AN EXPLORATION OF THE RELATIONSHIP BETWEEN MATHEMATICS ANXIETY LEVEL AND PERCEPTUAL LEARNING STYLE OF ADULT LEARNERS IN A COMMUNITY COLLEGE SETTING

by

Roberta Parrino Cook

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This dissertation was prepared under the direction of the candidate's dissertation advisors, Dr. Lucy Guglielmino, Department of Educational Leadership, and Dr. John D. Morris, Department of Educational Technology and Research, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the College of Education and was accepted in partial fulfillment of the requirements for the degree of Doctor of Education.

SUPERVISORY COMMITTEE:

Lucy M. Guglielmino
Co-chairperson, Director of Dissertation

John D. Morris
Co-chairperson, Director of Dissertation

Albert Johnson

Mary B. Gray

David G. MacKenzie
Chairperson, Department of Educational Leadership

Jerry Lafferty
Dean, College of Education

John T. Jurewicz
Dean of Graduate Studies and Research

10/30/97
Date

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ABSTRACT

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This study investigates the relationships between and among math anxiety level, perceptual learning style (audio, visual, tactile/kinesthetic), age, gender, and math performance. The subjects were 501 community college students taking remedial credit Introductory Algebra and college credit Basic College Algebra. A questionnaire measuring math anxiety level, perceptual learning style, and personal demographics was developed and administered to the participants. Math anxiety level was measured by the Brief Math Anxiety Rating Scale (BMARS), a subscale of Suinn's Math Anxiety Rating Scale (MARS). Perceptual learning style was measured by the Learning Style Inventory-Adapted (LSI-A), an adaptation of the CITE Learning Style Inventory.

The results showed that math anxiety level was significantly correlated to one or more learning styles for all groups studied. Math Anxiety level was also significantly correlated to gender but did not have significant correlations with age

or math performance. For the female subjects, there were significant positive correlations between math anxiety level and two learning styles: tactile/kinesthetic and audio. For males, there was a significant positive correlation between math anxiety level and audio learning style only. While the math anxiety levels of females were significantly higher than those of males, their course grades were as well. They were also significantly older than the males in the study group and had significantly higher preferences for the visual learning style than the males.

Multiple regression analyses were performed with the predictor variables of age, gender, learning style; and the criterion variable math anxiety level. The regression models were statistically significant and predicted up to 15% of the variance in math anxiety level. Multiple regression analyses were performed on subgroups of the original groups. These groups were comprised of the participants who received letter grades from A - F. Those receiving incompletes or withdrawals were not included in this part of the study. The predictor variables for the regressions in these models were: age, gender, math anxiety level, and perceptual learning style. The criterion variable was math performance, measured by the final grade in the course. All but one of the regression models were statistically significant, predicting up to 16% of the variance in math performance. The remedial credit model was not significant.

Further research is needed with a more comprehensive learning style instrument and possibly a different measure for evaluating math performance that would also include all the incomplete grades and withdrawals.

To Mom
who was the first to make me so aware
of the devastating power of math anxiety

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CHAPTER ONE

INTRODUCTION AND PROBLEM

General Orientation

Mathematics anxiety can affect all aspects of an adult learner's life and hinder the achievement of educational or economic success (Gammage, 1994). The phenomenon moved into social consciousness mostly through the efforts of individuals involved with the women's movement of the 70's (Schneider & Nevid, 1993). During this time two separate studies about the mathematics preparation of students entering universities were conducted. One of the studies was conducted in 1972 by feminist socialist Sells (1973, 1978) and the other in 1973 by mathematician Ernest (1976). The conclusion derived by both studies was the same: mathematics was a "critical filter" (Ernest, 1976, p. 596, Sells, 1973, p. 1) preventing college students who were mathematically underprepared in high school from entering any math or science related majors. This condition related more to women than men, but both genders were affected. This lack of preparation was caused by "math avoidance" (Tobias, 1976, p. 56). Tobias (1976) popularized the idea that this math avoidance which leads to poor math preparation was caused by math anxiety.

