improve upon past experiences in the mathematics classroom. The video was casted by five actors who had similar demographics to the developmental learners and was directed towards alleviating mathematics anxiety, improve mathematical ability, create positive experiences while learning, and improve confidence. The videos were about adult learners solving mathematics problems and their journey to the final answer.

There were 23 developmental mathematics participants who ranged in ages 20-50 years old. Participants watched the video and then discussed the video in groups designated by the authors. The results revealed that participants enjoyed the video, felt that it was a good orientation to the beginning of their course, and that attitudes were improved at the beginning of the course.

Palacios, Arias and Arias (2014) defined attitudes towards mathematics as “the valuation, the appraisal, and the enjoyment of the discipline” (p. 68). Positive attitudes towards mathematics influence learners in ways that encourage understanding and use of mathematics outside of the classroom. Improvement in attitudes for adult learners is important for their understanding of mathematics, since this could lead to completing developmental mathematics coursework.

This is evident in a study conducted by Ahmet Akin (2012) that examined the relationship between achievement and mathematics attitudes. The study had 569 university student participants who completed the mathematics attitudes scale and another questionnaire. The results revealed that negative attitudes were predicted positively with avoidance of mathematics and positive attitudes were negatively predicted with avoidance of mathematics.

Coping Strategies and Improving Attitudes

While a high percentage of developmental learners are unsuccessful and many do have high mathematics anxiety and negative attitudes towards mathematics, some are able to cope with the anxiety, improve attitudes, and successfully complete all the needed developmental courses to move on to credit-bearing courses. What strategies do they use to cope with the anxiety and improve attitudes? Literature suggests that seeking help from various resources and strategies can help alleviate mathematics anxiety and improve attitudes towards mathematics.

These include, but are not limited to, the instructor of the mathematics class, on-campus lab tutoring centers, textbooks, and study groups (Dahlke, 2008; Piercey & Tobias, 2012; Smith & Hageman Smith, 2006). When learners utilize these resources, they are encouraged to persevere and reinforce what they have gained in their mathematics classes. Dahlke (2008) states, “Receiving help is a sign of strength, regardless of the difficulty you want to overcome” (p.487).

Instructors

Learners are encouraged to talk to their instructors to devise a plan to overcome mathematics anxiety. This plan can include asking questions one-on-one, conducting oral reviews, or sending emails until the learner feels comfortable with the material (Dahlke, 2008; Piercey & Tobias, 2012). According to Hembree (1990), mathematics anxiety should be addressed individually instead of by groups or whole classes. Instructors are also encouraged to create active learning environments, which are positive by nature (Chapin & Eastman, 1996; Jang, 2008).

A study about developmental mathematics success was conducted by Benken, Ramirez, Li and Wetendorf in 2014. The participants were both instructors and developmental learners and were from California. There were four instructors and 306 developmental learners. A survey developed by the authors was administered to the developmental learners at the beginning and end of the semester. An email survey also developed by the authors was administered to the instructors at the end of the semester. The study revealed that the developmental learners who thought their instructors were helpful were more likely to complete developmental coursework and have a positive attitude towards mathematics.

Therefore, instructors who were available for questions and gave positive feedback had more success with their developmental learners (Benken, Ramirez, Xuhui Li, & Wetendorf, 2015). Other studies also show that learners who are able to talk through materials and ask questions to peers or instructors can leave the classroom with a positive attitude. (Chapin & Eastman, 1996)

Lab Tutorials

Many community colleges and universities provide learners a place for tutorials that is at no extra cost for the students. Learners can schedule appointments or drop by after class for help (Dahlke, 2008; Piercey & Tobias, 2012). According to Dahlke (2008), lab tutorials for learners are a proven technique and provide one-on-one tutoring from a professional tutor and encourage studying mathematics. Lab tutorial centers may have varying names from campus to campus. The names from the community college in this study are The Math Lab, The Center for Academic Excellence, and TRIO. The Math Lab and the Center for Academic Excellence are local names for the tutoring centers. TRIO, on the other hand, is a national program. In 1965, the Higher Education Act was passed and three programs were created, which resulted in the name of TRIO (Texas Association of Student Support Services Programs, Inc., 2012).

TRIO helps to provide educational opportunities for every American of any ethnic background, economic circumstances or race. Over the last several years, TRIO has expanded to eight programs for two-year and four-year institutions. The names of the programs are Educational Opportunity Centers, Student Support Services, Upward Bound, Veterans Upward Bound, Ronald E. McNair Postbaccalaureate Achievement, Talent Search, Upward Bound Math-Science, and Training Program for Federal TRIO Programs Staff (U.S. Department of Education, 2016).

A study about peer tutoring college learners was conducted by Evans, Flower, and Holton in 2001. Participants were experienced tutors who had five or more years of teaching experience. The study revealed that tutees were greatly benefited. Tutees gained confidence and improved attitudes. Participants did agree that tutoring should not be the main mode of instruction, but that it was helpful (Evans, Flower, & Holton, 2001).

Another study about peer tutoring was conducted by Kostecki and Bers in 2008. The study took place at a community college and participants were enrolled in developmental courses. The results revealed that participants who had received tutoring throughout the semester were more likely to successfully complete their developmental courses than those who did not receive tutoring (Kostecki & Bers, 2008).

Study Groups

Study groups are another effective way for learners to understand mathematical concepts (Dahlke, 2008; Piercey & Tobias, 2012). Dahlke (2008) discusses that study groups can be small or large. Small study groups have two to three learners and large study groups have four or more persons. Study groups are beneficial to learners because learners can discuss class material together and help increase interest of mathematics in the class (Dahlke, 2008). Tobias and Piercey (2012) also encourage the formation of study groups since they can help learners collaborate about important concepts, which help learners to do better on tests. A study about required study groups was conducted by Brown in 2012.

There were 39 developmental mathematics learners who were divided into two groups, one group was required to participate in study groups in and out of class and the other group was not required to participate in study groups. All participants were given surveys about attitudes towards mathematics. Their test grades were also collected to gather achievement data. The result of the study revealed that learners who were in the study groups were greatly benefited. The learner who participated in study groups had an improvement in attitudes towards mathematics and were more likely to complete the course (Brown, 2012).

Textbooks

Textbooks are another great strategy for learners to understand mathematical concepts. Within textbooks, there are examples and in depth explanations that are written to help learners understand concepts covered in class (Dahlke, 2008).There are not very many studies on students who utilized their textbooks and more studies need to be conducted.

Online Tutorials and Other Resources

Textbooks may also be purchased online or packaged with an online homework program. Online textbooks often include videos, practice problems and other interactive learning tools (Piercey & Tobias, 2012) .Some learners find help from other resources. Other sources include, but are not limited to, online websites independent of textbooks and private tutors.

For example, Khan Academy is a no cost, online resource that contains almost 3,300 videos on many different subjects (Ani, 2013). Online resources such as Khan Academy can be utilized at any time during the day or night, which can be helpful if the adult learner cannot attend lab tutorials or talk to the instructor and/or classmates.

A study about the effectiveness of online resources such as Khan Academy and Google was conducted by Tracey Muir in 2014. There were 120 seventh, eighth, and ninth grade students who participated in watching a clip from Khan Academy and then completed an online survey that contained 28 questions about online resources for mathematics. There were also 30 participants who volunteered for a post-interview after the showing of the clip. The results of the study revealed that students felt that online resources were helpful with learning mathematics.

The ninth grade students were more likely to turn to online resources while at home than any other grade level. However, Muir observed that when students were engaging in the clips, they were engaging at an operative level and not a cognitive level (Muir, 2014). There is limited literature available on the impact of these resources suggesting more studies need to be conducted.

Mathematics Anxiety Measures

Literature began to appear in the 1950s, by psychologists and educators who became interested in mathematics anxiety. Mary Fides Gough (1954) first published an article discussing a type of phobia of mathematics, which she coined “mathemaphobia”. Gough (1954) also recommended that “mathemaphobia” could be helped by lightening the attitude of the classroom before an outbreak (Gough, 1954, p. 294).

A few years later, in 1957, a study about college students with number anxiety was conducted by Dreger and Aiken. Dreger and Aiken set out to define number anxiety, but attitudes towards mathematics was explored instead (Dreger & Aiken, 1957). Table 2.3 provides a summary for Dreger and Aiken's scale.

However, mathematics anxiety had yet to be defined and measured. Nearly two decades later, in the early 1970s, Richardson and Suinn developed a type of scale to measure mathematics anxiety directly. Their instrument was named the Mathematics Anxiety Rating Scale (MARS). The scale contained 98 items that were evaluated on a five-point Likert-scale response. They published their findings in "The Mathematics Anxiety Rating Scale: Psychometric Data" in 1972. This article opened the door to examining mathematics anxiety as a unique measure. By obtaining a measurement, educators and psychologists could identify individuals with mathematics anxiety, better understand its effects on the individuals and possibly help individuals overcome mathematics anxiety. This opened the door to the development of more instruments of mathematics anxiety and studies for all ages and levels.

Adaptations of MARS Scales

Researchers began exploring the idea of measuring mathematics anxiety in young learners. Suinn, who developed the MARS, was interested in mathematics anxiety in children and adolescents. So, he adapted the original MARS for children and adolescents in 1982. The MARS-A contains 98 items that are evaluated on a five-point Likert-scale response and the items are similar to the original MARS, but are reworded for children and adolescents (Suinn & Edwards, 1982).

Several years later, the MARS-E was developed by Suinn, Taylor and Edwards in 1988, which contains 26 items that are worded for elementary students in fifth and sixth grades and evaluated on a five-point Likert-scale response. For adult learners, there are several shortened versions of the MARS test that were developed over time (Suinn & Winston, 2003). Table 2.1 provides summaries for the MARS-A and MARS-E scales.

In 1980, Rounds and Hendel developed a 30-item MARS test. Two years later, Plake and Parker developed a 24-item MARS test. Several years later, in 1989, Alexander and Martray developed a 25-item MARS test, which is called the sMARS or RMARS test and scored on a five-point Likert-scale. The RMARS is the anxiety scale that will be utilized in this study since it is very reliable and easy to read. The Child Math Anxiety Questionnaire (CMAQ) was adapted from the MARSE by Ramirez et. al in 2013. The CMAQ is an eight-item scale that is utilized for fourth through sixth grades.

As one can see, there have been many changes to the mathematics anxiety rating scales. These changes have dealt with changing learner populations and the time needed to administer these tests. These scales are not perfect at measuring the exact feelings of mathematics anxiety, but they are reliable and valid (Suinn & Winston, 2003). Since the administration and response time is quick, the most popular scale is the RMARS (Ashcraft & Moore, 2009). Table 2.1 provides a summary of characteristics of the RMARS, CMAQ, and other MARS adaptations mentioned in the previous section.

Table 2.1: MARS Adaptations

Name of Scale	Purpose	Number of items	Authors
Mathematics Anxiety Rating Scale (MARS)	Measure mathematics anxiety in adults	98	Richardson & Suinn (1972)
Mathematics Anxiety Rating Scale	Measures mathematics anxiety in adults	30	Rounds & Hendel (1980)
Mathematics Anxiety Rating Scale	Measures mathematics anxiety in adults	24	Plake & Parker (1982)
Mathematics Anxiety Rating Scale Adolescents (MARS-A)	Measure mathematics anxiety in children and adolescents	98	Suinn & Edwards (1982)
Mathematics Anxiety Rating Scale Elementary (MARS-E)	Measures mathematics anxiety in elementary students (5th and 6th grades)	26	Suinn, Taylor & Edwards (1988)
Revised and Shortened Mathematics Anxiety Rating Scale (RMARS or sMARS)	Measures mathematics anxiety in adults	25	Alexander & Martray (1989)
Child Math Anxiety Questionnaire (CMAQ)	Measures mathematics anxiety in children (1st and 2nd grades)	8	Ramirerz, Gunderson, Levine & Beilock (2013)

Other Mathematics Anxiety Scales

Even though the MARS and its derived versions are very popular instruments for measuring mathematics anxiety, other scales exist (Capraro, Capraro, & Henson, 2001). Table 2.2 provides a summary for the AMAS, SIMA, and other anxiety scales mentioned in this section. Another popular instrument is the Abbreviated Math Anxiety Scale (AMAS), which was developed by Hopko, Mahadevan, Bare, and Hunt in 2003 and has nine items (Hopko, Mahadevan, Bare, & Hunt, 2003).

