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Mathematics anxiety and the college student

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MATHEMATICS ANXIETY AND THE COLLEGE STUDENT

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ABSTRACT

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This study was designed to investigate whether mathematics anxiety is correlated to choice of major in college, the need to be enrolled in a remedial math course and average mathematics grades. Types of mathematical problems, statements and situations were also viewed to determine which of the latter caused the greatest anxiety among volunteers. Volunteers were given an experimenter designed mathematics anxiety survey in which they rated problems, statements and situations pertaining to math on a five-point likert scale. Upon performance of correlations, results proved non-significant for all conditions. Thus, mathematics anxiety in this particular sample was not correlated to choice of major in college, the need to be enrolled in a remedial math course or average mathematics grades.

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Need

Math anxiety is experienced by many students, as well as teachers and professionals in the United States. Whether a pupil is in elementary school, middle school, high school, or college, math anxiety affects students at alarming rates. Math anxiety is a vicious cycle that can affect a student's public performance in math, choice of math classes and choice of career. Although, few studies have researched the direct effects of math anxiety in college students and how it effects their performance in college level courses, their scores on standardized testing, and the need to enroll in remedial courses to "brush up" on their math and test taking skills. It is interesting to see that even one who excelled at the high school level, and who is enrolled in graduate courses and receiving straight A's is effected by an anxiety in mathematics. This anxiety thus sets up stage for a low efficacy in mathematics, thus further affecting one's performance and anxiety within the subject. Math anxiety may also prove to be more overwhelming for some ever since the passing of the No Child Left Behind Act of January 2002, the requirement of most colleges and universities for a student to have taken and gained acceptable scores on the Scholastic Achievement Test (SAT) or the Graduate Record Examination (GRE), and lastly, dependent on the scores from the latter, the requirement to take math entrance tests to determine one's placement in freshman college level courses.

Purpose

The present researcher has found it necessary to understand what percentage of college students, both under graduate and graduate, are affected by math anxiety, and which types of mathematical problems induced the most anxiety in the college population. The researcher has also found it necessary to find if each subject surveyed was or is enrolled in a remedial mathematics course, and if any gender differences were significant in the rates of each subjects math anxiety. In looking at students at the college level, the researcher will be able to examine if math anxiety affects students who have successfully graduated high school and in some cases, undergraduate requirements. Through these findings, the researcher also finds it necessary to include strategies in improving one's math anxiety thus making one more comfortable when confronted with the pressure of every day, or timed and tested mathematics.

Hypothesis

This study will examine if an above average number of college students are affected by math anxiety regardless of previous academic achievement and if there is a disparity between math anxiety and gender and the need to be enrolled in remedial math courses. To research this hypothesis, the researcher constructed surveys which were distributed to under graduate and graduate level college students in the Southern New Jersey area. Each survey included math problems which were rated on one's initial anxiety upon viewing the problem; the problems were not solved. Statements and situations pertaining to math were also included in the survey. Five-point likert scales were used to measure volunteer's anxiety. It has also been hypothesized that students

will rate more complex problems, such as those involving algebra or geometry, more anxiety provoking.

History

Mathematics anxiety, as it has become more popular in recent years, has been a subject of interest to scholars, researchers, teachers and students alike. Not only can mathematics anxiety contribute to a person's self concept of what one is capable of performing like in math, it is also responsible for one's choice of high school or college electives, college major and career choice as well. One's math anxiety is highly correlated to one's own self perceptions of performance in the subject, one's role models, one's professors or teachers (supportive, highly qualified or just the opposite) in the subject, and one's aspirations for their future career. Some like to refer to math anxiety as a "learned anxiety" (Ashcraft and Krause, 2007) that develops over years of schooling and difficulties in math and science. Other researchers have also found it to be true that one's working memory, or capacity to perform many tasks at once, can also be responsible for one's performance within the subject; this finding contributes to higher level mathematics where carrying and borrowing are essential factors in solving the problem at hand. Working memory also contributes to one's preoccupancy with their performance in math, thus hindering their direct performance when confronted with mathematical tasks. Therefore it is especially important for teachers to avoid stressing themselves and their students about a standardized or chapter test since their minds may become preoccupied with the importance or need to do well.

Timed test taking, as with all standardized tests implemented to students in the United States (unless otherwise noted in an Individual Education Plan), have also been

found to affect one's math anxiety and thus one's performance on the timed test. In a study done by Tsui and Mazzocco (2007), it was found that students with a higher level of math anxiety performed better on an administered untimed test then when administered with a timed test. This study suggested that timed tests are not helpful in one's levels of math anxiety, raising the question are timed standardized tests and effective and equal way to measure one's abilities within a particular subject.

Math anxiety is also not a standalone issue. Those who have trouble with reading and comprehension could also prove to have trouble with certain mathematical problems, especially word problems or those requiring sophisticated vocabulary that one may not be familiar with. When performing mathematical operations, there are little, or no contextual clues to allow a person to further grasp the concept if they have had no prior, or little previous understanding in the area.

Anxiety, as pertaining to test taking and mathematics can also be seen in two ways. First, there is facilitative anxiety, which helps one complete, successfully, the task they are presented with. Second, there is debilitative anxiety which hinders one's performance on a given task (Tsui & Mazzocco, 2007).

Previous research has also found it apparent that a student's parents can also be responsible for their achievements in mathematics. If a parent is not supportive of a student's academic career in math or science, especially when they are having difficulties, this student is again more unlikely to pursue further courses in mathematics beyond the requirements, and most certainly less likely to take on a math or science college major and therefore pursue a career in the field.

Definitions

Math anxiety as used in the present study can be defined as "the feeling of tension and anxiety that interferes with manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Tsui and Mazzocco, 2007). Test anxiety, as used in the study is defined as the feeling of tension and anxiety that interferes with one's ability to perform calmly on any type of test. Dyscalculia is a "neurologically based disorder of mathematical abilities" (Wadlington and Wadlington, 2008). A mathematics "brush up" course is usually required in one's freshman year in college if one scores below a certain score on entrance mathematics testing. The courses cover anything from basic mathematics to geometry to algebra. The course credits do not count towards graduation, and once fulfilled, the student is able to register for general education mathematics courses. Working memory is defined as "a type of short term memory individuals use to retain a limited amount of information while working on a task" (Cavanagh, 2007).

Assumptions

The sample used in this study was taken from both graduate and undergraduate courses at Rowan University in Glassboro, New Jersey. By exploring a college population, who have gone through all of their schooling, it is assumed that a college population's math anxiety is representative of those who did not attend college as well as those who are still enrolled at the elementary, secondary and high school levels. By examining students at the college level, one may gain a better understanding on preventative measures dealing with math anxiety, clues on how to deal with one's math anxiety throughout life, and possibly creative ways to make mathematics classes as well

as tests easier to deal with for those who are affected by math anxiety. Although, it may be difficult to predict whether or not the results of the current study prove universal for students below the college level. Further examination should be done in elementary and high school students to further support the data found in the present study.

Limitations

One of the limitations of this study is an uneven number of males and females surveyed when comparing gender differences. The inability to accurately recall one's overall performance in high school or college mathematics courses may also prove as a limitation to the study. A small sample size is also a limitation of the current study.

There is no established reliability for the brief researcher developed self report mathematics survey that each student in the study has partaken in. Although, the variety of mathematical problems included have been taken from samples of various standardized tests such as the NJ ASK, SAT and GRE. The inclusion of problems from these tests will allow each student surveyed an opportunity to experience different types of mathematical problems for different age and education levels. Although, these problems in no way meet all of the mathematical requirements one experiences throughout school; therefore the math problems presented may not elicit math anxiety for some students.

Those students who are affected by dyscalculia, dyslexia, or any other type of anxiety disorder are also not recognized in this study. Although, one can also assume that a college population has either overcome their math anxiety or is not affected by math anxiety at all; this is why it is especially important to look at each student's major.

Summary

Through exploring the effects of math anxiety, one will be able to determine what percentage of college students surveyed are affected by such an anxiety, what types of mathematical problems pose more of a threat to one's perceived math anxiety, if one's overall math grades are correlated with math anxiety, and if the need to be enrolled in a remedial math course is correlated with math anxiety.