One way of lowering anxiety about a subject is to teach in a way that matches students' individual perceptual learning style preference (Dunn & Dunn, 1993). When students are not taught in a mode consistent with their learning style preference, they may experience tension and anxiety (Buchanan, 1992).

Statement of the Problem

The number of community college students successfully completing mathematics classes, whether it be at the remedial or college level, has long been an issue for mathematics educators and their institutions of learning. For too many schools there is a less than 50% success rate in remedial math classes (Nolting, 1990). Many of the students in those classes are adults. The age of the traditional college student is rising (Elliott, 1990), and some adult learners returning to school are finding themselves in a dilemma because they have difficulty dealing with the mathematics requirements for their programs. One of the causes of this predicament is mathematics anxiety. Mathematics anxiety has been known to have a negative effect on mathematics achievement and cause math avoidance (Tobias, 1993; Kogelman & Warren, 1978). Mathematics anxiety can close doors of opportunity to individuals who are otherwise intelligent and capable (Morris, 1981).

Attending to a student's learning style preference can enhance the quality of learning and increase success (Buchanan, 1992). There is a certain degree of discomfort or anxiety when a learner is not taught in her or his preferred mode (McCoy, 1990). For some, the degree of discomfort prevents them from achieving success in the mathematics classroom. According to the Dunn and Dunn (1993) learning style model there are 21 elements that affect how students learn. These 21 elements are classified into five categories: environmental; emotional; sociological; physiological and psychological. One of the classifications under the physiological category is perceptual modes. There are three major perceptual learning style modes: auditory or audio (hearing), visual (seeing), and tactile/kinesthetic (touching or doing). The lecture method, which is geared to the auditory learner, is the main mode of instruction at the college level. Visual and tactile/kinesthetic learners have more difficulty absorbing the material with lecture instruction. Hodges (1983) suggests that mathematics success or failure may be more an issue of how the material is presented than the material itself. Since a student may feel a certain level of discomfort when not taught in her or his preferred learning style mode, there may be a relationship between learning style and math anxiety. A study conducted by McCoy (1990, 1992) indicated that there may be a significant relationship between mathematics anxiety and the tactile/kinesthetic mode preference.

Significance of the Problem

If a relationship is found to exist between learning style and mathematics anxiety, then this research may provide information which will help both the math educator and the math student enhance the student's learning efficiency in mathematics by considering an individual's learning style preference and level of mathematics anxiety. If this research reveals a relationship, the information gained could be used to revise teacher training and development programs. The resulting changes in teacher awareness and teaching approaches could lead to increased student success and could improve student retention rates. This work could also benefit those people in society who have avoided mathematics because of their anxiety, giving them some hope of a way to deal with the problem. The research could benefit students of all ages and levels, mathematics educators, institutions of learning, and society in general.

Statement of Purpose

The purpose of this research was to determine if a relationship exists between an adult learner's level of math anxiety and her or his perceptual learning style preference. The researcher also investigated possible relationships among mathematics anxiety level, perceptual learning style preference and performance (grade) in a mathematics course. The impact of age, gender, and level of mathematics course (remedial credit Introductory Algebra or college credit Basic College Algebra) were also investigated.

Research Questions

This study was designed to answer the following questions:

1. Is math anxiety level predictable from perceptual learning style, gender and age of the total sample?
2. Is math anxiety level predictable from perceptual learning style, gender and age of the female participants?

3. Is math anxiety level predictable from perceptual learning style, gender and age of the male participants?
4. Is math anxiety level predictable from perceptual learning style, gender and age of the participants in the college credit course?
5. Is math anxiety level predictable from perceptual learning style, gender and age of the participants in the remedial course?
6. Is performance in a mathematics course predictable from the level of math anxiety, perceptual learning style, gender and age of the total participants?
7. Is performance in a mathematics course predictable from the level of math anxiety, perceptual learning style, gender and age of the female participants?
8. Is performance in a mathematics course predictable from the level of math anxiety, perceptual learning style, gender and age of the male participants?
9. Is performance in a mathematics course predictable from the level of math anxiety, perceptual learning style, gender and age of the participants in the college credit course?
10. Is performance in a mathematics course predictable from the level of math anxiety, perceptual learning style, gender and age of the participants in the remedial course?