There is also and the Single-Item Math Anxiety Scale (SIMA) developed by Ashcraft in 2002 (Ashcraft, 2002; Forgasz, Leder, & Gardner, 1999; M. Isabel Núñez-Peña, Guilera, & Suárez-Pellicioni, 2014). The Math Anxiety Questionnaire (MAQ) was developed by Meece in 1981 and has 22-items to determine six of dimensions of mathematics anxiety. The SIMA and MAQ are summarized in Table 2.2.

The six dimensions are, discomfort, lack of confidence, dislike, worry, confusion/frustration and fear and dread (Wigfield & Meece, 1988). The Multidimensional Anxiety Scale for Children (MASC) was developed by in 1997 by March, Parker, Sullivan, Stallings and Conners to measure anxiety in children. The MASC has four subscales of physical symptoms, social anxiety, separation anxiety and harm avoidance (Galla & Wood, 2012). There is a plethora of mathematics anxiety rating scales that can be used for children or adult learners to determine their level of anxiety towards mathematics. By determining the level of mathematics anxiety, educators may be able to work with their learners to lessen the anxiety or even overcome it.

Table 2.2: Other Mathematics Anxiety Scales

Name of Scale	Purpose	Number of items	Author(s)
Single-Item Math Anxiety Scale (SIMA)	Measures mathematics anxiety	1	Ashcraft (2002)
Abbreviated Math Anxiety Scale (AMAS)	Measures mathematics anxiety	9	Hopko, Mahadevan, Bare, and Hunt (2003)
Math Anxiety Questionnaire (MAQ)	Measures mathematics anxiety	22	Wigfield & Meece 1981
Multidimensional Anxiety Scale for Children (MASC)	Measures mathematics anxiety	39	March, Parker, Sullivan, Stallings & Conners 1997

Mathematics Attitude Scales

There are many instruments that measure learners' attitudes towards mathematics. One of the first instruments, Mathematics Attitudes Scale (MAS), was developed by Aiken and Dreger in 1961. There were 10 negative items and 10 positive items, for a total of 20-items that were evaluated by a five-point Likert scale (L. R. J. Aiken & Dreger, 1961). Two years later, Aiken revised the MAS by updating words in the items.

The scale still had 10 positive items and 10 negative items for a total of 20-items evaluated by a five-point Likert scale (L. R. Aiken, 1963). The revised MAS has a test/retest reliability of 0.94 (Shaw & Wright, 1967).

The MAS is the attitude scale that will be utilized in this study since it is reliable and easy for learners to read. Aiken also followed this scale with two other attitude scales, the Enjoyment of Mathematics (E) and the Value of Mathematics (V), in 1974. The E scale has 12-items and the V scale has 11-items and both are evaluated on the five-point Likert scale (Alken, 1974). Table 2.3 provides a summary of the MAS and its revisions.

Another popular attitude scale is the 108-item Mathematics Attitudes Scale developed by Fennema and Sherman (FSMAS) in 1976. There are nine subscales that measure attitude toward success in mathematics, mathematics as a male domain, the mother/father scale, the teacher scale, the confidence in learning mathematics scale, the mathematics anxiety scale, the effectance motivation scale in mathematics, and the mathematics usefulness scale. All of the scales have 12-items that are evaluated by a five-point Likert scale (Fennema & Sherman, 1976). Table 2.3 provides a summary of the FSMAS and its characteristics.

There are also other scales that have been developed to measure attitudes towards mathematics. The Student Attitude Questionnaire (SAQ) was developed by Eccles in 1983 and measures students' expectancies for success, incentive values, perceived ability, perceived effort, and perceived task difficulty in various academic settings (Wigfield & Meece, 1988).

Table 2.3 Mathematics Attitude Scales

Name of Scale	Purpose	Number of Items	Author(s)
Mathematics Attitudes Scale (MAS)	Measures attitudes towards mathematics	20	Aiken and Dreger (1961)
Revised MAS	Measures attitudes towards mathematics	20	Aiken (1963)
Enjoyment of Mathematics (E)	Measures enjoyment of mathematics	12	Aiken (1974)
Value of Mathematics (V)	Measures value of mathematics	11	Aiken (1974)
Mathematics Attitudes Scale (FSMAS)	Measures attitudes towards mathematics	108	Fennama and Sherman (1976)
Student Attitude Questionnaire (SAQ)	Measures attitudes towards mathematics	12 to 18	Eccles (1983)

Purpose and Questions

In review, mathematics anxiety and attitudes towards mathematics have a detailed and ever-evolving body of literature aimed to improve attitudes and alleviate anxiety. To continue to add to the body of literature, the purpose of this exploratory, correlational study was to examine the relationship between successful adult developmental learners' attitudes toward mathematics and their levels of mathematics anxiety in relation to their use of available resources and strategies.

For the purpose of this study, there is a main research question and seven sub-questions. The main research question is: Are mathematics anxiety and attitudes toward mathematics contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study? The seven sub-questions are:

1. Is there a relationship between the learners' mathematics anxiety and the strategy/strategies utilized by the learners?

2. Is there a relationship between the learners' attitudes towards mathematics and strategy/strategies utilized by the learners?

3. Is there a relationship between the resources and strategies utilized and successful completion of developmental mathematics?

4. Is there a relationship between learners' mathematics anxiety and biological gender?

5. Is there a relationship between the learners' attitudes towards mathematics and biological gender?

6. Is there a relationship between the learners' mathematics anxiety and ethnic origin?

7. Is there a relationship between the learners' attitudes towards mathematics and ethnic origin?

CHAPTER THREE

Methods

This chapter provides the context, the participants, the main research question and the seven sub-questions, the instruments used, the procedures for collecting data, and the statement of the research hypothesis.

Context of Study

The study took place at a community college in central Texas. The community college offers developmental, freshman and sophomore level courses. The freshman and sophomore level courses can transfer to other area colleges and universities and can apply towards associate degrees, certificates and marketable skills (Online Catalog, 2015).

In order to register for class, learners were required to take the TSI assessment. This assessment helps to place learners in the appropriate level: college ready or developmental. After taking the TSI assessment, the community college reported over the last three academic years (Fall 2013 to Spring 2016), that approximately 63.4% of adult learners were required to enroll in developmental mathematics courses. Of those adult learners, only 25.9% complete the required developmental mathematics courses in 2 years. These are alarming statistics. What is contributing to the 37.5% of adult learners who fail to complete their developmental mathematics courses within 2 years?

Participants

In the spring of 2016, there were a total of 8,296 learners enrolled at the community college. Of the learners enrolled, 65.9% were female and 34.1% were male. By ethnicity, those enrolled were 53.6% White, 27.4% Hispanic, 12.7% African American, and 6.1% Other. There were a total of 254 learners enrolled in the two developmental mathematics courses. In Table 3.1 the participant demographics are summarized. All statistics were reported by the participating community college.

Participants of the study were enrolled in the first developmental mathematics course at a community college in central Texas. The name of the first developmental mathematics course is MATH 0307. MATH 0307 is known as Beginning Algebra and the lowest college credit course in which a learner may enroll. It is also the only developmental course for learners going into a liberal arts mathematics course or statistics.

According to the online college course catalog, the description of MATH 0307 is as follows:

> Topics in mathematics such as arithmetic operations, basic algebraic concepts and notation, geometry, and real and complex number systems. Course topics include: solution of linear equations and inequalities, graphing of points and lines in a rectangular coordinate system, introduction to functions, solving systems of linear equations, laws of exponents, operations and factoring of polynomials, and real-world applications of these concepts. (Online Catalog, 2015)

This course was chosen to gather data since the course is a prerequisite for a college level mathematics credit and has a large enrollment. This was a purposeful sample since the participants were enrolled in a developmental mathematics course and were actively partaking in completing the course. There were 83 participants enrolled from five sections of MATH 0307. Of the participants there were 26 males and 57 females. There were 15 African Americans, 27 Hispanics, 34 Caucasians and 7 identified as Other. In Table 3.1, the overall participant demographics are summarized.

Table 3.1: Overall Participant Demographics

Participant	African American	Hispanic	White	Other	Percentage
Male	7	10	7	2	31.3%
Female	8	17	27	5	68.7%
Percentage	18.1%	32.5%	41%	8.4%	100%

Research Questions

Recall, that for the purpose of this study, there is a main research question and seven sub-questions. The main research question is: Are mathematics anxiety and attitudes toward mathematics contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study? The seven sub-questions are:

1. Is there a relationship between the learners' mathematics anxiety and the strategy/strategies utilized by the learners?
2. Is there a relationship between the learners' attitudes towards mathematics and strategy/strategies utilized by the learners?
3. Is there a relationship between the resources and strategies utilized and successful completion of developmental mathematics?

4. Is there a relationship between learners' mathematics anxiety and biological gender?

5. Is there a relationship between the learners' attitudes towards mathematics and biological gender?

6. Is there a relationship between the learners' mathematics anxiety and ethnic origin?

7. Is there a relationship between the learners' attitudes towards mathematics and ethnic origin?

Instrumentation

Revised Mathematics Anxiety Rating Scale

The instrument to be used to measure mathematics anxiety in this study is the shortened and revised Mathematics Anxiety Rating Scale (RMARS) test developed by Alexander and Martray (1989). The scale was developed from a 69-item scale version of the MARS by taking the highest coefficient alphas for each item. The result was a 25-item survey that is rated using the five-point Likert-scale for each item. The responses are 'not at all', 'a little', 'a fair amount', 'much', or 'very much' (Alexander & Martray, 1989).

Within the 25-items, there are three subcategories: questions 1 to 15 have a subcategory of mathematics test anxiety and have a coefficient alpha of 0.96, questions 16 to 20 have a subcategory of numerical task anxiety and have a coefficient alpha of 0.86 and questions 21 to 25 have a subcategory of mathematics course anxiety and have a coefficient alpha of 0.84 (Alexander & Martray, 1989).

The RMARS is suitable for learners coming into college since it is highly correlated to the American College Test (ACT) and the original MARS test (Alexander & Martray, 1989, p. 148). The RMARS is displayed in Figure 3.1. The scale is internally consistent and has high test-retest reliability. Overall, it has a coefficient correlation of 0.97 with the original MARS. It is convenient for quick administration and available at no cost (Alexander & Martray, 1989; Ashcraft & Moore, 2009). The RMARS has a composite score between 25 and 125, with 25 meaning low mathematics anxiety and 125 meaning very high mathematics anxiety (Alexander & Martray, 1989).

Revised and Shortened Mathematics Anxiety Rating Scale Questionnaire by Alexander & Martray 1989

Directions: Indicate the level of anxiety you feel in the following situations. Select one choice per question.

	Not at all	A little	A fair amount	Much	Very Much
Studying for a math test					
Taking the mathematics section of college entrance exam					
Taking an exam (quiz) in a math course					
Taking an exam (final) in a math course					
Picking up math textbook to begin working on a homework assignment					
Being given homework assignments of many difficult problems that are due the next class meeting					
Thinking about an upcoming math test 1 week before					
Thinking about an upcoming math test 1 day before					
Thinking about an upcoming math test 1 hour before					
Realizing you have to take a certain number of math classes to fulfill requirements in your major					
Picking up math textbook to begin reading a difficult assignment					
Receiving your final math grade in the mail					
Opening a math or stat book and seeing a page full of problems					
Getting ready to study for a math test					
Being given a "pop" quiz in a math class					
Reading a cash register receipt after your purchase					
Being given a set of numerical problems involving addition to solve on paper					
Being given a set of subtraction problems to solve					
Being given a set of multiplication problems to solve					
Being given a set of division problems to solve					
Buying a math textbook					
Watching a teacher work on an algebraic equation on the blackboard					
Signing up for a math course					
Listening to another student explain a math formula					
Walking into a math course					

Figure 3.1: *The RMARS Test*

Mathematics Attitudes Scale

The instrument to be used to measure attitudes towards mathematics in this study is the Mathematics Attitudes Scale (MAS) test developed by Aiken (1963). Aiken revised the original MAS developed by him and Dreger in 1961 by updating words in the items. The revised scale has a test/retest reliability of 0.94 (Shaw & Wright, 1967). The scale still has 10 positive items and 10 negative items for a total of 20-items evaluated by a five-point Likert scale (Aiken, 1963). The MAS is displayed in Figure 3.2.