Chapter two will be a review of the literature supporting the need for this particular study. Chapter three will include the steps taken for data collection. Chapter four will provide an analysis of the data found. Chapter five will discuss the findings of the study and further discuss explanations for these findings.

Chapter II

Literature Review

Chapter two will focus on previous literatures that have studied the impacts of mathematics anxiety on individuals throughout elementary school to college. Through this examination, one will be able to get a general idea of how and where mathematics anxiety affects not only students but teachers as well. Gender, working memory, teaching techniques, Scholastic Aptitude Test scores, physiological stressors, learning strategies, choice of college major, test anxiety, math efficacy and math confidence are just a few of the topics examined to support the hypothesis of the researcher. At the end of the chapter, the most interesting findings from these literatures will be summarized in the closest relation to the current research on mathematics anxiety and college students.

Teaching Techniques

Teachers and schooling are an integral ingredient of the most important developmental periods in one's life. Looking at this, it is not surprising to conclude that a teacher's inadequacy in a particular subject will ultimately have an effect on a student's current performance, future performance and sense of adequacy in that particular subject. According to Kesici and Ahmet (2009), teachers can cause math anxiety by treating students unfairly because of gender or race, by embarrassing students in front of classmates by having them volunteer in class, by lacking the necessary communication needed for math, holding unrealistic expectations, or demonstrating anger or uncaring attitudes. This lack of empathy for students in mathematics classes causes them to hold

lower expectations for themselves in mathematics and to hesitate in taking mathematics classes as electives, majoring in a math related major in college, or pursuing careers that require computational skills. Teachers should also stress less about mathematics lessons and testing themselves; not only can math anxiety be caused by one's teacher, it can also be passed on through one's teacher; this is why Gresham (2007) exemplifies the importance of requiring those majoring in pedagogy to enroll in math preparatory courses. It is also of importance that teachers try to focus on increasing student's self confidence in math. Because of this research, a question pertaining to the environment in which math was taught in is included in the current math anxiety survey.

Teachers also need to be cognizant that mathematics cannot be taught in isolation. According to Schwartz (2000), mathematics not only requires an understanding of numbers, but of language as well. If one is unable to grasp the language of mathematics, such as that used in word problems, a vicious cycle of misunderstanding may occur. Not only does not understanding the language of math hinder further achievement in the subject, it also hinders one's explanations of problem solving and steps taken in the mathematical process (Schwartz, 2000). Given today's strong emphasis on exhibiting or explaining one's conclusions during test taking, understanding the language of mathematics is utterly important in developing the skills necessary to be successful in the subject. When looking at the concept of "street math," Grieiffhagen (2008), comments that mathematics taught in school can have "alienating effects" and is not related to everyday math encounters such as grocery shopping and measurement.

Alsup has taken the teaching techniques research a step further by examining pre-service elementary school teachers and their capacity to effectively and confidently teach

mathematics. The college students who took part in the study were all members of Math Concepts I or II courses, which focus on algorithms, basic problem solving, fractions, integers, percents, geometry and statistics (Alsup). Students were divided into three classes; two experimental groups which received special, student-centered instruction and one, the control group, which received nothing but lectures. Alsup hypothesized that students who took part in the experimental groups of the study would have an increase in their confidence to teach mathematics and a decrease in their mathematics anxiety. Through this experiment, Alsup concluded that "math anxiety decreased dramatically for all participants in the study, when they [were] viewed collectively." Through implementing interactive and collaborative teaching strategies, Alsup also found that "students became less anxious about math, more confident in their ability to teach it, and more empowered with regard to their own learning." Through these findings it is assumed that unique teaching strategies, especially when implemented at the college level, have an effect on reducing student's math anxiety. If these student centered techniques, in contrast of skilling and drilling techniques, are used at the elementary and secondary levels of education, math anxiety among college students could be significantly reduced. The current researcher views this as important in the current assessment of mathematics anxiety to possibly shed some light on the origination of the surveyed college student's math anxiety if any exist.

In contrast, Greiffenhagen and Sharrock (2008) comment on "street" or "everyday" mathematics in other countries, such as Africa or Brazil, where schooling is not as important as it is here in the United States. Through their review of literature, Greiffenhagen and Sharrock (2008) concluded that street vendors, tailors, carpenters, and

candy sellers were above adequate in their mathematical skills needed for their careers, regardless of level of schooling. Greiffenhagen and Sharrock (2008) go even further in citing Lave (1977) while spreading the messages that all math problems that we encounter in everyday life are not necessarily learned in formal schooling and that people think of unique ways of using math to solve these problems. For example, when measuring food, one may not directly use a one cup measuring cup, but instead, use an ordinary drinking glass or container that he or she knows, from outside experience, that this particular glass or container is equal to one cup. These "everyday" math encounters can happen at the grocery store when comparing products and prices as well as at home when managing one's bank account. From the data presented here, one begins to believe that more than required schooling in mathematics for one who does not care for mathematics is not a necessity to get by in life. Many people are clever enough to come up with their own ways of estimating and calculating that sometimes, formal operations are substituted by those one believes to be easier for him or her to understand and use.

Environmental Influences

As with the influences of teachers, environmental influences are just as important when examining the concept of math anxiety. Parents, friends, family, the media, and general perceptions of math are among the most influential. If parents are harsh in punishment for bad grades received in math; stress, anxiety and avoidance of the subject may only increase (Miller and Mitchell, 1994). Tocci and Engelhard state that "achievement in mathematics represents direct experiences with the attitude object, providing students with information that might affect their belief systems, feelings, and intended behaviors." By what one hears and sees in regards to math ultimately sets up

future experiences in the subject. If one is constantly faced with statements such as 'math is not important in the world' or 'you are not a math person,' these statements could eventually turn into one's beliefs about their own competency in math. Not only is what one hears about mathematics important, but the seemingly social acceptance of having less than great abilities in math also plays a vital part (Chinn, 2008). If society views a lack of mathematical skills as adequate or just enough to get by, one may be simply 'ok' with not doing so well in the subject; this belief could account for possible findings of mathematics anxiety at the college level.

To further examine these reactions, Tocci and Engelhard looked at the influence of parental support on math anxiety. In order to measure the effects, Tocci and Engelhard administered the Parental Support for Mathematics scale and found that parental support had a significant effect on all attitudes measured. The researchers also found that the higher the parental support, the higher the scores were for attitudes toward mathematics.

High Stress Situations

As if mathematics is not stressful enough for some, add in timed test taking and only one correct answer and those who were already stressed by the math situation are now highly stressed. In relation to this statement, Beilock (2008) decided to create stress laden situations in his laboratory to investigate just why and how performance crumbles in stressful situations. Not only did Beilock (2008) focus on math anxious individuals in his study, those who were not categorized as math anxious were also looked at. After dividing participants into low pressure groups (those told to try their best) and high pressure groups (those that were offered money based on their achievement that were

also told they were being videotaped), Beilock (2008) found that the high pressure scenario "increased participants' reported feelings of pressure and reduced their math accuracy relative to individuals in the low pressure group."

By looking at these results, one can conclude that stressful situations undoubtedly have an impact on math performance. Again, given the great emphasis on test taking and student's being pressured to be 'proficient' in mathematics testing, one begins to look at the potential consequences that standardized testing may bring; as well as begin to wonder what impact mathematics has on those already anxious individuals, given that there is only one right answer at any given time. Questions regarding timed math tests and quickness of working out problems are thus included in the current math anxiety survey.

Physiological Stresses

In describing math anxiety, many researchers use the key terms "sweaty palms," "elevated heart rate," and "tension" just to name a few. Contrary to the beliefs of the physical signs of mathematics anxiety, Dew, Galassi & Galassi (1984) found that math anxiety and the physiological measures used in their study (heart rate, skin conductance level and spontaneous skin fluctuations) during problem solving were only minutely related to math anxiety. Although the measurement of physiological reactions will not be used in the current study, the researcher finds it necessary to make clear the fact that math anxiety can present itself in a number of ways, and does not necessarily have to be through physical symptoms. Given this unique finding by Dew, et al. (1984) one is able to question just how does math anxiety affect the body if it does not cause an increase in heart rate? Could it be that math anxiety is solely a fragment of one's imagination? Or,

could it be that math anxiety is a self-fulfilling prophecy among students in the United States and other countries as well? Could it be possible that the statistics found by Dew, et al. (1984) are due to interference in one's working memory while performing these mathematical operations?