Hypotheses

Each hypothesis was be tested at the .05 alpha level. This study tested the following hypotheses:

1. H_0: The set of predictor variables (audio level, visual level, t/k level, gender, age) predicts mathematics anxiety level no better than chance for the total participants.

2. H_0: The set of predictor variables (audio level, visual level, t/k level, gender, age) predicts mathematics anxiety level no better than chance for the female participants.

3. H_0: The set of predictor variables (audio level, visual level, t/k level, gender, age) predicts mathematics anxiety level no better than chance for the male participants.

4. H_0: The set of predictor variables (audio level, visual level, t/k level, gender, age) predicts mathematics anxiety level no better than chance for the participants in the college credit course.

5. H_0: The set of predictor variables (audio level, visual level, t/k level, gender, age) predicts mathematics anxiety level no better than chance for the participants in the remedial course.

6. H_0: The set of predictor variables (mathematics anxiety level, audio level, visual level, t/k level, gender, and age) predicts performance in the

mathematics course for grades A-F no better than chance for the total participants.

7. H_0: The set of predictor variables (mathematics anxiety level, audio level, visual level, t/k level, gender, and age) predicts performance in the mathematics course for grades A-F no better than chance for the female participants.

8. H_0: The set of predictor variables (mathematics anxiety level, audio level, visual level, t/k level, gender, and age) predicts performance in the mathematics course for grades A-F no better than chance for the male participants.

9. H_0: The set of predictor variables (mathematics anxiety level, audio level, visual level, t/k level, gender, and age) predicts performance in the mathematics course for grades A-F no better than chance for the participants in the college credit course.

10. H_0: The set of predictor variables (mathematics anxiety level, audio level, visual level, t/k level, gender, and age) predicts performance in the mathematics course for grades A-F no better than chance for the participants in the remedial course.

Assumptions

This study was conducted under the terms of the following assumptions:

1. Participants responding to the questionnaire will answer truthfully.

2. Self-report of feelings on the mathematics anxiety scale will accurately represent levels of mathematics anxiety.

3. Self-report on the learning style inventory will accurately evaluate perceptual learning style preferences.

Delimitations of the Study

This study was restricted by the following delimitations:

1. The research sample was drawn from a single community college within the State of Florida.

2. The study was conducted only during the spring term of 1997.

3. Because of changes made to the mathematics scale and the learning style inventory no norms were available for statistical comparison.

Limitations of the Study

This study was restricted by the following limitations:

1. All predictors in this study were in the form of self-reported information.

2. There is a less than perfect correlation between actual learning style and measured learning style.

Definitions

Mathematics anxiety: "a clear-cut, negative, mental, emotional, and/or physical reaction to mathematical thought processes and problem solving" (Arem, 1993).

Mathematics anxiety level: the score arrived at by summing the self reported responses on the BMARS. The higher the score, the higher the math anxiety level.

Learning Style: the complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store and recall what they are attempting to learn, (James & Blank, 1993).

Perceptual learning style: the senses through which a learner concentrates, processes, and retains new and difficult information. The senses this study focused on are: hearing (audio); seeing (visual), and touching and physical movement (tactile/kinesthetic)(t/k). Perceptual learning style is measured on the LSI-A by three different scores (audio, visual, and t/k). These scores are arrived at by calculating the arithmetic mean of the responses to the items in each category and then doubling the mean.

Mathematics performance: the final grade received in a mathematics course. The grades range from A through F and also I (incomplete) and W (withdraw). I's and W's were not studied because of the inconsistencies in their meaning across the courses.

Gender: a self report as to whether the participant is female or male. Male was reported as one and female as two.

Age: a self report of the participant's age in one of eleven categories from age eighteen to over sixty-five years. These are the eleven categories: #1, 18-20; #2, 21-25; #3, 26-29; #4, 30-34; #5, 35-39; #6, 40-44; #7, 45-49; #8, 50-54; #9, 55-59; #10, 60-64; and #11, 65 and up.