Scoring for the MAS begins by separating the positive items (3, 4, 5, 9, 11, 14, 15, 18, 19, and 20) and the negative items (1, 2, 6, 7, 8, 10, 12, 13, 16, and 17). Once they are separated, the positive items are weighted by 1 point for "Strongly Disagree", 2 points for "Disagree", 3 points for "Undecided", 4 points for "Agree" and 5 points for "Strongly Agree". The negative items are weighted by 1 point for "Strongly Agree", 2 points for "Agree", 3 points for "Undecided", 4 points for "Disagree" and 5 points for "Strongly Disagree". Scores for the MAS are the points totaled from the weights and they can range from 20 (a negative attitude towards mathematics) to 100 (a positive attitude towards mathematics).

Math Attitude Scale by L.R. Aiken (1963)	1	2	3	4	5
	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I am always under a terrible strain in a math class.					
I do not like mathematics, and it scares me to have to take it.					
Mathematics is very interesting to me, and I enjoy math courses.					
Mathematics is fascinating and fun.					
Mathematics makes me feel secure, and at the same it is stimulating.					
My mind goes blank, and I am unable to think clearly when working math.					
I feel a sense of insecurity when attempting mathematics.					
Mathematics makes me feel uncomfortable, restless, irritable, and impatient.					
The feeling that I have toward mathematics is a good feeling.					
Mathematics makes me feel as though I'm lost in a jungle of numbers and I can't find my way out.					
Mathematics is something which I enjoy a great deal.					
When I hear the word math, I have a feeling of dislike.					
I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.					
I really like mathematics.					
Mathematics is a course in school which I have always enjoyed studying.					
It makes me nervous to even think about having to do a math problem.					
I have never liked math, and it is my most dreaded subject.					
I am happier in a math class than in any other class.					
I feel at ease in mathematics, and I like it very much.					
I feel a definite positive reaction to mathematics; it's enjoyable.					

Figure 3.2: *The MAS Scale*

Resource and Strategy Questionnaire

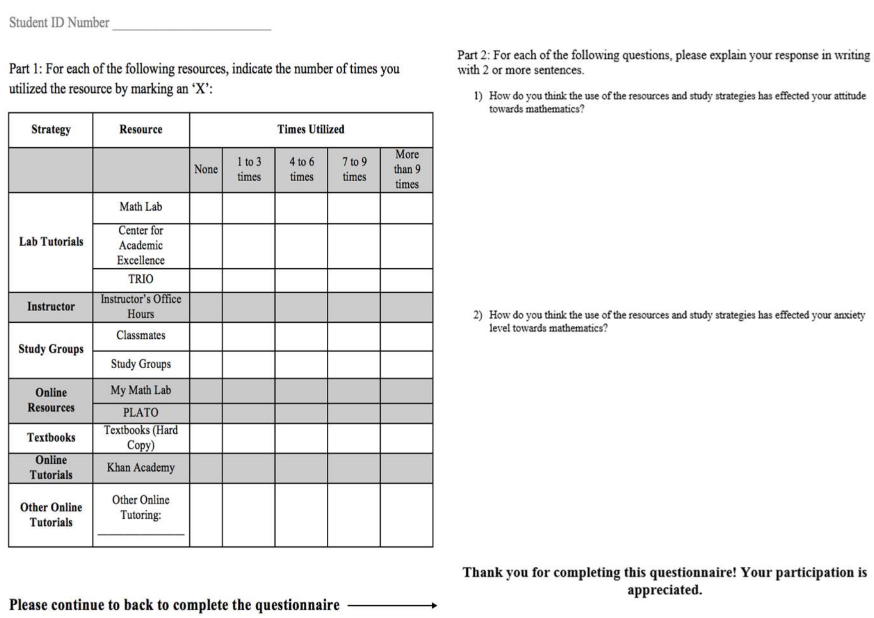
The Resource and Strategy Questionnaire (RSQ) was developed by the researcher based upon the review of literature to better understand which resources and strategies for coping with mathematics anxiety and improving attitudes towards mathematics were being utilized by the participants. The RSQ is displayed in Figure 3.3. Questions pertain to resources available to the participants, the number of times resources were used, how long the resources were used, and if feelings of anxiety were present after using the resources. The resources are defined as strategies in Table 3.2. All of the resources and strategies are described in detail in chapter two.

The Math Lab, Center for Academic Excellence and TRIO resources are defined as the Lab Tutorials strategy. The Instructor's Office Hour resource is defined for the strategy of the Instructor. The Classmates and Study Group resources are defined for the strategy of Study Groups.

The Textbooks category is defined for the strategy of Textbooks. The Khan Academy, My Math Lab, and PLATO and Other Online Tutorial resources are defined for the Online and Other Resources. For definitions of the resources and strategies, please see *Coping Strategies and Improving Attitudes*.

Table 3.2: Groups of Resources and Strategies

Resources	Strategies
Math Lab, Center for Academic Excellence, TRIO	Lab Tutorials
Instructor's office hours	Instructor
Classmates, Study Groups	Study Groups
Textbooks	Textbooks
My Math Lab, Plato, Khan Academy, Other Online Tutorials	Online Tutorials and Other Resources



Student ID Number ____________________

Part 1: For each of the following resources, indicate the number of times you utilized the resource by marking an 'X':

Strategy	Resource	Times Utilized				
		None	1 to 3 times	4 to 6 times	7 to 9 times	More than 9 times
Lab Tutorials	Math Lab					
	Center for Academic Excellence					
	TRIO					
Instructor	Instructor's Office Hours					
Study Groups	Classmates					
	Study Groups					
Online Resources	My Math Lab					
	PLATO					
Textbooks	Textbooks (Hard Copy)					
Online Tutorials	Khan Academy					
Other Online Tutorials	Other Online Tutoring: ____________					

Please continue to back to complete the questionnaire →

Part 2: For each of the following questions, please explain your response in writing with 2 or more sentences.

1) How do you think the use of the resources and study strategies has effected your attitude towards mathematics?

2) How do you think the use of the resources and study strategies has effected your anxiety level towards mathematics?

Thank you for completing this questionnaire! Your participation is appreciated.

Figure 3.3: *Resource and Strategy Questionnaire*

Procedures

Adult learners who were enrolled in MATH 0307 (Beginning Algebra), who volunteered for the study, were given the RMARS, MAS, the RSQ during final week of class of the spring semester. Data were collected well after the final drop day of March 28th. After the drop date, learners are not allowed to drop the course, which helped to retain the sample size. Information that was obtained from the learners included the following: consent form of participation, student ID number, biological gender, ethnic origin, and final grades. The consent form is displayed in Figure 3.4.

Consent Form

AN EXPLORATORY EXAMINATION OF THE RELATIONSHIP BETWEEN MATHEMATICS ANXIETY, ATTITUDES TOWARDS MATHEMATICS, AND SUCCESSFUL ADULT DEVELOPMENTAL LEARNERS

Please read this form carefully. The purpose of this form is to provide you with important information about taking part in a research study. If any of the statements or words in this form are unclear, please let us know. We would be happy to answer any questions. You have the right to discuss this study with another person who is not part of the research team before making your decision whether or not to be in the study.

Taking part in this research study is up to you. If you decide to take part in this research study, we will ask you to sign this form. We will give you a copy of the signed form. The person in charge of this study is Molly Veselka (Faculty Advisor: Dr. Trena Wilkerson, Baylor University). Molly will be will referred to this as the "researcher" throughout this form.

The purpose of this study is to examine the relationship between successful adult developmental learners' attitudes toward mathematics and their levels of mathematics anxiety in relation to their use of available strategies and resources. This study is supported by Baylor University.

The researcher is asking you to take part in this study because you are adult developmental learners enrolled in the course of Beginning Algebra (MATH 0307). About 60 subjects will take part in this research study at McLennan Community College.

The following table displays the data items to be collected from the subjects, when it will occur and how long subjects need to complete each item:

Data to be collected	**Days of collection**	**Time Needed**
Consent form	April 25th and 26th	10 minutes
Revised Mathematics Anxiety Rating Scale (RMARS)	April 27th and 28th	8-10 minutes
Mathematics Attitudes Scale (MAS)	April 27th and 28th	8-10 minutes
Resource and Strategy questionnaire	April 27th and 28th	8-10 minutes

- The RMARS has 25 questions and responses are: 1 "Not at all", 2 "A little", 3 "A fair amount", 4 "Much", and 5 "Very much". There are no correct answers.
- The MAS has 10 questions and responses are: 1 "Strongly Disagree", 2 "Disagree", 3 "Undecided", 4 "Agree", and 5 "Strongly Agree". There are no correct answers.
- The Resource and Strategy Questionnaire has two parts. The first part has 12 questions about how many times you have used the resource or strategy. The second part has two questions about the usefulness of the resources or strategies that you have used. There are no correct answers.

The subject will need to provide their student ID and demographics for the following to match all data items:

- RMARS
- MAS
- Resource and Strategy Questionnaire
- Final Grades

Consent Form

After all data has been collected and matched the subject's student ID number and demographics will:

- Stored in a password protected SPSS file by the researcher only
- Be randomly coded with a number between 1 and 60
- (original ID) Will be deleted after matched
- Will not appear in the thesis in any way

By participating in this study you could:

- Gain an understanding of strategies and resources that work for you
- Alleviate your mathematics anxiety
- Improve your attitude towards mathematics

You can call us with any concerns or questions about the research. Our telephone numbers are listed below:
Molly Veselka, McLennan Community College, Phone: (254) 299-8858
Dr. Trena Wilkerson, Baylor University, Phone: (254) 710-6162
You may contact us between Monday-Friday 8:00-5:00.

If you want to speak with someone **not** directly involved in this research study, you may contact the Baylor University IRB through the Office of the Vice Provost for Research at 254-710-1438. You can talk to them about:

- Your rights as a research subject
- Your concerns about the research
- A complaint about the research

Taking part in this study is your choice. You are free not to take part or to withdraw at any time for any reason. No matter what you decide, there will be no penalty or loss of benefit to which you are entitled. If you decide to withdraw from this study, the information that you have already provided will be kept confidential. You cannot withdraw information collected prior to your withdrawal.

You may choose not to be in the study or to stop being in the study before it is over at any time. This will not affect your class standing or your grades at McLennan Community College. You will not be offered or receive any special consideration or extra if you take part in this research study.

Indicate your decision for the below optional research discussed earlier in this form:

Are you willing to participate in this study? ______ YES

Do you agree to let us store your study information for future research related to mathematics anxiety and attitudes in mathematics in adult learners?

_____YES ______INITIALS

SIGNATURE OF SUBJECT:

I have read the information in this consent form including risks and possible benefits. I have been given the chance to ask questions. My questions have been answered to my satisfaction, and I agree to participate in the study.

_________________________ ______________
Signature of Subject Date

Figure 3.4: *Consent Form*

Participants who agreed to participate completed the consent form and signed with their student ID on April 25th and April 26th. The consent form allowed the researcher to keep the learner's ID for 8 weeks in order to match the RMARS and MAS tests, RSQ and final grades for each of the participants. After all data items were matched, participants were randomly coded with a number between 1 and 83 and actual student IDs were discarded. All collected data were stored in a password protected document.

On April 27th and April 28th, the RMARS, MAS, and a RSQ were administered to gather information about levels of mathematics anxiety, attitudes towards mathematics and resources utilized by the participants. Participants self-reported levels of anxiety, attitudes towards mathematics and resources utilized. On May 9th, all grades were finalized by the community college and the final grades were collected from the community college with consent of the participants. On May 16th, all data items were matched and students' IDs were discarded. The timeline of procedures is displayed in Figure 3.5.

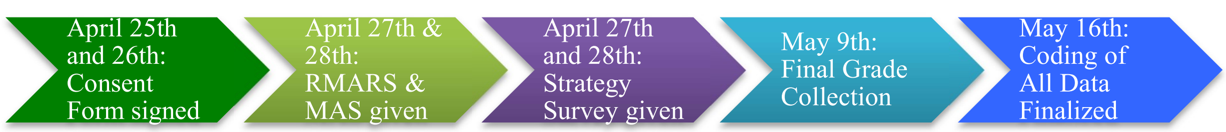


Figure 3.5: *Timeline of Procedures*

Research Hypothesis

It was hypothesized that when adult developmental learners utilize various resources and strategies to cope with their mathematics anxiety and poor attitudes towards mathematics, their mathematics anxiety levels would be lower, their attitudes toward mathematics would be more positive and they would be more likely to successfully complete a developmental mathematics course with a letter grade of A, B or C.