Working Memory

Ashcraft and Krause (2007) based their research on working memory and its effects on math performance and math anxiety. Working memory is strongly needed to perform well in mathematics in order to perform multiple operations and to hold numbers and answers in memory while performing multiple operations, especially when numbers become increasingly larger. Because of this effect, Ashcraft and Krause (2007) make the statement that since "larger arithmetic problems occur less frequently, and [hence] are stored in memory at lower levels of strength" that give the current researcher insight as to the ratings of more complex problems. As stated in Beilock (2008) "if the ability of working memory to maintain task focus is disrupted, performance may suffer." Because of these conclusion drawn by Ashcraft and Krause (2007) and Beilock (2008) the current researcher can make the inference that the more complex problems included in the survey will be rated as more anxiety provoking than the less complex problems presented.

Therefore, if a math anxious person has a difficult time with working memory, math anxiety will be increased since the reliability on facts being held in working memory is compromised by one's preoccupation with their own math anxiety. This introduces a "dual task" situation in which one's processing of numbers and thoughts is effected by math anxiety. Ashcraft and Krause (2007) also discovered that those math anxious individuals often sacrifice accuracy for speed in order to get through the required

problems, or finish testing in the time allotted; this is especially evident when math problems become more challenging. In relation to the present study, this sacrificing of accuracy for speed could have detrimental effects on one's Scholastic Aptitude Test (SAT) scores therefore having a spiraling effect on college choice, college major, the requirement to take remedial math courses, and the choice of one's career path.

Perfectionism, Self-efficacy, and Confidence

Having the trait of being a perfectionist is either something to love or loathe. In the case of math anxiety, perfectionism may get in the way of accurately solving certain math problems. Because of one's tendency to be a perfectionist, math anxiety may be elevated in timed and untimed testing conditions where one may challenge their self to move faster or do better than previous testing situations. Tsui and Mazzocco (2007) indeed found that higher ratings of perfectionism were related to smaller discrepancies in math performance in both timed and untimed testing conditions. Significant correlations between math anxiety and perfectionism were also found between the Mathematical Anxiety Rating Scale and the Multidimensional Perfectionism Scale; as math anxiety increased, so did perfectionism. To this finding, Tsui and Mazzocco (2007) concluded that "three measures were positively correlated with math anxiety: concern over mistakes, doubts about actions, and parental criticism." In the study by Tsui and Mazzocco (2007), it is evident that math anxiety may be viewed in different ways when taking into account one's perfectionism. In this case, perfectionism contributed to math anxiety by having individuals over-think the given problems. In any situation where math is given, being a perfectionist may contribute to falling grades since one is over occupied with thinking about getting the right answer, quite similar to the findings on working memory.

Confidence in a subject, as one can guess, can either make or break a grade. This is why Mackenzie (2002) decided to have students rate their confidence levels on mathematical problems. When surveying college students in New England, Mackenzie (2002) found that 25% showed concern over their competency and confidence in mathematics. More surprisingly, when looking at students from the United States, over 40% of those surveyed showed avoidance of the subject. More reassuringly, only 1% of the population surveyed with the mathematical statements were not at all confident about "written calculations, measuring and using a hand calculator" (Mackenzie, 2002), while 6% of males and 7% of females were not confident at all in any skills surveyed. Confidence was substantially lower for fractions (51%), percentages (38%), converting units (79%) and perspective (57%) just to name a few. This leads the current researcher to assume that those questions posed in the present experimental surveys which refer to mental calculations, fractions, and geometry will be the most anxiety provoking since Mackenzie's (2002) study shows that confidence levels are low in these particular areas. Casey, Nuttall, and Pezaris (1997) also state that self confidence in mathematics can be attributed to lower achievement among genders, as will be discussed later in Chapter 2.

According to Kesici and Ahmet (2009), one's self-efficacy in mathematics can be determined through their motivational beliefs. When surveying students enrolled in entry level math courses for majors in chemistry, physics and computers Kesici and Ahmet (2009) discovered that self-efficacy can be a significant predictor in college student's math anxiety. In fact, 22% of the variance in math anxiety was related to self-efficacy for learning and performance. These findings are surprising since students enrolled in majors such as those mentioned above require an abundance of mathematical skills and

confidence in the subject; this fact will be analyzed in more depth later in Chapter 2 as choice of college major and math anxiety is reviewed. In turn, high motivational beliefs in the subject are needed to calm one's anxiety in regards to mathematics.

Learning Strategies

Learning strategies are unique to individuals and are said to play important roles when examining math anxiety. Most importantly in mathematics is the learning strategy of self regulation. This strategy can either increase success in mathematics or contribute to failure in mathematics. Those who are self regulated learners set goals and develop plans to realize their maximum potential when presented with a task. Examples of self regulation include motivation and cognition, self-determination, interest, self-worth and values. A study by Kesici and Ahmet (2009) looked at these self regulated learning strategies and found that cognitive strategies, such as rehearsal and elaboration, were of particular significance in college student's math anxiety. To be more specific, about "3% of the variance in math anxiety was explained by rehearsal cognitive learning strategy, while about 7% of its variance was explained by rehearsal and elaboration cognitive learning strategies" (Kesici and Ahmet, 2009). Therefore, if one is able to cognitively regulate the mathematics task at hand, their math anxiety can be significantly reduced.

Wadlington and Wadlington (2008) take time to note that there are two different learning strategies when it comes to mathematics; quantitative and qualitative. Understanding these learning strategies of students can help one come to a deeper understanding of why a student may be performing at the rate they are, and what one can do to help them. Those students who are quantitative learners are good with words and tend to solve problems piece by piece, developing a part to whole perspective. Those

who are qualitative learners are good with calculations and numbers, can develop new techniques for solving problems and are considered to be whole to part oriented. While looking at the differences of the two types of learners, the current researcher may infer that those who score relatively higher in math anxiety are those learners who are more quantitative in their learning styles. One would think that these students have substantially higher scores on the verbal part of standardized testing than the mathematical part.

Aside from learning strategies used, biological explanations can also be used to explain the prominence of math anxiety. Brain lateralization in particular may be helpful in understanding these phenomena. Those who consider themselves more left brain dominant, the area responsible for calculations, may be more successful at math than those who consider themselves right brain dominant, the area responsible for art. Twin studies have also shown success when looking at math anxiety from a biological perspective, showing a ".53 heritability rate" (Baus and Welch, 2008).

Global learners, those who are often categorized as being holistic, seeing the whole picture, and having trouble with details, were found by Gresham (2007) to have higher amounts of math anxiety; as "global orientation scores increased, mathematics anxiety scores increased as well." This can be due to the fact that global learners do not only seek one definitive answer, but instead are global learners who are more prone to expecting numerous answers or numerous procedures to work their way through a problem. Global learners are also known as right brain dominant as mentioned previously in this section.

Choice of College Major

The choice of college major, as well as one's career path is highly affected by how one perceives their abilities in math, as well as how much one enjoys math in general. Not having the options of choice of college major or the motivational beliefs to do well in math has been found to be highly predictive of one's occupation in life. As included in the researchers study, it is important to find whether or not possessing an anxiety towards math indeed steers students in the direction of non-math related majors such as the arts and humanities. Although, in some humanities majors such as psychology and sociology, math and statistics are necessary courses in order to fulfill degree requirements and analyze and collect data in studies specific to these majors. It would be interesting to see the prevalence rates of math anxiety in these majors alone since math is not a critical part of obtaining a degree, but an essential part instead.