CHAPTER TWO

Review of the Literature

Introduction

Although some research was done on mathematics anxiety in the 50's and 60's, the majority of research has been done in the last 25 years. Most of the search for information on mathematics anxiety was done on the computer using online services. The main sources for this review were as follows: Educational Resources Information Center (ERIC); Dissertation Abstracts International; Psychological Abstracts (PsycINFO); and the bibliographies from the actual research articles. Various keyword searches were conducted using "mathematics anxiety," "adult learner," "learning style," and combinations of these.

As the amount of research collected increased, certain themes emerged. By analyzing the themes, a deficiency in the literature became evident. This review of the literature will start with addressing the general issue of mathematics anxiety and adults. The review will then explore more controversial issues: mathematics anxiety and gender; mathematics anxiety and mathematics performance; and mathematics anxiety and learning style. It will be shown that the research relating mathematics anxiety to learning styles, specifically to perceptual learning styles, is sparse.

Math Anxiety and the Adult Learner

Betz (1978) and Gourgey (1984) found that older students displayed higher levels of math anxiety than younger students. Benn and Burton (1994), Heher (1988), and Ulrich (1989) found that there was no clear correlation between age and mathematics anxiety. Conversely, Whittlesy (1991) found that younger students at a community college had higher levels of anxiety toward mathematics than older students. Gourgey (1984, p.16) believes that the problems that adult learners have with math anxiety are not simply a function of the passage of time. Math anxiety appears to have a variety of different causes (Norwood, 1994). Adult learners' beliefs about themselves and mathematics can greatly influence their level of math anxiety (Gammage, 1994; Gourgey, 1984).

Wilson and Wilson (1984) assert that math anxiety poses at least some difficulty for a majority of adult students (p. 31). An adult learner's math anxiety has developed and been reinforced for years (Gammage, 1994; Handler, 1990; Robertson, 1991; Wilson & Wilson, 1984). It has become ingrained into the learner's beliefs and behavior patterns. It can greatly affect a person's self-worth (Buxton, 1982).

Many math-anxious adults have developed a creative coping system by depending on family and friends to perform everyday math tasks like checkbook handling and management of the household budget (Benn-Jacob, 1986;

Gammage, 1994, p. 101). Because of their math anxiety, some of these adults will trust store clerks to charge the right price and give the correct change, and depend on the banks to keep their accounts in order. This dependency takes a heavy toll.

Math anxiety is a political and economic issue for adult learners. It is a filter that blocks many adults, especially women, from numerous professional and technical job opportunities (Donady & Tobias, 1977; Morris, 1981; Tobias, 1991; Wilson & Wilson, 1984). With the rapid developments in technology, adults are returning to educational institutions to upgrade or acquire skills necessary for either job maintenance or advancement. Other adults, mostly women, need training to be able to return to the workforce after raising a family (Wilson & Wilson, p. 27). Adult learners come to school highly motivated to learn (Wieschenberg, 1994; Wilson & Wilson). For many adults, returning to this setting and dealing with tasks that require numbers can be a trigger for math anxiety (Wilson & Wilson, p. 26). For other adults, math anxiety may go undetected all through their school years, surfacing only in adulthood. Handler (1990) notes that such adults may experience a panic attack or other anxiety reaction when math skills are being evaluated on the job or when confronted with a math-related problem that does not have an immediate answer.

Many adults with math anxiety, having experienced so many years of avoidance, failure and negative school memories, falsely believe that they have reached their limit, that they are as "smart" as they are going to get and are not capable of doing mathematics (Handler, 1990; Robertson, 1991; Wilson &

Wilson, 1984). A learner with a history of problems or negative experiences in math may be more likely to give up quickly than a learner with a history of success in math (Miller & Mitchell, 1994).They may return to the educational setting out of necessity, but they have "an emotional backpack heavy with memories, experiences and beliefs about school" (Gammage, 1994, p.103). This frame of mind predisposes them to failure and a willingness to give up easily.