CHAPTER FOUR

Analysis and Results

This chapter provides the procedures and results of the statistical analysis. Recall, for the purpose of this study, there is a main research question and seven sub-questions. The main research question is: Are mathematics anxiety and attitudes toward mathematics contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study? The seven sub-questions are:

1. Is there a relationship between the learners' mathematics anxiety and the strategy/strategies utilized by the learners?
2. Is there a relationship between the learners' attitudes towards mathematics and strategy/strategies utilized by the learners?
3. Is there a relationship between the resources and strategies utilized and successful completion of developmental mathematics?
4. Is there a relationship between learners' mathematics anxiety and biological gender?
5. Is there a relationship between the learners' attitudes towards mathematics and biological gender?
6. Is there a relationship between the learners' mathematics anxiety and ethnic origin?
7. Is there a relationship between the learners' attitudes towards mathematics and ethnic origin?

Statistical analysis was performed using the Statistical Package for Social Scientist (SPSS) program version 23.0. A summary of all the sub-questions, data collected and statistical analysis may be found in Table 4.20. Variables were created in SPSS to organize the data for the 83 participants. The individual variables named in SPSS were student number, gender, ethnic origin, RMARS, MAS, Math Lab, Center of Academic Excellence, TRIO, Instructor Office Hour, Classmates, Study Group, MyMathLab, PLATO, Textbook, Khan Academy, Other Online Resources, and final grade. The definitions of the resources may be found in Chapter 2. Table 4.1 summarizes the individual variables and definitions of the variables. Data were entered into SPSS for the 83 participants for each of the individual variables. The RSQ responses were analyzed for frequencies of each of the resources and each of the strategies.

These were later compared to the RMARS score and the MAS score to determine any relationship between strategies and mathematics anxiety. The final grades were compared to the frequencies of each resource and strategies listed to determine if there was a relationship between final grades and resources and strategies utilized. After individual variables were entered into SPSS for the 83 participants, the group variables were created. In order to put data into the group variables, the Compute Variable function in SPSS was utilized. This function in SPSS allows individual variables to be summed and grouped to form a new variable. Some of the individual variables were grouped and given a group name to create the each of the strategies. The strategies of Instructor and Textbooks consisted of only one variable, and therefore were measured by the individual variables. Table 4.1 summarizes the individual variables that represent individual resources.

Table 4.1: Individual Variables (*All self-reported)

Variable Name	Variable Measure
Student Number	Random number between 1 and 83 given by the researcher to uniquely identify each participant
Gender	Biological gender of participant
Ethnic Origin	Ethnic origin of the participant
RMARS	Level of mathematics anxiety
MAS	Level of attitudes towards mathematics
Math Lab	Number of times participant utilized the Math Lab resource during the 16 week semester
Center of Academic Excellence	Number of times participant utilized the Center of Academic Excellence resource during the 16 week semester
TRIO	Number of times participant utilized TRIO resource during the 16 week semester
Instructor Office Hour	Number of times participant utilized the instructor office hour resource during the 16 week semester
Classmates	Number of times participant utilized the classmate resource during the 16 week semester
Study Group	Number of times participant utilized the study group resource during the 16 week semester
MyMathLab	Number of times participant utilized the MyMathLab resource during the 16 week semester
PLATO	Number of times participant utilized the PLATO during the 16 week semester
Textbook	Number of times participant utilized the textbook during the 16 week semester
Khan Academy	Number of times participant utilized Khan Academy during the 16 week semester
Other Online Resources	Number of times participant utilized the other online resources during the 16 week semester
Final Grade	Final letter grade of A, B, C or No Credit (NC)

By grouping the individual resources, strategies could then be statistically analyzed. The group variables are summarized in Table 4.2. The group variables were named Tutoring Sum, Study Groups, Online Tutorials and Other Online Resources. The Tutoring Sum group variable contains the individual variables of the Math Lab, Center of Academic Excellence and TRIO. Together these three individual variables measure the Lab Tutorials strategy.

The Study Groups variable contains individual variables of Study Group and Classmate. Together these two individual variables measure the Study Groups strategy. The Online Tutorials group variable contains the individual variables of MyMathLab and PLATO. Together these individual variables measure the Online Tutorials strategy. The Online Resources group variable contains the individual variables of Khan Academy and Other Online Resources. Together these individual variables measure the Online Resources strategy.

Table 4.2: Group Variables

Group Variable Name	Variables within group	Strategy Measured
Tutoring Sum	Math Lab, Center of Academic Excellence and TRIO	Lab Tutorials
Study Groups	Study Group and Classmates	Study Groups
Online Tutorials	MyMathLab and Plato	Online Tutorials
Other Online Resources	Khan Academy and other online resources	Online Resources

Relationships

Anxiety and Strategies

The first research sub-question explored the possible relationship between the learners' mathematics anxiety score and the strategy/strategies utilized by the learners. The one-way multivariate analysis of variance (MANOVA) has ten assumptions that must be satisfied: (1) two or more dependent variables, (2) independent variable that has two or more independent groups, (3) independence of observations, (4) no univariate and multivariate outliers, (5) multivariate normality, (6) no multicollinearity, (7) a linear relationship between dependent and independent variables, (8) adequate sample size, (9) homogeneity of covariance matrices and (10) homogeneity of variances ("One-way MANOVA in SPSS Statistics | Laerd Statistics Premium," 2016).

All assumptions were met for the MANOVA. Anxiety and attitude scores were normally distributed for gender and ethnic origin groups, as assessed by Sharpio-Wilk's test (p>.05). There were no univariate outliers in the data as assessed by inspection of a boxplot. There was no multicollinearity, as assessed by Pearson correlation (r=.272, p=.013). There was a linear relationship between anxiety and attitude scores for each gender, as assessed by scatterplot. There was a linear relationship between RMARS and MAS scores for each ethnic origin group, as assessed by scatterplot. The sample size is adequate since there are more than two cases per group ("One-way MANOVA in SPSS Statistics | Laerd Statistics Premium," 2016).

A one-way MANOVA was run to determine the relationship between mathematics anxiety and ethnic groups. Two measures of performance were assessed: the RMARS and final grade. The developmental learners were grouped by self-reported use of strategies. The differences between the strategy groups on the combined dependent variables was not statistically significant, $F(2, 13) = 0$, $p = 1.0$; Roy's Largest Root = 0; partial $\eta^2 = 0$. Table 4.3 displays the overall relationship of anxiety and individual resources as revealed by the MANOVA.

Table 4.3: Overall Relationship of Anxiety and Resources

F-statistic	p-value	Roy's Largest Root	Partial η^2
F(2, 13)=0	1.0	0	0

Following the MANOVA, eleven tests of one-way analysis of variance (ANOVA) were conducted between the mathematics anxiety score and each study strategy to further investigate relationships between strategies and mathematics anxiety. The ANOVA has six assumptions that must be satisfied: (1) independence of observations, (2) one dependent, continuous variable, (3) one independent, categorical variable, (4) no significant outliers, (5) dependent variable approximately normally distributed, and (6) homogeneity of variance ("One-way ANOVA in SPSS Statistics | Laerd Statistics Premium," 2016). All assumptions were satisfied.

Each of the observations was independent since each survey and questionnaire was gathered once per participant. The dependent, continuous variable is the mathematics anxiety score and the independent, categorical variable is the resource. There were no significant outliers as assessed by boxplot.

The dependent variable was approximately normally distributed by Sharpio-Wilk's test (p>.05) and there was homogeneity of variances, as assessed by Levene's test of homogeneity of variances. Even though the overall relationship between the mathematics anxiety score and the Instructor Office Hour resource was not statistically significantly different $F(2,79)=2.455$, $p=.092$, there was statistical significance between specific groups.

Figure 4.1 displays the graph of the means of anxiety scores for each group. Table 4.4. Table 4.5 displays the statistically significant pair. Participants were grouped by their self-reported use of instructor office hours: "None" (n=67), "1 to 3 times" (n=13), "4 to 6 times" (n=2) and "more than 9 times" (n=1). The group of "more than 9 times" was excluded from the ANOVA since there was only one case. displays the results of the overall relationship between the resource of Instructor Office Hour and anxiety score.

Table 4.4: Overall Result of Instructor Office Hour and Anxiety Score

Result	Degree of Freedom	F-statistic	Significance	Partial η^2
Contrast	2	2.455	.092	.059
Error	79			

Through pairwise comparison testing, other statistical significance was revealed between different groups. The mathematics anxiety score was statistically significantly lower in the "None" group (M=62.7) compared to the "1 to 3 times" group (M=73.92, SD=13.9), with a mean decrease of 11.2, 95% CI [58.3, 67.1], p=.037.

Table 4.5: Significant Group Differences of Instructor Office Hour and Anxiety Score

Groups of Instructor Office Hours		Mean Differences	Significance	Lower Bound	Upper Bound
None	1 to 3 times	-11.237	0.037	-21.777	-.696

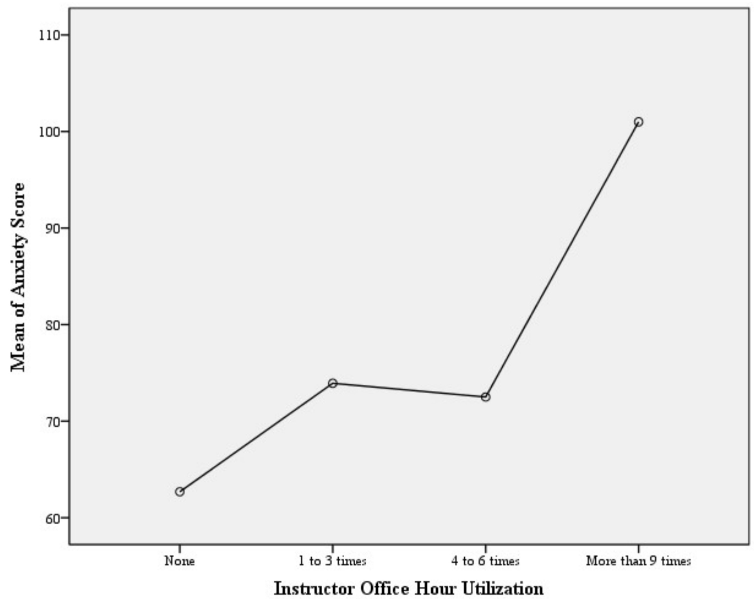


Figure 4.1: *Graph of Instructor Office Hour and Mean of Anxiety Score*

Attitudes and Strategies

The second research sub-question explored the relationship between the learner's attitude toward mathematics score and strategy/strategies utilized by the learner. A one-way MANOVA was run to determine the relationship between attitudes towards mathematics and strategy/strategies utilized. Table 4.6 reveals the overall relationship as revealed by the MANOVA.

All necessary assumptions were satisfied to conduct the MANOVA. Two measures of performance were assessed: the attitude scores and final grade. The developmental learners were grouped by self-reported use of strategies. The differences between the strategy groups on the combined dependent variables was not statistically significant, $F(2, 13) = 0$, $p = 1.0$; Roy's Largest Root = 0; partial $\eta^2 = 0$.

Table 4.6: Overall Relationship of Attitude and Resources

F-statistic	p-value	Roy's Largest Root	Partial η^2
F(2, 13)=0	1.0	0	0

Following the MANOVA, eleven one-way analysis of variance (ANOVA) were conducted between the attitudes towards mathematics score and each resource to further investigate relationships. Only two of the eleven ANOVAs returned a significant result. All assumptions were satisfied to conduct the ANOVA. The one-way ANOVA that resulted as statistically significant was the relationship between attitudes towards mathematics score and the Instructor Office Hour resource and the attitude score and the resource of Khan Academy.