According to Baus and Welch (2008), the specific college majors of liberal arts, communication and business all yielded significant effects on math anxiety, as well as math self- efficacy. Those who majored in business were found to have higher self-efficacy in math than those majoring in both liberal arts and communication. In fact, communication majors had the highest rates of math anxiety and the lowest of math self-efficacy. Math performance was also found to be higher in business majors than those majoring in liberal arts or communication. Through this study, it is apparent that math anxiety is a useful predictor in of a college student's major. In relation, Hackett (1985) also found relationships between math anxiety and the college majors of science and math. Those who encountered more years of preparatory math courses in high school were more likely to major in math or the sciences at the college level. Those who rated

themselves lower on math anxiety and higher on math self-efficacy were also more likely to major in the sciences or mathematics when entering college.

Mackenzie (2002) has also found interesting results in the study of math anxiety and college major. When surveyed, 33% of students majoring in the social sciences reported math avoidance. As mentioned above, this statistic is worrisome since some degrees in the social sciences, such as psychology and sociology, require students to take statistics courses and perform adequately in these courses in order to fulfill degree requirements. Although, closely significant findings resulted when students were asked if they expected to work with mathematical constructs in their degree. Of 466 students surveyed, 4% strongly agreed with this statement, 30% agreed, 38% neither agreed nor disagreed, 22% disagreed and 6% strong disagreed.

Gender and Math Anxiety

Given previous findings and stereotypes of gender gaps in mathematical achievement the researcher finds it necessary to review literature that has examined the relationship between these factors. As with environmental influences, women may be less encouraged or supported in their efforts at mathematics since it is seen as a "male" subject. Given this view, many women's anxieties in mathematics may be raised, thus hindering their outright performance in the subject. As early as first grade gender stereotypes surrounding the fields of science and math can be developed and are difficult to get rid of given the perpetuations of such beliefs. This leads one to view math anxiety among females as a universal anxiety. When Beilock (2008) reminded female participants of the stereotype that "men are better at math than women," women under this condition performed more poorly on math problems than those receiving no

stereotype. These women also reported "worrying more about the experimental situation and its consequences than controls did" (Beilock, 2008).

As Casey, et al. (1997) states, at the high school level, boys have more of an advantage at mathematics than girls. Because of this advantage, those with math related careers are those who score in the 90th percentile in math in high school, girls are at a disadvantage for their entrance into math or science related fields after high school is completed. According to their study of high achieving students, Casey, et al. (1997) found that gender was significantly correlated to math anxiety with girls showing higher amounts of math anxiety than boys. Boys were also found to have higher self confidence than girls when taking mathematics related college entrance tests, a topic which will be discussed further in Chapter 2; although this gender difference can be due to the fact that males and females use different strategies to solve mathematical problems.

In agreement with this study, Chinn (2008) found that among males and females, math anxiety was rated lower among males than females and those males who reported being dyslexic. Among the highest math anxious were seventh grade dyslexic males. An increase in math anxiety was seen for females in eleventh grade who also scored higher on the anxiety scale than their male counterparts. Again, similar results were found by Baus and Welch where women scored relatively higher (39.29 average) on math anxiety than men (34.50 average). Through this finding, it was found that "sex predicted 2% of the variance in math anxiety…and 19% the variance in math self-efficacy" (Baus & Welch). Through this study, math self-efficacy was a useful indicator of a student's sex. Hackett (1985) found that gender predicted math scores on the ACT, but contrary to the aforementioned studies, did not predict math self-efficacy directly. Similarly, Mackenzie

(2007) also did not find that gender was significant in math confidence levels. Hackett (1985) also only found a moderate amount of variability in gender related to math anxiety in her sample of students surveyed. Gender was also found to predict an effect on college major.

When searching for gender differences in attitudes towards math, Tocci and Engelhard found that gender had a significant effect on attitudes towards math as well as anxiety towards math. Not only was this finding significant among students in the United States, female students in Thailand were also found to have higher ratings of math anxiety and lower ratings of attitudes towards math. In both countries, females believed that math was a more male appropriate field and viewed that math was less useful in society than males viewed. This study shows that not only is the gender gap in math anxiety important for teachers and researchers to view in the United States, it is also a growing epidemic overseas. In contrast, Cavanagh (2008) states in his literature review that "American culture is thwarting girls' math development." Cavanagh (2008) attributes this thwarting to environmental influences, as discussed previously and a lack of support from teachers and counselors.

Test Anxiety

As with math anxiety, test anxiety has been measured in many studies. Of those reviewed for the current experimental research, some conflicting results have been found when taking into combination test anxiety and it's relation to math anxiety. According to Tsui and Mazzocco (2007) math performance was found to be less accurate during timed than untimed testing conditions. In fact, when students were not timed in taking the sample test, they took twice as long to complete it as opposed to when they were timed.

By looking at these results, test anxiety may be provoked by having to finish a set of math problems in an allotted amount of time. If one is affected by math anxiety as well as test anxiety, both anxieties may combine causing a student's performance to drop significantly. When looking at timed testing conditions, Cates and Rhymer (2003) administered math probes in which students were timed in their completion and graded on their accuracy of solving various mathematical problems. Students with lower levels of math anxiety completed more problems per minute than those with high levels of math anxiety. Could the factor of time be included in this variance of data? In agreement with this statement, Kesici and Ahmet (2009) found that test anxiety was a significant predictor for math anxiety; "about 18% of the variance in mathematics anxiety was explained by test anxiety" (Kesici and Ahmet, 2009). Although this finding could lead to the explanation that some student's math anxiety may be due to a generalized test anxiety; Kesici and Ahmet (2009) state that "test anxiety is one of the most significant predictors of math anxiety." Thus, those students who experience anxiety while taking tests may be at a heightened risk for experiencing math anxiety.

Contrary to the above findings, Dew et al. (1984) previously found through their study that math anxiety and test anxiety are two separate anxieties; the two are only related, but not identical. Dew et al. (1984) found that the measures used for math anxiety were more closely related than those used for measuring test anxiety. Math anxiety measures shared "42.6%-65.6% in common as opposed to 3.6%-31.3% common variance with test anxiety" (Dew et al., 1984). Since these findings are so significantly different from the previously mentioned, one can only look at the year the study took place, 1984, and suggest that different times call for different measures in this particular

area. Walsh, in conducting a study with nursing students, includes a comment made by a participant contrasting math anxiety with test anxiety "the anxiety wasn't so much that I couldn't do the problems, but that I could only make one mistake. That was the most nerve-racking part of the nursing math tests." Through this comment, it is also easy to distinguish math and test anxiety as two different modules to be studied; the test caused the most anxiety because only one mistake could be made.

Test anxiety and math anxiety in relation to college entrance test scores, such as the SAT, was also an important factor to look at when reviewing data for the current research experiment. SAT scores are of the utmost importance to college students, they can determine which school one will be accepted to as well as whether or not one will have to take remedial math classes for no credits. According to Casey et al. (1997) more than half of high school students lowered their college entrance expectations because of low SAT scores. Casey also found that males scored higher on the math component of the SAT when compared to females, especially in mental rotation tasks and when considering their higher self confidence. Also important to note, high achievement in math classes did not account for higher scores on the math component on the SAT. This leads the researcher to conclude that test anxiety may be a large contributing factor to SAT scores despite the number of math courses taken at the high school level. Dew et al. (1984) concluded that scores on the SAT are excellent predictors for one's math anxiety in general, supporting Casey et al's. (1984) finding that attitudes toward math predicted math SAT scores in their study.

Math Anxiety

Math anxiety has been looked at by a number of researchers throughout the United States and abroad; math anxiety can start interfering with a student's abilities in the subject as early as fourth grade and elevates itself during middle and high school (Scarpello, 2007) as math classes become more advanced and based on prior knowledge of the subject. It seems as if many students, both elementary and college level, are affected by some form of math anxiety as well as test anxiety. In over 30 years of teaching, Arthur E. Schwartz (2000) has come across numerous cases of math anxiety. Chinn (2008) found that between "2 and 6% of mainstream students experience levels of anxiety about maths at a level that suggests they are 'often' anxious." According to Fawcett and Smith (2007) when reporting on a survey conducted by the American Council of Education, 70% of Americans surveyed believed that math and science are very important for students and graduates, while 44% believed that many students avoid the subjects because they are too difficult. This is not a complicated statistic to consider when thinking about the controversies surrounding America's shortage for science, technology, engineering and math (STEM) jobs. A reason why these jobs are flourishing in other countries, such as China, is because those teachers presumably have a deeper understanding of math and its content (Goldman, 2007) giving students better opportunities to grasp the material given to them.

Ashcraft and Krause (2007) state that math anxiety is a "learned anxiety" through environmental influences and past experiences in schooling and math classes. It can develop into a vicious cycle once one perceives that he or she is not adequate at the subject. As Ashcraft and Krause (2007) state "the higher one's math anxiety, the lower

one's math learning, mastery, and motivation." Therefore, a relationship does exist between math performance and math anxiety (Cates & Rhymer, 2003, and Kesici & Ahmet, 2009). This is supported by the findings of Cates and Rhymer (2003) that those students with lower amounts of math anxiety were able to complete more correct problems in a timed situation. The fact that math is a very abstract subject only adds to this cycle since it proves problematic for those students who tend to take situations literally, or who are global learners. This cycle can also lead to an avoidance of math related activities such as college major, occupation or choice to enroll in math classes beyond those required for graduation.

In contrast, Dew, et al. (1984) found that math anxiety did not account for math ability; only a small relation was found between the two. Although, as Mackenzie (2002) states, students may not be good at math due to their comfort ability, not understanding or lack thereof, of the subject. This comfort ability in turn interferes with one's beliefs about themselves regarding the subject, thus creating anxiety.

To add specifics to the term math anxiety, Chinn (2008) citing Datta and Scarfpin (1983) points out that there are two types; mental block and socio-cultural. During mental block anxiety, a student experiences just that, a mental block in learning math. These blocks can be triggered by certain types of problems or lessons that the student encounters. Socio-cultural anxiety is very similar to environmental factors; it comes about from stereotypes of beliefs throughout one's culture in regards to math. When viewing these two definitions one can assume by looking through the previous literature review that these two types of math anxiety are experienced and can be experienced simultaneously, especially when considering the literature regarding gender differences.

The data that Chinn (2008) found presents more concise situations in which math anxiety is experienced. For example, taking an end of term exam was ranked the highest in anxiety provoking among those surveyed followed by waiting for scores on an exam and taking a written math test. These results lead the current researcher to believe that items included on the present survey such as "solving advanced problems without a calculator" and "waiting to hear scores on the SAT/GRE" will be ranked among the highest in anxiety provoking as well. In addition to mental block and socio cultural math anxiety, specific and global math anxieties are also described in the research done by Wadlington and Wadlington (2008) in citing Sharma (1990). In a specific math anxiety someone is anxious about a particular mathematical situation, whereas in a global math anxiety, an individual is anxious in all mathematical situations. With the current research in mind, it will be important to view how the college students rate the various math problems included in the survey. By doing this, the researcher may be able to develop a picture of students being affected by particular problem sets in the survey, or the entire problem sets given.

Summary

Overall, much research has been conducted on the phenomena of math anxiety, although the research seems limited in the age groups of those tested. It is important to indicate that gender has been found to have significant effects on math anxiety and performance. Math anxiety has also had a tremendous effect on math performance and self-confidence as well. Through self-report surveys given to college students, the current researcher hopes to uphold the previous findings about math anxiety in regards to gender, college major and self confidence at the college level.

Chapter III

Method

Chapter three will focus on the subjects, methods, hypotheses and type of measures used to determine the outcome of the current study on mathematics anxiety as experienced by college students.

Subjects

The subjects used were 27 graduate and 7 undergraduate students, 34 total subject size, at Rowan University in Glassboro, New Jersey. There were 31 female volunteers and 3 male volunteers who participated in the study. The undergraduate students were volunteers from a background of majors while the graduate students were volunteers mostly from the School Psychology program working towards Masters or Educational Specialist degrees.

Design

The math anxiety questionnaire used in the study was developed by the current researcher. The researcher used self-made questions throughout the questionnaire, with the exception of the mathematical problems which were pulled from practice tests of the NJASK, GRE and SAT. The questionnaire was broken down into four different sections (background information, levels of anxiety, agreement to statements and feelings to statements) for better understanding when volunteers filled it out and for when statistics were performed. Because the math anxiety questionnaire was developed by the researcher, it has no established validity or reliability.

The study examined the correlation between math anxiety and choice of college major as well as the correlation between math anxiety and gender. The data collected from the math anxiety questionnaire was used to determine whether or not there were correlations between mathematics anxiety and choice of major in college as well as if any correlations existed between mathematics anxiety and gender. Correlations and descriptive statistics were used to analyze the data obtained from the questionnaires. The types of math problems that caused the greatest anxiety were also examined as well as statements and situations which caused the highest anxiety among volunteers.

Variables

Since correlations were used to determine the results of this study, no independent or dependant variables needed to be identified.

Measures

A survey was designed by the researcher to measure college student's math anxiety. The intent of the survey was to measure how much college students experience math anxiety, if math anxiety was or was not related to choice of major in college and if gender has an effect on math anxiety. The type of math problems that caused the greatest anxiety were also examined as well as statements and situations which caused the highest anxiety among volunteers. The survey consisted of 26 questions.

The first six questions asked the volunteers for background information such as age, gender, academic status and major. The next six questions had the volunteers rate their initial anxiety upon viewing different mathematical problems. This rating was done using a 5-point likert scale with 1=not anxious at all to 5=very anxious. The volunteers were prompted to not solve any of the mathematical problems presented in this question

set. Any problem rated as 4 or above was considered highly anxious, while anything rated as a 1 or 2 was considered not anxious at all and a rating of 3 was considered neutral. The next nine questions had volunteers rate their comfort ability with a series of statements pertaining to math. This problem set was also rated using a 5-point likert scale; 1=strongly agree to 5=strongly disagree. Any question rated as 4 or above was considered highly anxious, while anything rated as a 1 or 2 was considered not anxious at all. The last five questions had volunteers rate their feelings on statements pertaining to mathematics anxiety. This problem set also used a 5-point likert scale; 1=not anxious at all to 5=very anxious. Again, any situation rated as 4 or above was considered highly anxious, while anything rated as a 1 or 2 was considered not anxious at all and a rating of 3 was considered neutral.

The current math anxiety questionnaire was developed by the researcher for this specific study so its reliability and validity is unknown.

Procedure

The study examined the prevalence of math anxiety in college students and the relationship of math anxiety to choice of college major as well as the relationship between math anxiety and gender in both graduate and undergraduate students and the relationship between math anxiety and the need to be enrolled in a remedial math course. The data collected were used to see if there was a correlation between math anxiety and choice of college major, as well as measure the prevalence and severity of math anxiety in college students. The type of math problems that caused the greatest anxiety were also examined as well as statements and situations which caused the highest anxiety among volunteers.

Graduate and undergraduate students enrolled in a variety of classes at Rowan University were given the surveys and prompted that they had the choice to participate if willing and were given a brief introduction to the purpose of the study. Names were kept anonymous so no consent form was needed for the surveys. The researcher was present while the subjects completed the surveys. Upon completion, the surveys were collected by the researcher and placed in a sealed manila envelope for organization and the viewing and computing of statistics.

Upon receiving the final surveys, the researcher composed organizational tables using Microsoft Office Excel 2007 according to the questions included in the surveys in which all data from questions 8-26 were organized by the numbers received on the likert scales. For questions 1-6, numbers were designated by the researcher for gender (1=female, 2=male), major, average grades (1=A, 2=B, 3=C, 4=D and 5=F), and the need to be enrolled in remedial math courses (1=yes, 2=no). For question number 7 in the second problem set, volunteer's ratings were also coded (1=yes, 2=no and 3=neutral). Lastly, each volunteer's ratings were added up separately for each section in order to obtain a total anxiety score. The collected data was then typed into a spread sheet using SPSS version 18.0 for Microsoft using a desktop PC where the diagnostic testing was performed and the statistics were found.