Instructor Office Hour. For the test between the attitude score and the Instructor Office Hour resource, participants were grouped by their self-reported use of instructor office hours: "None" (n=67), "1 to 3 times" (n=13), "4 to 6 times" (n=2) and "more than 9 times" (n=1). The "more than 9 times" group was not included in the analysis due to a singular case. Table 4.7 displays the overall result of the relationship.

The overall relationship between mathematics attitude score and instructor office hours was statistically significantly different between the groups $F(2,79)=3.884$, $p=0.025$.

Table 4.7: Overall Result of Instructor Office Hour and Attitude Score

Result	Degree of Freedom	F-statistic	Significance	Partial η^2
Contrast	2	3.884	.025	.059
Error	79			

Through pairwise comparison testing, other statistical significance was revealed between specific groups. Table 4.8 displays the specific statistically significant groups. Figure 4.2 displays the graph of the means attitude scores per group. The attitudes towards mathematics score was statistically significantly higher in the "None" group (M=56.04) compared to the "4 to 6 times" group (M=22.0, SD=2.8), with a mean increase of 34.0, 95% CI [51.5, 60.6], p=.014.

Table 4.8: Significant Group Differences of Instructor Office Hour and Attitude Score

Groups of Instructor Office Hours		Mean Differences	Significance	Lower Bound	Upper Bound
None	4 to 6 times	34.045	0.014	-3.506	19.287

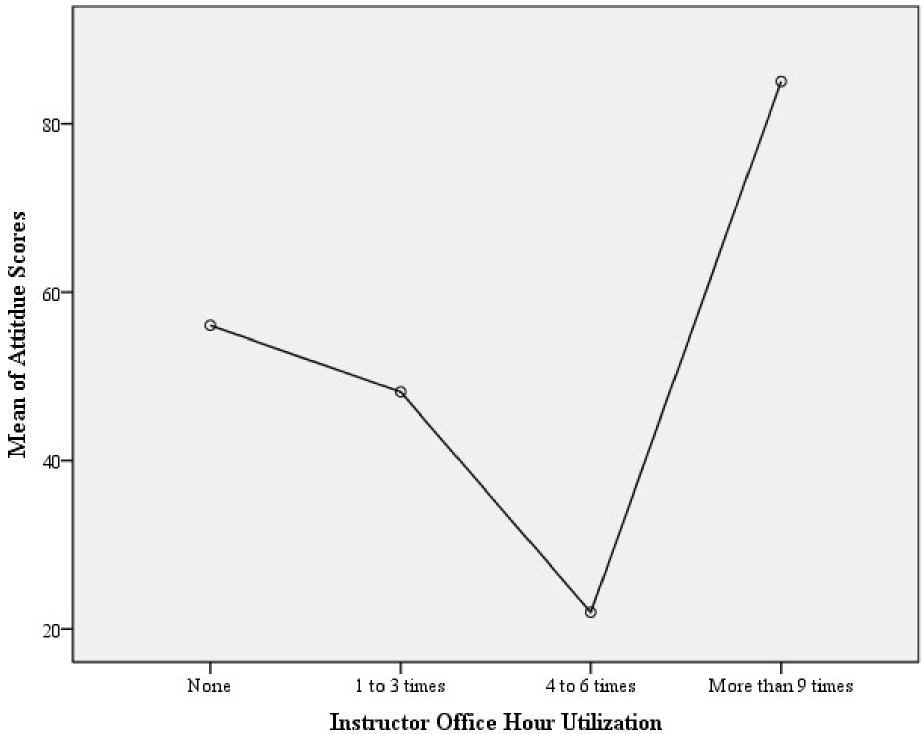


Figure 4.2: *Graph of Instructor Office Hour and Mean of MAS*

Khan Academy. For the test between the attitude score and the use of the Khan Academy strategy, participants were grouped by their self-reported use of instructor office hours: “None” (n=64), “1 to 3 times” (n=12), “4 to 6 times” (n=3), “7 to 9 times” (n=3), and “more than 9 times” (n=1). The “more than 9 times” group was excluded from the statistical analysis since it is a unique case. Table 4.9 displays the overall relationship between the resource and the attitude score. The overall relationship between the attitudes towards mathematics score and Khan Academy was statistically significantly different between the groups $F(3,78)=5.416$, $p=0.002$.

Table 4.9: Overall Result of Khan Academy and Attitude Score

Result	Degree of Freedom	F-statistic	Significance	Partial η^2
Contrast	3	5.416	0.002	.172
Error	78			

Through pairwise comparison testing, other statistical significance was revealed between specific groups. Table 4.10 displays the summary of the differences between the specific groups. The attitudes towards mathematics score was statistically significantly lower in the "None" group (*M*=54.1) compared to the "1 to 3 times" group (*M*=65.9, *SD*=5.3), with a mean decrease of 11.8, 95% CI [49.6, 58.6], *p*=.043. The attitudes towards mathematics score was statistically significantly higher in the "None" group (*M*=54.1) compared to the "4 to 6 times" group (*M*=27.0, *SD*=10.5), with a mean increase of 27.1, 95% CI [49.6, 58.6], *p*=.014. The attitudes towards mathematics score was statistically significantly higher in the "None" group (*M*=54.1) compared to the "7 to 9 times" group (*M*=31.7, *SD*=10.5), with a mean increase of 22.4, 95% CI [10.7, 52.6], *p*=.04.

The attitudes towards mathematics score was statistically significantly higher in the "1 to 3 times" group (*M*=65.9) compared to the "4 to 6 times" group (*M*=27.0, *SD*=10.5), with a mean increase of 38.9, 95% CI [49.6, 58.6], *p*=.001. The attitudes towards mathematics score was statistically significantly higher in the "1 to 3 times" group (*M*=65.9) compared to the "7 to 9 times" group (*M*=31.7, *SD*=10.7), with a mean increase of 34.3, 95% CI [6.1, 47.9], *p*=.005. Figure 4.3 displays the graph of the means of the attitudes per group compared to the utilization of Khan Academy.

Table 4.10: Significant Group Differences of Khan Academy and Attitude Score

Groups of Instructor Office Hours		Mean Differences	Significance	Lower Bound	Upper Bound
None	1 to 3 times	-11.807	.043	-23.212	-.403
None	4 to 6 times	27.109	.014	5.693	48.525
None	7 to 9 times	22.443	.040	1.027	43.859
1 to 3 times	4 to 6 times	38.917	.001	15.515	62.318
1 to 3 times	7 to 9 times	34.250	.005	10.848	57.652

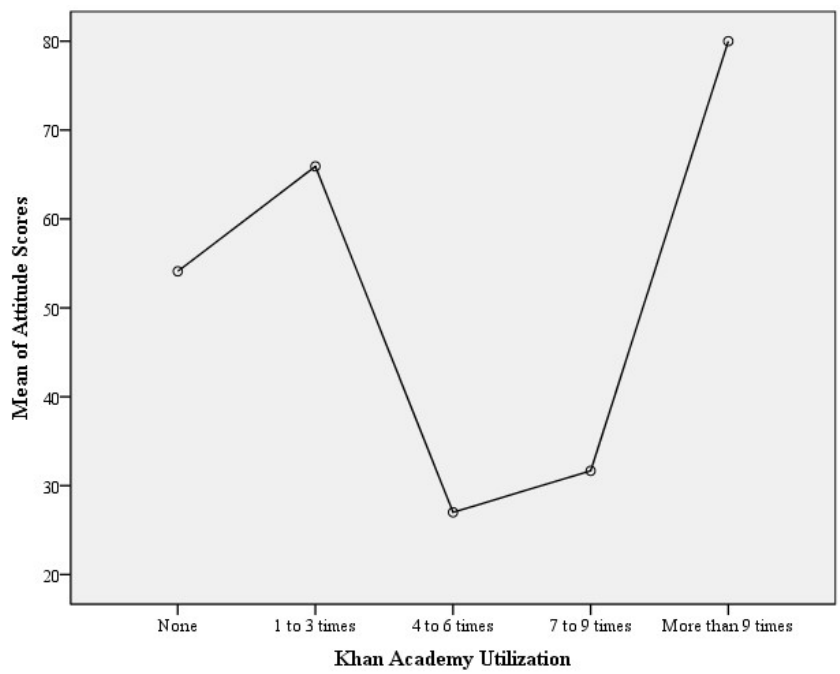


Figure 4.3: *Graph of Khan Academy Strategy Utilization and MAS*

Strategies and Completion

The third research sub-question explored the relationship between the resources and strategies utilized and successful completion of developmental mathematics. To explore these relationships, the Goodman and Kruskal's λ test was utilized. This test measures the association between two independent nominal variables. There are two assumptions that must be made (1) there must be one independent variable and one dependent variable and (2) there should be independence of observations ("Goodman and Kruskal's lambda in SPSS Statistics | Laerd Statistics Premium," 2016). The first assumption was satisfied by the study strategies being the independent variable and the final grade the dependent variable. The second assumption was satisfied since participants self-reported their individual uses of each strategy and not a combination of strategies.

Eleven Goodman and Kruskal's λ tests were conducted to determine relationships between the individual resources and the resulting final grade. Out of the eleven tests, only one was statistically significant. The Goodman and Kruskal's λ test which yielded in a significant result was the relationship between the resource of Khan Academy and the final grade. Table 4.11 displays the directional measures from the Goodman and Kruskal's λ. Figure 4.4 displays the graph of the utilization of the Khan Academy resource grouped by the final grade. Goodman and Kruskal's λ was run to determine whether the final grade could be better predicted by utilizing the resource of Khan Academy. Goodman and Kruskal's λ was .093. This was a statistically significant reduction in the proportion of errors due to the utilization of the study strategy of Khan Academy as a predictor of the final grade, p =.021.

Table 4.11: Directional Measures of Khan Academy Resource

Lambda	Value	Asymptotic Standard Error	Approximate T[b]	Approximate Significance
Final Grade Dependent	.093	.039	2.307	.021

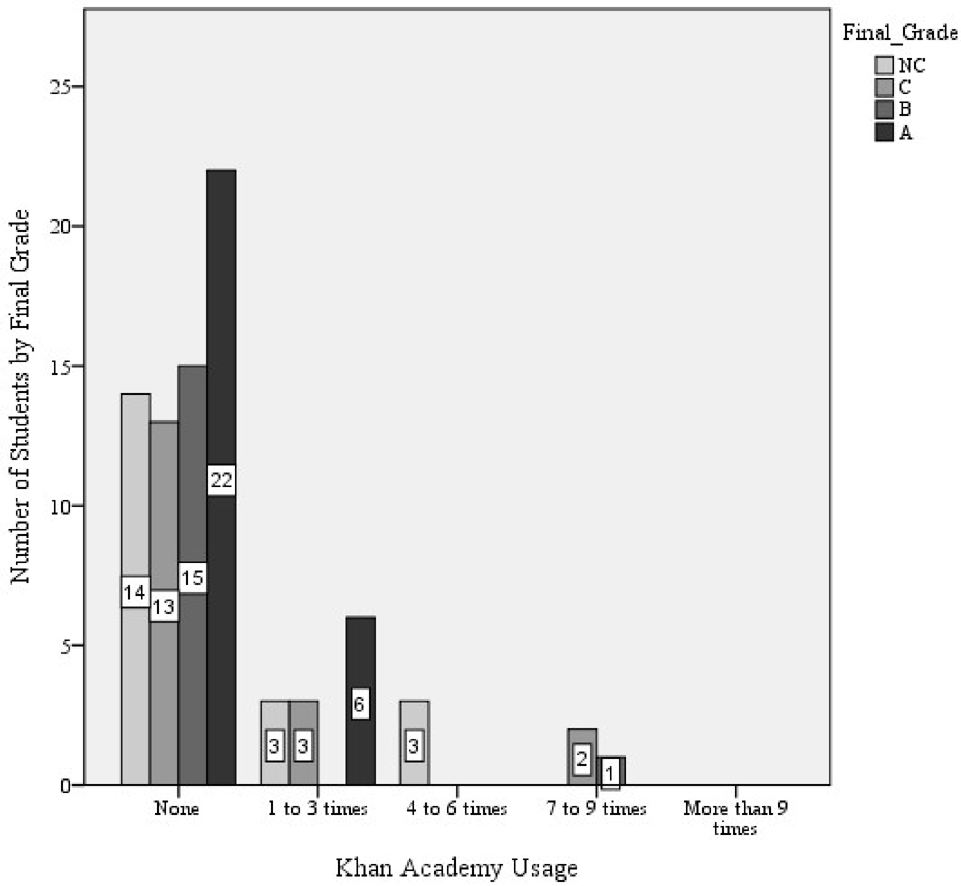


Figure 4.4: *Frequency of Khan Academy Utilization by Final Grade*

Anxiety and Biological Gender

The fourth research sub-question explored the relationship between learners' mathematics anxiety score and biological gender. All six assumptions were satisfied to conduct the ANOVA. Each observation was independent since each anxiety score was gathered once per participant.