Analysis

Correlations were used to determine the relationship between mathematics anxiety and college major as well as to determine the need for remedial math courses and math anxiety and average math grades in relation to math anxiety. Descriptive statistics were used to determine the type of math problems that caused the greatest anxiety as well

as statements and situations which caused the highest anxiety among volunteers. Any problem rated as 4 or above was considered highly anxious, while anything rated as a 1 or 2 was considered not anxious at all and anything rated as a 3 was considered neutral.

Hypothesis

Null hypotheses: Math anxiety will not be correlated to choice of major in college. The need to be enrolled in a remedial math course will not be correlated to mathematics anxiety. Gender will not have an effect on overall mathematics anxiety in college students. Average math grades will not be related to math anxiety.

Alternate hypotheses: Math anxiety will be correlated to choice of major in college. The need to be enrolled in a remedial math course will be correlated to mathematics anxiety. Gender will have an effect on overall mathematics anxiety in college students. Average math grades will be related to math anxiety.

Summary

The goal of the current research was to find a relationship between math anxiety and choice of college major, and gender as well as the prevalence and severity of math anxiety in college students and the relationship of math anxiety and the need to be enrolled in a remedial math course. The type of math problems that caused the greatest anxiety were also looked at as well as statements and situations which caused the highest anxiety among volunteers.

A survey was developed by the current researcher to measure math anxiety on a number of realms and to relate this anxiety to college major, volunteer's gender and the need to be enrolled in a remedial math course. No validity or reliability was established in this survey since it was developed by the researcher. The subjects used were 34

graduate and undergraduate students at Rowan University in Glassboro, New Jersey. The undergraduate students came from a background of majors while the graduate students were mostly School Psychology majors either enrolled in the Masters or Educational Specialist programs offered at Rowan University.

After analyzing the data using Correlations in SPSS version 18.0 for Microsoft using a desktop PC, the researcher was able to conclude that no correlations were found between math anxiety and gender, choice of major, average math grades, vision of math as a female subject and need to be enrolled in a remedial math course. Therefore, the null hypotheses were found to be significant in the current research.

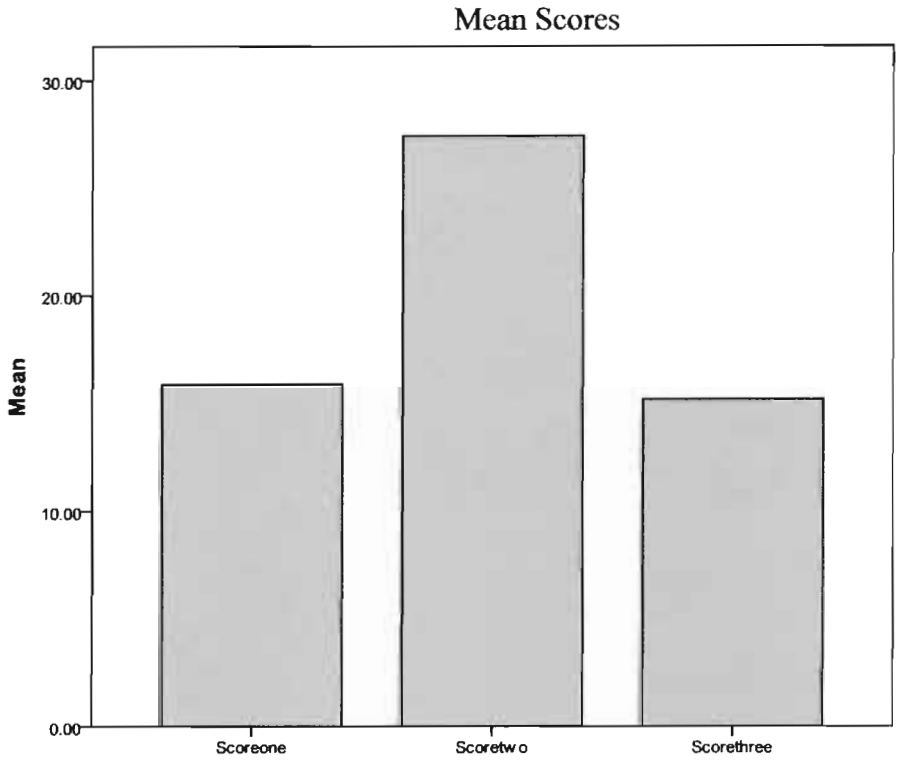
Chapter IV

Findings

Math anxiety is a growing concern for many around the globe. It's prevalence among teachers, elementary and high school students as well as college students is on the rise. The purpose of this study was to determine if there were any correlations between math anxiety and gender as well as choice of major in college among both graduate and undergraduate students. Types of math problems and anxiety provoking situations were also analyzed to determine which type of problems and situations bring about the most anxiety. Female's take on math and gender was also taken into consideration. The null hypothesis for the study stated that math anxiety will not be correlated to choice of major in college; the prevalence of math anxiety among college students will be significantly low, and gender will not have an effect on overall mathematics anxiety in college students. The alternate hypothesis for the study stated that math anxiety will be correlated to choice of major in college; the prevalence of math anxiety among college students will be significantly high, and gender will have an effect on overall mathematics anxiety in college students.

A short survey was given to both graduate and undergraduate volunteers at Rowan University. The data collected from these surveys was analyzed in SPSS using descriptive statistics and correlations. The experimenter focused on the volunteer's gender, college major as well as ratings on the likert scales of the various problem sets included in the survey. See Appendix A for survey.

In looking at descriptive statistics, the data collected on each problem set showed that 17.6 percent of volunteers scored a 16 on problem set one, 14.7 percent of volunteers scored a 29 on problem set two while 15 percent of volunteers scored a 16 on problem set three. The mean score for problem set one was 15.85, for problem set two the mean score was 27.41 and the mean score for problem set three was 15.18. See Figure 4.1 on page 43 for mean scores. Because the means on each problem set were significantly lower than the highest possible scores (30 for problem set 1, 45 for problem set 2 and 25 for problem set 3), the researcher concluded that no math anxiety exists among volunteers.



Forty seven percent of volunteers did not view math as a female subject. When broken down by gender, 45 percent of females did not see math as a female subject and 67 percent of males did not see math as a female subject. This high percentage among male volunteers could be due to the fact that there was such a small sample size for males. As for the need to be enrolled into remedial math courses, 82 percent of volunteers were not required to take a remedial math course upon entrance into college. When viewing the problems and statements that caused the most anxiety among volunteers, 56 percent of volunteers found problem 6 in problem set one to cause the most anxiety, 47 percent of volunteers disagreed with statements 1 and 7 in problem set 2 while 47 percent agreed with statement 9 also in problem set 2. 74 percent of volunteers

found that statement 2 caused the most anxiety in problem set 3. See Appendix A for survey. See Appendices B-E for percentage tables.

Table 4.1 Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Major	34	1.00	11.00	4.0588	3.25615
Scoreone	34	6.00	26.00	15.8529	4.70417
Scoretwo	34	19.00	38.00	27.4118	3.94752
Scorethree	33	5.00	21.00	15.1818	3.81980
Ques7	34	1.00	3.00	2.1176	.72883
Remedial	34	1.00	2.00	1.8235	.38695
GPA	34	1.00	3.00	1.6324	.68875
Gender	35	1.00	2.00	1.0857	.28403
Valid N (listwise)	33				

Upon viewing correlations, the data for math anxiety and choice of major was found to be statistically non-significant; for score one, r = (-.27), p = (.11), for score two, r = (-.18), p = (.29), and for score three p = (-.13), p = .44. See Table 4.2 below.

Table 4.2 Correlations between Major and Anxiety

		Major	Scoreone	Scoretwo	Scorethree
Major	Pearson Correlation	1	-.278	-.186	-.139
	Sig. (2-tailed)		.111	.293	.440
	N	34	34	34	33
Scoreone	Pearson Correlation	-.278	1	.527**	.508**
	Sig. (2-tailed)	.111		.001	.003
	N	34	34	34	33
Scoretwo	Pearson Correlation	-.186	.527**	1	.501**
	Sig. (2-tailed)	.293	.001		.003
	N	34	34	34	33
Scorethree	Pearson Correlation	-.139	.508**	.501**	1
	Sig. (2-tailed)	.440	.003	.003	
	N	33	33	33	33

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

When looking at gender, the results were inconclusive due to a larger number of female volunteers (31) to male volunteers (3). Because of this factor, this part of both the null and alternate hypotheses were unable to be proven significant or non-significant.