The dependent continuous variable was the anxiety score and the independent variable was a categorical variable of biological gender. There were no significant outliers as assessed by boxplot. The dependent variable was approximately normally distributed by Sharpio Wilk's test ($p>.05$) and there was homogeneity of variances as assessed by Levene's test of homogeneity of variances.

A one-way ANOVA was conducted to determine if biological gender could be related to developmental learners' mathematics anxiety (RMARS score). Participants were classified by male ($n=26$) and female ($n=57$). Table 4.12 displays the overall relationship between gender and anxiety. Figure 4.5 displays the graph of the means of anxiety scores for males and females. The anxiety score was not statistically significantly different between males and females even though there is a large difference between the two means, $F(1, 81)=.556$, $p = .454$. There were no outliers and all data tested homogenous and normal.

Final grades, gender and anxiety scores were also tested in a univariate ANOVA, but no significant differences were found. Table 4.13 displays the results for the univariate ANOVA. Figure 4.6 displays the graph of the means of anxiety scores between males and females grouped by final grades.

Table 4.12: ANOVA Result of Biological Gender and Anxiety Score

Result	Degree of Freedom	F-statistic	Significance
Contrast	1	.556	.454
Error	81		

Table 4.13: Univariate Result of Final Grade, Biological Gender and Anxiety Score

Result	Degree of Freedom	F-statistic	Significance	Partial η^2
Contrast	3	.467	.706	.018
Error	75			

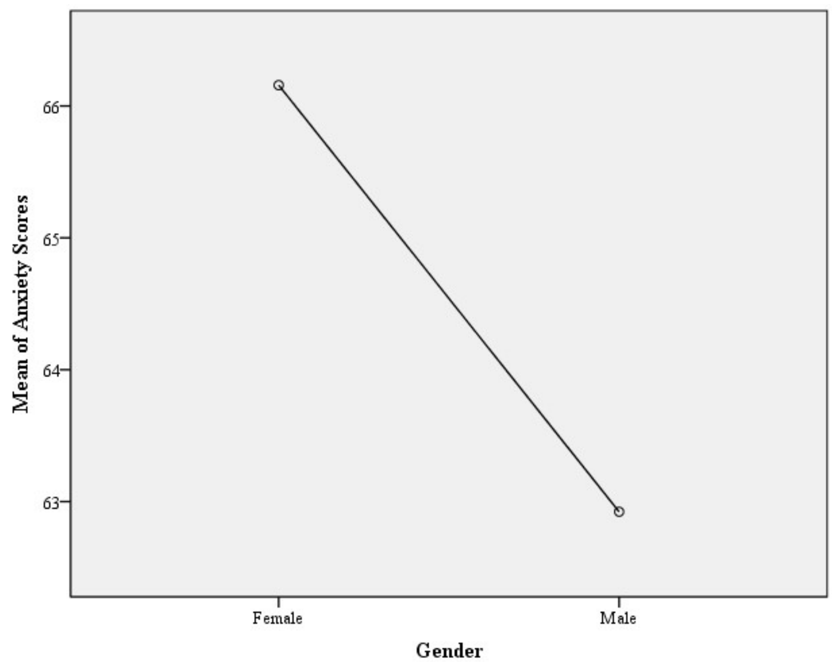


Figure 4.5: *Graph of Gender Means by RMARS Means*

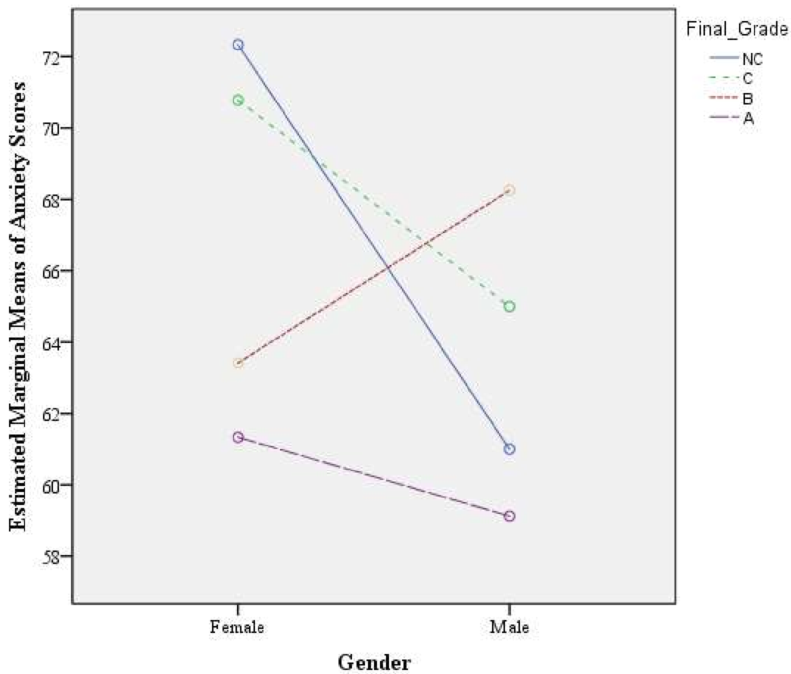


Figure 4.6: *Graph of Biological Gender Mean and RMARS by Final Grade*

Attitudes and Biological Gender

The fifth research sub-question explored the relationship between the learners' attitudes towards mathematics and biological gender. All six assumptions were satisfied to conduct the ANOVA. Each observation was independent since each attitude score was gathered once per participant. The dependent continuous variable was the attitude score and the independent variable was a categorical variable of biological gender. There were no significant outliers as assessed by boxplot. The dependent variable was approximately normally distributed by Sharpio Wilk's test ($p>.05$) and there was homogeneity of variances as assessed by Levene's test of homogeneity of variances.

A one-way ANOVA was conducted to determine if biological gender could be related to developmental learners' attitudes towards mathematics (MAS score). Table 4.14 displays the result of the attitude score and gender ANOVA. Participants were classified by male ($n=26$) and female ($n=57$). The MAS score was statistically significantly different between males and females, $F(1, 81)=4.179$, $p < .05$. The MAS score was lower in females ($M=51.40$, $SD=19.8$) than males ($M=60.77$, $SD=18.3$). Comparisons revealed that the mean decrease between male and females was statistically significant ($p=.044$).

Table 4.14: Result of Attitude Scores and Biological Gender

Result	Degree of Freedom	F-statistic	Significance
Contrast	1	4.179	.044
Error	81		

To further explore the relationship, a point-biserial correlation was run between gender and attitude score. Preliminary analyses showed that there were no outliers as assessed by boxplot; attitude score was normally distributed, as assessed by Sharpio-Wilk's test ($p>.05$); and there was homogeneity of variances as assessed by Levene's test for equality of variances ($p=.671$).

The point-biseral correlation revealed that there was a significant correlation between gender and attitude score, $r_{pb}(81)=.222$, $p=.044$. Males were showing a more positive attitude towards mathematics than females. Gender accounted for 4.9% of variability in attitude scores. Table 4.15 displays the results of the point-biseral correlation between biological gender and attitude scores.

Table 4.15: Correlation of Biological Gender and MAS

Result	Statistic	Gender	MAS
Gender	Pearson Correlation	1	.222*
	Sig. (2-tailed)		.044
	Sum of Squares and Cross-products	17.855	167.229
	Covariance	.218	2.039
	N	83	83
MAS	Pearson Correlation	.222*	1
	Sig. (2-tailed)	.044	
	Sum of Squares and Cross-products	167.229	31920.554
	Covariance	2.039	389.275
	N	83	83

*. Correlation is significant at the 0.05 level (2-tailed).

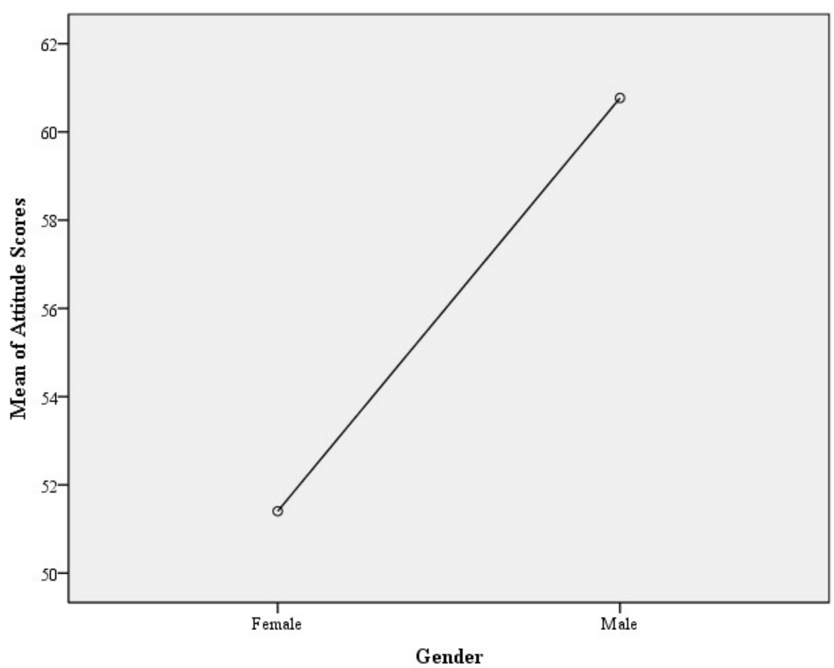


Figure 4.7: *Graph of Gender and Mean of MAS*

Final grades, gender and attitude scores were also tested in a univariate ANOVA, and significant results were found between the final grade and MAS. Table 4.16 displays the overall result between the attitude scores and final grade. The participants were grouped by the final grade earned in the class, “NC” (No Credit) (n=20), “C” (n=18), “B” (n=16) and “A” (n=29). The overall relationship between attitudes toward mathematics score and final grade was statistically significantly different between the groups $F(3,75)=7.231$, $p=0.0003$.

Table 4.16: Overall Result between Attitude Scores and Final Grades

Result	Degree of Freedom	F-statistic	Significance
Contrast	3	7.231	.0003
Error	75		

Through pairwise comparison testing, other statistical significance was revealed between specific groups. Table 4.17 displays the statistically significant groups. The attitudes towards mathematics score was statistically significantly lower in the “NC” group (M=42.7) compared to the “A” group (M=66.0, SD=18.3), with a mean decrease of 25.0, 95% CI [13.5, 36.6], p=.00005. The attitudes towards mathematics score was statistically significantly higher in the “A” group (M=66.0) compared to the “C” group (M=53.7, SD=18.4), with a mean increase of 15.2, 95% CI [4.3, 26.1], p=.007. The attitudes towards mathematics score was statistically significantly higher in the “A” group (M=66.0) compared to the “B” group (M=48.6, SD=17.5), with a mean increase of 19.2, 95% C I [6.8, 31.5], p=.003. Figure 4.8 displays the graph of the mean attitude scores of males and females grouped by final grade.

Table 4.17: Significant Group Differences in Final Grades and Attitude Score

Groups of Final Grades		Mean Differences	Significance	Lower Bound	Upper Bound
NC	A	-25.030	.000	-36.569	-13.491
C	A	-15.196	.007	-26.136	-4.257
B	A	-19.155	.003	-31.538	-6.771

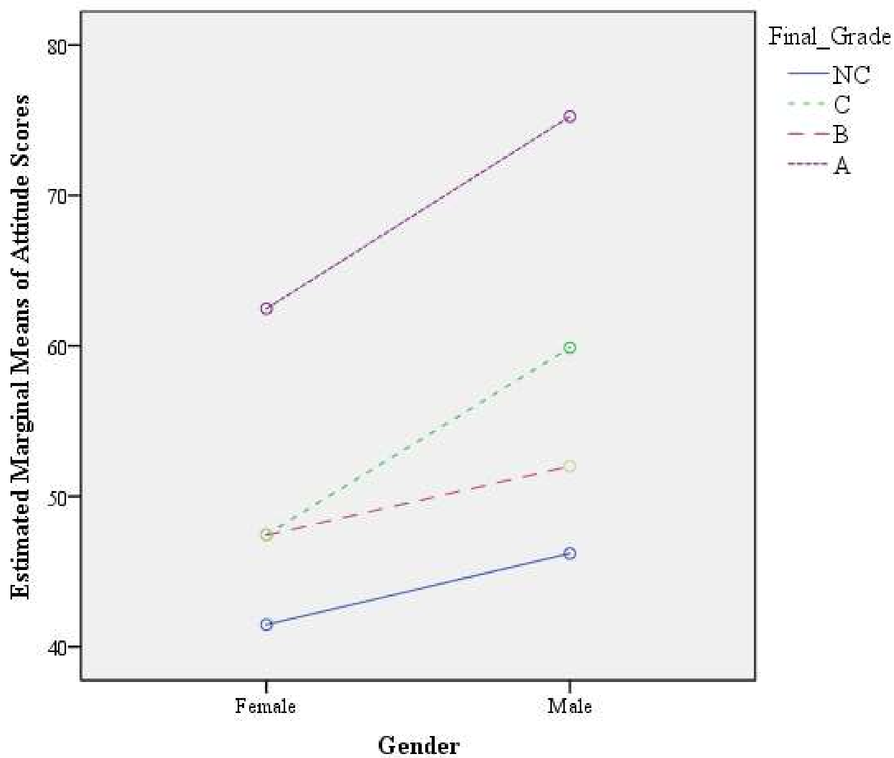


Figure 4.8: *Graph of Biological Gender and Mean of MAS by Final Grade*

Anxiety and Ethnic Origin

The sixth research sub-question explored the relationship between the learners' mathematics anxiety and ethnic origin. A one-way MANOVA was run to determine the relationship between anxiety scores and ethnic groups. Two measures of performance were assessed: the anxiety score and final grade. The developmental learners were grouped by biological gender (male and female) and ethnic origin (White, Hispanic, African American and Other).

All assumptions were met for the MANOVA. Anxiety scores were normally distributed for biological gender and ethnic origin groups, as assessed by Sharpio-Wilk's test (p>.05). There were no univariate outliers in the data as assessed by inspection of a boxplot. There was no multicollinearity, as assessed by Pearson correlation. The sample size is adequate since there are more than two cases per group. Table 4.18 displays the results of the MANOVA.

African American females had the highest mean anxiety score (M=81, SD=12.06) and the lowest mean final grade (M=2.13, SD=1.13). Hispanic males had the highest mean anxiety score (M=65.90, SD=19.47) and African American males had the lowest mean final grade (M=2.14, SD=1.35). The differences between biological gender and ethnic groups on the combined dependent variables was not statistically significant, $F(6, 148) = .680$, $p = .666$; Wilks' $\Lambda = .947$; partial $\eta^2 = .027$. Following the MANOVA, a univariate ANOVA was conducted between the attitudes towards mathematics score and each of the ethnic origin groups to further investigate relationships. None were found to be statistically significant.

Table 4.18: Relationship between Anxiety Scores and Ethnic Groups

F-statistic	p-value	Wilks' Λ	Partial η^2
F(6, 148)=.680	.666	.947	.027

Attitude and Ethnic Origin

The seventh research sub-question explored the learners' attitudes towards mathematics and ethnic origin. All assumptions were satisfied to conduct the MANOVA. Attitude scores were normally distributed for biological gender and ethnic origin groups, as assessed by Sharpio-Wilk's test (p>.05). There were no univariate outliers in the data as assessed by inspection of a boxplot. There was no multicollinearity, as assessed by Pearson correlation. The sample size is adequate since there are more than two cases per group. Table 4.19 displays the results of the MANOVA.

A one-way MANOVA was run to determine the relationship between attitudes towards mathematics and ethnic groups. Two measures of performance were assessed: the attitude scores and final grade. The developmental learners were grouped by biological gender (male and female) and ethnic origin (White, Hispanic, African American and Other). White females had the lowest mean attitude score (M=46.93, SD=17.96) and African American females had the lowest mean final grade (M=2.13, SD=1.13). The male learners who identified themselves as "Other" had the lowest mean attitude score (M=52, SD=7.07) and African American males had the lowest mean final grade (M=2.14, SD=1.35). The differences between gender and ethnic groups on the combined dependent variables was not statistically significant, $F(6, 148) = .343$, $p = .666$; Wilks' $\Lambda = .913$; partial $\eta^2 = .014$.

Table 4.19: Relationship between Attitude Scores and Ethnic Groups

F-statistic	p-value	Wilks' Λ	Partial η^2
F(6, 148)=.343	.666	.913	.014

Following the MANOVA, a univariate ANOVA was conducted between the attitudes towards mathematics score and each of the ethnic origin groups to further investigate relationships. All assumptions were satisfied to conduct the ANOVA. None of the results were found to be statistically significant. Table 4.20 summarizes all of the sub-questions, data collected and statistical analysis that occurred for this study.

Summary of Results

In summary, a MANOVA was conducted for the first, second, sixth and seventh research sub-questions, a ANOVA was conducted for the fourth and fifth research sub-questions and a Goodman and Kruskal's λ test for the third research sub-question. Since MANOVAs yielded not statistically significant results, ANOVAs were conducted to further explore relationships between the variables. The ANOVAs revealed significance between RMARS and instructor office hours, MAS and instructor office hours, MAS and Khan Academy, and MAS and final grades. These relationships were then followed by pairwise comparisons to show significance between groups. Table 4.21 summarizes the results by sub-questions and significant results.

Table 4.20: Sub-questions, Data Collection and Statistical Analysis

Sub-question	Data Collection	Statistical Analysis
1. Relationship between mathematics anxiety and resources and strategies utilized	RMARS and Strategy Questionnaire	MANOVA
2. Relationship between attitudes towards mathematics and resources and strategies utilized	MAS and Strategy Questionnaire	MANOVA
3. Relationship between resources and strategies utilized and completion	Strategy Questionnaire and Final Grades	Frequency comparison
4. Relationship between mathematics anxiety and biological gender	RMARS and Biological Gender	ANOVA
5. Relationship between attitudes towards mathematics and biological gender	MAS and Biological Gender	ANOVA
6. Relationship between mathematics anxiety and ethnic origin	RMARS and Ethnic Origins	MANOVA
7. Relationship between attitudes towards mathematics and ethnic origin	MAS and Ethnic Origins	MANOVA

The ANOVAs for the fourth research sub-question did not have statistically significant results. On the other hand, the ANOVA for the fifth research sub-question did produce a statistically significant result between MAS and gender and a point-biseral correlation was conducted to further establish significance. The result of the point-biseral correlation revealed a small, but statistically significant correlation between gender and attitudes towards mathematics. Another statistically significant result occurred between MAS and final grade.

This relationship was followed by pairwise comparisons to show significance between groups. Goodman and Kruskal's λ test for the third research sub-question returned only one significant result between the Khan Academy variable and the final grade variable. The result of the Goodman and Kruskal's λ test for the strategy of Khan Academy and the dependent final grade revealed a small, but statistically significant prediction factor. Table 4.21 summaries the results and the statistically significant findings.

In summary, there are relationships and correlations that reveal that mathematics anxiety and attitudes towards mathematics are possible contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study. Mathematics anxiety scores were lower in adult learners who did not go to instructor office hours. Mathematics attitude scores were more positive in adult learners who did not go to office hours. The use of the Khan Academy resource was related to a more positive attitude towards mathematics. The use of the Khan Academy resource was associated with completing the developmental course with a final grade of C or better. Mathematics attitudes were more negative in females compared to males. Mathematics attitudes were more positive in students who completed the course with a final grade of an A than other letter grades.

In the next chapter, the interpretation of the results and its implications on teaching and learning mathematics will be discussed. Each of the significant results was interpreted and how they may potentially impact teaching and learning mathematics to and for adult developmental learners.

Table 4.21: Summary of Results

Sub-Question	Significant Results
1. Mathematics anxiety and resources and strategies utilized	RMARS and instructor office hours, group differences found
2. Attitudes towards mathematics and resources and strategies utilized	MAS and instructor office hours, and MAS and Khan Academy; group differences found
3. Resources and strategies utilized and completion	Khan Academy and the final grade, small prediction factor found
4. Mathematics anxiety and biological gender	No significance found
5. Attitudes towards mathematics and biological gender	Significance found between MAS and gender and MAS and final grade, point-biseral correlation follow up revealed small correlation for MAS and gender, pairwise comparison follow up for MAS and final grade
6. Mathematics anxiety and ethnic origin	No significance found
7. Attitudes towards mathematics and ethnic origin	No significance found

CHAPTER FIVE

Discussion

In this chapter, the interpretations and implications for education are discussed as well as the call for future research. Recall, the purpose of this exploratory, correlational study was to examine the relationship between successfully completing adult developmental learners' attitudes toward mathematics and their levels of mathematics anxiety in relation to their use of available resources and use of study strategies. In this study, 83 adult developmental learners participated in the gathering of data about their levels of mathematics anxiety, attitudes towards mathematics, resources and strategies that they used throughout the 16 week semester and final grades received. Table 3.1 displays the overall participant demographics.

Data for mathematics anxiety was measured by the shortened and revised Mathematics Anxiety Rating Scale (RMARS) (Alexander & Martray, 1989), attitudes towards mathematics was measured by the Mathematics Attitudes Scale (MAS) (Aiken, 1963), and strategies were measured by the Resource and Strategy Questionnaire. Data were entered and analyzed by IBM SPSS version 23.0 with direction from the seven research sub-questions. Table 4.20 summarizes the sub-questions, data collected and statistical analysis of this study.

It was hypothesized that when adult developmental learners utilize various resources and strategies to cope with their mathematics anxiety and poor attitudes towards mathematics, their mathematics anxiety levels would be lower, their attitudes toward mathematics would be more positive and they would be more likely to successfully complete a developmental mathematics course with a letter grade of A, B or C.

Based on the results on this study, part of the hypothesis was supported since adult developmental learners who utilized various resources and strategies had more positive attitudes towards mathematics and they were more likely to successfully complete a developmental mathematics course with a letter grade of A, B, or C. On the other hand, part of the hypothesis was not supported since the adult learner's level of mathematics anxiety was not statistically significantly related to success in a developmental mathematics course.

After data were analyzed, there were six statistically significant results, (1) mathematics anxiety score and the use of instructor office hours, (2) mathematics attitude score and the use of instructor office hours, (3) mathematics attitude score and the use of Khan Academy, (4) the use of Khan Academy and final grade, (5) mathematics attitude score and gender, and (6) mathematics attitude score and final grade. Table 4.21 summarizes the statistically significant results.

As reported in chapter 4, this study found that there are relationships and correlations that reveal that mathematics anxiety and attitudes towards mathematics are possible contributing factors of adult learners not completing the developmental mathematics requirement(s) in their programs of study.

Mathematics anxiety scores were lower in adult learners who did not go to office hours. Mathematics attitude scores were more positive in adult learners who did not go to office hours. The use of the Khan Academy resource was related to a more positive attitude towards mathematics. The use of the Khan Academy resource was associated with completing the developmental course with a final grade of C or better. Mathematics attitudes were more negative in females compared to males. Mathematics attitudes were more positive in students who completed the course with a final grade of an A than other letter grades.

Result One: Mathematics Anxiety and the Use of Instructor Office Hours

Interpretation

The pairwise comparisons revealed that adult learners who did not visit their instructor's office hour had lower mathematics anxiety scores than those adult learners who did visit their instructor's office hour. This may have occurred since less anxious adult learners may have not felt the need to communicate with the instructor during special office hours and were able to ask questions during class time or may not have had any questions. Table 4.5 displays the significant group result for instructor office hour and anxiety. The relationship revealed between the utilization of the strategy of instructor office hour and developmental learner's mathematics anxiety is still ambiguous. Even though learners who utilized the office hour 1 to 3 times during the semester had higher anxiety scores than those learners who did not use the office hour, this resource may still be helpful. The result in this study may have occurred due to a lack of communication between the learner and the instructor.