When taking average math grades and mathematics anxiety into consideration, this data was also found to be statistically non-significant; score one, r = (.00), p = .60, score two r = (.34), p = (.04) and score three r = (.12), p = (.12). See Table 4.3 below.

Table 4.3 Correlations between Average Math Grades and Anxiety

		Scoreone	Scoretwo	Scorethree	GPA
Scoreone	Pearson Correlation	1	.527**	.508**	.605**
	Sig. (2-tailed)		.001	.003	.000
	N	34	34	33	34
Scoretwo	Pearson Correlation	.527**	1	.501**	.347*
	Sig. (2-tailed)	.001		.003	.044
	N	34	34	33	34
Scorethree	Pearson Correlation	.508**	.501**	1	.273
	Sig. (2-tailed)	.003	.003		.124
	N	33	33	33	33
GPA	Pearson Correlation	.605**	.347*	.273	1
	Sig. (2-tailed)	.000	.044	.124	
	N	34	34	33	34

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

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

The data for the need to be enrolled in remedial math courses and math anxiety also was proven to be non-significant; score one, r = (-.19), p = (.26), score two, r = (-.18), p = (.28), and score three, r = (-.43), p = (.01). See Table 4.4 below.

Table 4.4 Correlations between Remedial Math Courses and Anxiety

		Scoreone	Scoretwo	Scorethree	Remedial
Scoreone	Pearson Correlation	1	.527**	.508**	-.198
	Sig. (2-tailed)		.001	.003	.262
	N	34	34	33	34
Scoretwo	Pearson Correlation	.527**	1	.501**	-.189
	Sig. (2-tailed)	.001		.003	.284
	N	34	34	33	34
Scorethree	Pearson Correlation	.508**	.501**	1	-.437*
	Sig. (2-tailed)	.003	.003		.011
	N	33	33	33	33
Remedial	Pearson Correlation	-.198	-.189	-.437*	1
	Sig. (2-tailed)	.262	.284	.011	
	N	34	34	33	34

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

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

The null hypotheses were accepted. The data found indicated there were no correlations found between math anxiety and choice of major in college, the need to be enrolled in a remedial math course, and average math grades. The data also found that the college students surveyed did not experience a significant amount of math anxiety.

Chapter five will include the discussion and implications for future research.

Chapter V

Discussion

The data found through correlations indicate there are no relationships between mathematics anxiety and choice of major in college, the need to be enrolled in a remedial math course or average math grades. Although, a large percentage of volunteers found problems with square roots and exponents to be the most anxiety provoking as well as situations in which math problems would have to be worked out quickly. Forty-seven percent of volunteers disagreed that they felt comfortable taking advanced math courses while 41% agreed they felt uneasy and clam up when taking a math test. Gender was unable to be a factor since there was a large disparity between the number of male and female participants; although 45% of females and 67% of males surveyed agreed that math was not a female subject. Percentages on feelings about math and situations pertaining to math showed to be more relevant than correlations between majors, remedial math courses and average math grades.

Of most significance to the current research, looking at the percentages in ratings of problems, statements and situations is most helpful in determining which types of situations cause anxiety among college students. Since correlations proved to be non-significant for all hypotheses tested, percentages allow the current researcher as well as future researchers to easily determine which elements of math cause college students to feel anxious. In looking at these percentages, future implications can be used in the classroom at the elementary and high school level to alleviate this anxiety as a student

enters college and is required to achieve a certain score on standardized testing in order to avoid being placed in a remedial math course as well as to relieve tension when enrolled in required math courses. See Appendices B-E for percentages on likert scale ratings on the math anxiety survey.

In a previous study conducted by Beilock (2008), high stress situations were found to heighten participant's pressure of performance and ultimately reduced their confidence. In agreement with this literature, the current research has found that most volunteers surveyed found that working out math problems quickly as well as answering math questions aloud in class made them highly anxious. Again in agreement with Beilock (2008) and Ashcraft and Krause (2007) the current researcher was able to accurately conclude that the more complex problems included in the survey caused the most anxiety among volunteers. Problems one and six in problem set one, which both included fractions and upon appearance were more complex than the rest of the problems, see Appendix A, were rated as more anxiety provoking by volunteers than the rest of the problems included in problem set one. According to previous research, these more complex problems would require more working memory and would be stored less prominently than problem number three in problem set one.

Mackenzie (2002) found that 40% of students surveyed in the United States showed avoidance of math. The current researcher found that only 29% of volunteers surveyed avoided taking math courses at all costs. This disparity could be due to the small sample size of the current research or the simple fact that most students surveyed did not seem to suffer from an over-all math anxiety.

In looking at college major and math anxiety in the current study, the data proved to be non-significant. Even though many different majors were included in the current research; business, recreation, psychology, education, and communications to name a few, the current research was significantly different from that of Baus and Welch (2008) who found that those majoring in liberal arts had higher math anxiety than those majoring in business. Again in the current study, math anxiety and choice of major in college were not correlated. Although closer to agreement with the current research, Mackenzie (2002) found that 33% of the population surveyed who majored in the social sciences reported math avoidance. This percentage is close to that in the current study since 29% avoided taking math courses at all costs and the majority of volunteers majored in psychology or school psychology which are both considered social sciences.

Due to non-significant results the current research is not in much agreement with any of the literature reviewed. Although previous research supports the alternate hypothesis of the current research, because of the statistical findings the null hypothesis is supported which found that math anxiety was not correlated to choice of major in college, the need to be enrolled in a remedial math course or average math grades. In contrast, the percentages of ratings on the likert scales included in the survey are in more of an agreement with previous research reviewed.

The results that were obtained in the current research can be proven non-significant for a number of reasons. First, the sample size was small, only encompassing 34 subjects. If the sample size were larger, significant results may have been obtained for each hypothesis included in the study. A high percentage of males believed that math was not a female subject; if more males had been included in the survey this percentage

may have been lower, or possibly even higher. The comparison of gender and mathematics anxiety was also unable to be calculated due to an unequal number of male and female volunteers. The current research was only conducted at the Rowan University campus in New Jersey. If a more diverse population would have been included in taking part in the mathematics anxiety survey, significant results may have been yielded. Since the majority of respondents were either Psychology or School Psychology majors, the non-significant results pertaining to choice of college major and math anxiety may also be attributed to this narrow sample. An inability to correctly recall one's grades in mathematics could also be attributed to the non-significant findings in correlations of math anxiety and average math grades. Since the survey administered to volunteers was developed by the experimenter, there was no established reliability or validity. If a more renowned and trusted survey were administered, significant results may have been obtained. Also, the survey was based on volunteer's self-report. Self-report surveys are known to be non-reliable at times since volunteers may have a tendency to answer questions in a manner in which they find may be more helpful to themselves or the researcher.

Since there was only a sample size of 34, in the future, more volunteers to partake in the mathematics survey would be helpful in possibly yielding significant results. Having a more diverse population by including more males in the research would also be helpful in being able to include gender results and differences in the study. Also, having volunteers from different colleges with different entrance requirements would also be of great help in finding significant results. Gathering students from different majors other than the majority that was included, psychology and school psychology, may also help

the research support the alternate hypothesis that choice of major would be correlated to math anxiety. Even though it would be difficult to use another method other than self report to achieve ratings on math anxiety, the possibility of using a test which actually had volunteers solve math problems may have been a more accurate way in determining math anxiety. Also, there are different varieties of math anxiety surveys available. If one of these surveys had been used in contrast to the researcher developed survey, there is a strong possibility that significant results could have been found for all alternate hypotheses.

References

Adams, C. Overcoming math anxiety. *Springer-Verlag, New York*, 2001, (23) 49-50.

Alsup, J. A comparison of constructivist and traditional instruction in mathematics. *Educational Research Quarterly,* 2004, 28 (4) 1-17.