The lack of communication could occur on the side of the instructor, the learner or a combination. Some learners may have felt that they could not talk to the instructor due to anxiety or lack of fit in the learners' schedules. Other learners may feel that written communication is more comfortable. Maloney & Beilock (2012) discussed that written communication can help to alleviate mathematics anxiety.

Communication, oral or written, is highly suggested by the Mathematical Association of America' Report, *Common Vision*. Educators are to help develop mathematical ideas in writing and orally within the first two years. Once learners complete degrees or certificates, they will be communicating with employers, collaborators, clients and others about their complex ideas (Saxe & Braddy, 2015). The study of communication between instructors and developmental learner's mathematics anxiety has been sparse and more research is needed.

Result Two: Mathematics Attitudes and the Use of Instructor Office Hours

Interpretation

Through the pairwise comparisons, adult learners who did not visit their instructor's office hour had a more positive attitude towards mathematics than those adult learners who did visit their instructor's office hour. Even though learners who utilized the office hour 4 to 6 times during the semester had a more negative attitude towards mathematics than those learners who did not use the office hour, this resource may still be helpful. The relationship revealed between the utilization of the strategy of instructor office hour and developmental learner's attitude towards mathematics is still ambiguous.

The result in this study may have occurred since adult learners with more positive attitudes towards mathematics were able to communicate with the instructor and ask questions during class time instead of going to office hours. Learners who may have not been able to communicate their concerns with their instructor may not have felt comfortable expressing concerns. The lack of communication could occur on the side of the instructor, the student or a combination. These findings did not agree with conclusions from existing literature.

In the study conducted by Benken, Ramirez, Li and Wetendorf (2014), developmental learners who communicated with their instructors were more likely to complete coursework and have a more positive attitude towards mathematics. Developmental learner's conversations with the instructor were documented throughout the semester and became more positive towards mathematics as the semester continued. In the current study, instructors and developmental learner conversations were not recorded which may have influenced the differences in results.

Result Three: Mathematics Attitudes and the Use of Khan Academy

Interpretation

Through the pairwise comparisons, developmental learners who utilized the resource of Khan Academy "1 to 3 times" a semester had a more positive attitude towards mathematics than those developmental learners who utilized Khan Academy "4 to 6 times" or "7 to 9 times" during the semester.

Even though learners who utilized the website multiple times during the semester had a more negative attitude towards mathematics than those learners who utilized the website less frequently, this resource may still be helpful. A study conducted by Muir (2014), found that online resources like Khan Academy, are helpful due to accessibility, but they do not replace the instructor. It was also reported that students were "engaging superficially rather than fully" (Muir, 2014, p. 849).

The relationship revealed between the utilization of the strategy of Khan Academy and developmental learner's attitude towards mathematics is still vague and thus caution must be taken in interpretation and application of this study's findings. The Khan Academy strategy is not well documented in current literature, but the use of video tutorials has been positively related to more positive attitudes towards mathematics. A study by Taylor and Galligan (2002) revealed that participants benefited from watching videos about adult learners solving mathematics problems and their journey to the final answer. The videos helped learners to gain confidence in their mathematical skills, alleviate mathematics anxiety and create positive experiences with mathematics.

Result Four: The Use of Khan Academy and Final Grade

Interpretation

The differences between the groups are very interesting and did not follow a pattern that was expected: the more use, the better the attitude. Instead, adult learners who utilized the Khan Academy website "1 to 3 times", had a more positive attitude towards mathematics than those who utilized the website more frequently, which also mirrors result two.

The results in this study may have occurred since the Khan Academy website may have given developmental learners in this study, a possible sense of ownership in their learning. This result may be connected to result three. The adult learners may have felt empowered, which could have helped to motivate them to finish the course. The singular case of using the website "more than 9 times" needs to be followed with more research.

Even though learners who utilized the website multiple times during the semester had a more negative attitude towards mathematics than those learners who utilized the website less frequently, this resource may still be helpful. Again, Muir (2014) found that Khan Academy and other online resources are helpful when learners are not in the classroom. The Khan Academy website is accessible any day or time and its videos are geared toward procedural ideas. Since many videos are procedural, this could be a possible reason for popularity in developmental mathematics courses. Again, caution should be taken in concluding that the Khan Academy website is a 'magic solution' to this problem. Ani (2013) states, "Khan has done something remarkable in creating such a vast library, and he deserves to be recognized…The real problem with Khan Academy is that we believe the promise of silver bullets—of simple solutions to complex problems—and in doing so become deaf to what really needs to be done" (p. 25).

Result Five: Mathematics Attitude and Biological Gender

Interpretation

Females had more negative attitudes towards mathematics than males. This result was followed by a small correlation between mathematics attitudes and biological gender.

The correlation factor showed that males had a more positive attitude towards mathematics than females. These findings agree with Cheryan (2011), who reviewed the last 30 years of gender gaps in mathematics and found that women were more likely to have poor attitudes towards mathematics. This may occur in young girls and continue into the college years.

A study conducted by Ramirez et al. (2013), found that negative attitudes towards mathematics in girls develops due to their teacher's negative attitude towards mathematics. Another study conducted by Llabre & Suarez (1985) agrees with the findings of this study. It was found that women were more affected by negative attitudes towards mathematics (Llabre & Suarez, 1985). Stereotypes about women in mathematics are present even though women are capable (Betz, 1978; Cheryan, 2011; Llabre & Suarez, 1985; Ramirez et al., 2013).

Result Six: Mathematics Attitude and Final Grade

Interpretation

Adult learners who earned an "A" in their course had a more positive attitude towards mathematics than any of the other final grade groups. This may have occurred since the learners with a more positive attitude towards mathematics were more confident in their understanding of mathematical concepts, which helped them to perform better in the course. Overall, in this study, attitudes were important and connected to successfully completing the developmental course.

These results agree with Akin (2012) and Núñez-Peña, Suárez-Pellicioni & Bono (2013) who both also found that positive attitudes towards mathematics are important in completing the course. Learners, whether male or female, need to have a more positive attitude towards mathematics, which may help them to succeed in the course.

Conclusion and Implications

In conclusion, through the results of the data analysis, adult developmental learners are facing challenges when attempting to complete their coursework. The adult learners' attitude towards mathematics played an important role for female adult learners. Females in this study revealed a negative attitude towards mathematics, which resulted in a negative relationship with final grades.

The adult learners' attitude was also related to completion. In this study, adult learners who earned an A had a more positive attitude than those who completed the coursework with a B or C. Study strategies were tested to determine if they were helpful to students, but only one strategy was statistically significant, the use of Khan Academy. Even though many adult learners did not use the Khan Academy website, those who utilized it, found the help that they needed to improve attitudes and complete coursework.

Anxiety, Attitudes, and Instructors

College mathematics instructors who teach adult developmental learners need to know how to communicate with all learners who have high mathematics anxiety and/or poor attitudes towards mathematics and make themselves accessible to these leaners.

College instructors play an important role in encouraging and helping developmental learners to prepare for college level credit (Chapin & Eastman, 1996; Dahlke, 2008; Piercey & Tobias, 2012). As mentioned in the literature review, instructors need to know the essential elements to create an effective developmental mathematics course. The essential elements are: access and equity, curriculum, tools and technology, assessment, and professionalism (NCTM, 2014).

When instructors utilize these elements to create an effective course, and make themselves accessible to learners with high anxiety and/or poor attitudes towards mathematics, they may be able to help the learner to ease their anxiety and/or increase the learner's positive attitude towards mathematics. By easing the learner's anxiety and/or increasing the positive attitudes towards mathematics, learners can better understand concepts, technology and tools available to them, complete developmental coursework and develop professionalism for their future careers.

In order to address the issues of mathematics anxiety, attitudes towards mathematics and instructor office hours, community college administrators could create training modules that show instructors how to communicate with learners who exhibit signs of high mathematics anxiety and/or poor attitudes towards mathematics. Also, policies and training about the creation of effective mathematics courses utilizing the NCTM essential elements should also be developed. With a policy in place, instructors will be able to know what is expected of them and how to create an effective course.

College instructors could also work with tutoring labs on campus, other instructors, and online resources to develop a strategy plan to recommend or create their own pathway of success for these learners. A strategy plan could include the instructor working one-on-one with the learner or connecting the learner to on-campus or online resources. The plan should be created by collaboration between the instructor and the learner to optimize time and resources.

Use of Khan Academy, Attitudes and Final Grade

As seen in this study, learners who utilized the Khan Academy website had higher attitude scores and were completing coursework with an A, B or C. Unfortunately, not much is known about Khan Academy and how it affects learners understanding of mathematical concepts or completion of coursework.

In order to address the issues of increasing attitudes and completion rates, college mathematics instructors could create their own video tutorials for classes or videos of former adult learners who have successfully completed the course. Adult learners could benefit from these videos since they are available at any time of the day and can be watched numerous times. They could benefit from seeing success stories in mathematics just like the participants in the study conducted by Taylor and Galligan (2002). They could also benefit from seeing concepts illustrated multiple times just like the video tutorials allow on the Khan Academy website. As Muir (2014) reiterates, online resources are accessible, but not meant to replace the instructor.

Attitudes, Gender and Final Grade

As seen in this study, females were more likely to have a negative attitude towards mathematics and those with negative attitudes were less likely to finish the developmental course. Negative gender stereotypes are, unfortunately, still present in adult developmental learners even though everyone is capable of learning mathematics.

In order to address the issues of attitudes, gender and completion, college mathematics instructors need to encourage their female learners and boost confidence in all developmental learners. This could be achieved by instructors and learners creating a strategy plan, instructors providing activities that have immediate feedback or instructors designing an effective course.

Limitations

In this study, there were several limitations that may have affected the results. The participants completed the questionnaire, MAS and RMARS surveys during week 15 of the semester. Even though this helped to create a healthy sample, it may have not allowed enough time to think about each question in more detail. Collecting more than one sample throughout the semester could also create a better understanding of why certain resources and/or strategies were utilized by the participants.

Also, many of the participants were female. Inspection of the data revealed that the differences in number between the males and females were not statistically significant. The final limitation was the questionnaire groupings for each strategy. It would have been helpful to know the exact number of times a strategy or resource was utilized as it could have clarified the differences between each strategy/resource.

Call for Future Research

Mathematics anxiety can be present in any learner at any age. Specifically in adult learners, it has been noted an "extremely common phenomenon" (Perry, 2004). Poor attitudes towards mathematics can also be common in adult learners and many times it begins when the learner is a child (Maloney & Beilock, 2012). Even though mathematics anxiety or negative attitudes towards mathematics have not been found to relate to intelligence, it can affect mathematics achievement (Dreger & Aiken, 1957; Maloney & Beilock, 2012; Perry, 2004).

Most notably for adult learners, mathematics anxiety can affect decisions of choosing a major in college, types of technical training and ultimately, career choices. Mathematics anxiety and poor attitudes towards mathematics should not be ignored by educators of adult learners; it does not simply disappear on its own. This is a problem that will not be easily solved and much more research is needed.

While this study contributes to the understanding of the relationship between successful adult learners, attitudes towards mathematics and mathematics anxiety, many questions still remain. What resources or strategies could be utilized to help adult learners who are experiencing mathematics anxiety and/ or negative attitudes towards mathematics? What are other contributing factors for adult learners? Is age a contributing factor for adult learners? What types of interventions are available to help ease mathematics anxiety and/or increase positive attitudes towards mathematics? How does the instructor's attitude towards mathematics affect the adult learner's attitude towards mathematics?

Of particular interest to the researcher, as a result of this study, what or how might a resource such as Khan Academy contribute to the success of adult learners in mathematics? The Khan Academy resource and other related online resources should be further examined to determine if it does help learners to increase their attitudes towards mathematics. The answers to these questions could help instructors understand how to help adult learners who exhibit high mathematics anxiety and/or poor attitudes toward mathematics to complete developmental mathematics requirements and continue their degree programs.

Gaining a clearer understanding of how mathematics anxiety and attitudes towards mathematics affect adult developmental learners could help colleges to increase completion rates. Learners could also benefit by understanding why a positive attitude towards mathematics is important and how alleviating mathematics anxiety could impact their understanding of mathematics. More studies need to be conducted on the relationship between mathematics anxiety, attitudes towards mathematics and successful completion of adult developmental learners.

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