Ashcraft, H. M., & Krause, A. J. Working memory, math performance, and math anxiety. *Psychonomic Bulletin and Review*, 2007, 14 (2) 243-248.

Baus, R. D., & Welch, S. A. Communication students' mathematics anxiety: Implications for research methods instruction, *Communcation Research Reports,* 2008, 25 (4) 289-299.

Beilock, S. L. Math performance in stressful situations. *Current Directions in Psychological Science,* 2008, 17 (5) 339-343.

Casey, B.M., Nuttall, R. L., & Pezaris, E. Mediators of gender differences in mathematics college entrance test scores: A comparison of spatial skills with internalized beliefs and anxieties. *Developmental Psychology,* 1997, 33 (4) 669-680.

Cates, G. L., & Rhymer, K. N. Examining the relationship between mathematics anxiety and mathematics performance: An instructional hierarchy perspective. *Journal of Behavioral Education,* 2003, 12 (1) 23-34.

Cavanagh, S. American culture seem to thwart girls' math development. *Education Week,* 2008, 28 (9) 10-10.

Cavanagh, S. Math anxiety confuses the equation for students. *Education Week*, 2007, 26 (24) 12-12.

Chinn, S. Mathematics anxiety in secondary students in England. *Dyslexia,* 2008, 15 61-68.

Dew, H. K. M., Galassi, J. P., & Galassi, M. D. Math anxiety: Relation with situational test anxiety, performance, physiological arousal, and math avoidance behavior. *Journal of Counseling Psychology,* 1984, 31 (4) 580-583.

Fawcett, G., & Shannon-Smith, E. Community Connections. *Educational Leadership,* 2007, 74-75.

Greiffenhagen, C., & Sharrock, W. School mathematics and its everyday other? Revisiting Lave's 'Cognition in Practice.' *Educ Stud Math,* 2008, 69, 1-21.

Gresham, G. A study of mathematics anxiety in pre-service teachers. *Early Childhood Education Journal,* 2007, 35 (2), 181-188.

Gresham, G. An invitation into the investigation of the relationship between mathematics anxiety and learning styles in elementary preservice teachers. *Journal of Invitational Theory and Practice,* 2007, 13, 24-33.

Hackett, G. Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology,* 1985, 32 (1), 47-56.

Kesici, S., & Ahmet, E. Predicting college students' mathematics anxiety by motivational beliefs and self-regulated learning strategies. *College Student Journal,* 2009, 43 (2), 631-642.

Mackenzie, S. Can we make maths count at HE? *Journal of Further and Higher Education,* 2002, 26 (2), 159-169.

Miller, D. L., & Mitchell, C. E. Mathematics anxiety and alternative methods of evaluation. *Journal of Instructional Psychology,* 1994, 21 (4), 353-359.

Scarpello, G. Helping students get past math anxiety. *Techniques,* 2007, 34-35.

Schwartz, A. E. Axing math anxiety. *The Hispanic Outlook in Higher Education,* 2000, 62-64.

Thilmay, J. Math anxiety. *Mechanical Engineering,* 2009. 11-11.

Tocci, C. M., & Engelhard, G. Achievement, parental support, and gender differences in attitudes toward mathematics. *Journal of Educational Research,* 1991, 84 (5), 280-286.

Tsui, J. M., & Mazzocco, M. M. Effects of math anxiety and perfectionism on timed versus untimed math testing in mathematically gifted sixth graders. *Roeper Review,* 2007, 29 (2), 132-139.

Wadlington, E., & Wadlington, P. L. Helping students with mathematical disabilities to succeed. *Preventing School Failure,* 2008, 53 (1), 2-7.

Walsh, K. The relationship among mathematics anxiety, beliefs about mathematics, mathematics self-efficacy, and mathematics performance in associate degree nursing students. *Nursing Education Perspectives,* 2008, 29 (4), 226-229.

NO AUTHOR. Overcoming math anxiety. *Journal of Developmental Education*, 2007, 30 (3), 40-41.

NO AUTHOR. Don't worry, be smarter. *NEAtoday*. 2007.

APPENDIX A

Mathematics Anxiety Survey

Please answer the following questions.

1. What is your age?

____

2. What is your gender?

a. Female b. Male

3. What is your current academic status?

a. Freshman b. Sophomore
c. Junior d. Senior
e. Graduate Student

4. What is your current major? If you are a graduate student, please include your undergraduate major.

_____

5. Were you required to take any remedial math courses for entry into a college?

a. Yes b. No

6. What were your average math grades in high school / college?

a. A b. B
c. C d. D
e. F

Please rate your initial level of anxiety (1= not anxious at all, 5=very anxious) when viewing the problems below. Please DO NOT solve!

1. The projected sales volume of a video game cartridge is given by the function $s(p) = \frac{3000}{2p + a}$, where s is the number of cartridges sold, in thousands; p is the price per cartridge, in dollars; and a is a constant. If according to the projections, 100,000 cartridges are sold at \$10 per cartridge, how many cartridges will be sold at \$20 per cartridge?

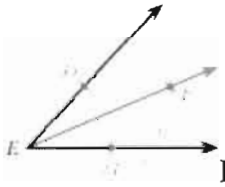
1 2 3 4 5

2. If $3x - 2 = 7$, then $4x =$

1 2 3 4 5

3. What is the greatest common factor of 42, 126, and 210?

1 2 3 4 5

4.  In the figure, ray $\overrightarrow{EF}$ was constructed starting from rays $\overrightarrow{ED}$ and $\overrightarrow{EG}$. By using a compass, D and G were marked equidistant from E on rays $\overrightarrow{ED}$ and $\overrightarrow{EG}$. The compass was then used to locate a point F, distinct from E, so that F is equidistant from D and G. For all constructions defined by the above steps, the measures of $\angle DEF$ and $\angle GEF$

1 2 3 4 5

5. In a certain shop, notebooks that normally sell for 59 cents each are on sale at 2 for 99 cents. How much can be saved by purchasing 10 of these notebooks at the sale price?

1 2 3 4 5

6. If $x > 1$ and $\frac{\sqrt{x}}{x^3} = x^m$, what is the value of m?

1 2 3 4 5

Please rate the following questions (1=strongly agree, 5=strongly disagree).

1. I feel comfortable taking advanced math courses

1 2 3 4 5

2. When I take a math test, I clam up and feel uneasy

1 2 3 4 5

3. I am confident in my abilities in math

1 2 3 4 5

4. I feel as if I can never study enough for a math test

1 2 3 4 5

5. Math is very important to me and the world around me

1 2 3 4 5

6. Math was taught to me in an encouraging environment

1 2 3 4 5

7. Math is a female subject

1 2 3 4 5

8. I have no problem taking timed math tests

1 2 3 4 5

9. I avoid taking math courses at all costs
1 2 3 4 5

Please rate your feelings (1=not anxious at all, 5=very anxious) on the following questions.

1. Having to work out math problems quickly
1 2 3 4 5

2. Waiting to see/hear your score on a math test, such as the SAT or GRE
1 2 3 4 5

3. Answering math questions aloud in class
1 2 3 4 5

4. Counting money when you go shopping
1 2 3 4 5

5. Solving advanced math problems (fractions, long division, etc.) without a calculator
1 2 3 4 5

APPENDIX B
Percentages for Problem Set One

Question #	Total Percentage of Anxiety
1	50%
2	18%
3	15%
4	38%
5	21%
6	56%

APPENDIX C

Percentages for Problem Set Two

Question #	Percentage in Agreement
1	29%
2	41%
3	24%
4	35%
5	35%
6	38%
7	21%
8	38%
9	47%

Question #	Percentage in Disagreement
1	47%
2	35%
3	44%
4	41%
5	35%
6	26%
7	47%
8	44%
9	29%

APPENDIX D

Percentages for Problem Set Three

Question #	Percentage of Anxious Feelings
1	59%
2	74%
3	53%
4	0%
5	41%

APPENDIX E

Percentages for Question 7 in Problem Set Two

Percentage of Female's Ratings

Strongly Agree	Neutral	Strongly Disagree
23%	32%	45%

Percentage of Male's Ratings

Strongly Agree	Neutral	Strongly Disagree
0%	33%	67%