In summary, the majority of the research supports the idea that mathematics anxiety for adults is an issue. Various reasons or sources for the anxiety were explored. Among them were poor performance in the past, negative school memories, discomfort in evaluation settings, and beliefs about oneself.

Math Anxiety and Gender

Lucy Sells, a feminist sociologist, privately circulated an unpublished report about the incoming freshmen in 1972 at the University of California at Berkeley. What Sells reported was that 92% of the females and 43% of the males entered the university with less than three years of high school math and were therefore not eligible to enter 15 of the 20 major fields offered at the university (Sells, 1978, p. 28). This meant that the only fields of study open to these students were the humanities, music, social work, elementary education, and guidance and counseling.

A similar study was done by mathematician Ernest (1976) on the students entering the University of California at Santa Barbara in 1973. Ernest concluded that his studies "confirm the hypothesis of the sociologist Lucy Sells, that mathematics is a 'critical filter' tending to eliminate women from many fields, from chemistry, physics and engineering, to architecture and medicine."(p.596). This lack of preparation on the part of females was attributed to what Sells called "math avoidance" (Sells, 1978). Tobias and Weissbrod (1980, p. 65) examined the relationship between math anxiety and math avoidance and concluded that "...anxiety inhibits work because in order to avoid the anxiety the student will stop studying mathematics."

The reason for this anxiety which is related to math avoidance, poor math preparation, and poor math performance is embedded in many socio-cultural issues (Ernest, 1976; Fox, 1976; Tobias, 1976). Hendel (1980, p. 219) suggests that "sex differences in math performance may be accounted for by differences in how females and males are socialized in mathematics." Research has shown that as soon as mathematics classes become optional in high school many more girls than boys opt not to take any more mathematics (Fauth & Jacobs, 1980). As Fennema and Sherman (1977, p. 67) point out, "One learns what one studies. If girls do not take as many advanced courses in mathematics as boys take, no wonder they do not perform as well on mathematics tests in the general population." In 1977 the National Institute of Education (NIE) called a conference on Women in Mathematics and commissioned papers from Sherman, Fennema, and Fox which challenged the notion that underachievement in mathematics among females was a natural phenomenon (Tobias, 1980, p. 64).

The research on gender differences and math anxiety has produced conflicting results. There are those studies that found that females have significantly higher levels of math anxiety than males (Alexander & Martray, 1989; Atkinson, 1988; Benn & Burton, 1994; Bernstein, 1992; Betz, 1978; Burton, 1979; Dew, Galassi & Galassi, 1983; Ernest, 1976; Foss & Hadfield, 1993; Hembree, 1990; Llabre & Suarez, 1985; Skiba, 1990; Tobias, 1976, 1980, 1981). Conversely, some studies revealed no significant gender difference in the levels of math anxiety when ability and math background were held constant (Cooper & Robinson, 1989; Flessati & Jamieson, 1991; Gressard & Lloyd, 1987; Heher, 1988; Lussier, 1996; Resnick, Viehe & Segal, 1982; Schumacher, Morahan-Martin & Olinsky, 1993; Ulrich, 1989; Whigham, 1988). A study conducted by Llabre and Suarez (1985) held ability and math background constant and reported that females had higher levels of math anxiety and higher levels of math performance than males.

The most generally accepted belief is that gender is a predictor of math anxiety (Reilly, 1992, p. 1). Some researchers believe that these differences in levels of math anxiety between the genders may actually be due to cultural expectations rather than any real differences in ability; (Ernest, 1976; Flessati & Jamieson, 1991; Fox, 1976; Reilly, 1992; Sells, 1978; Tobias, 1976,1980,1981, 1993). Fennema and Sherman (1977, p. 69) stated that, "many females have as much mathematical potential as do many males. The generalized belief that females cannot do well in mathematics is not supported." Society has discouraged females from excelling in mathematics (Ernest, 1976; Fox, 1976; Rogers & Kaiser, 1995; Sells, 1978; Tobias, 1976; Zaslavsky, 1994). As Tobias (p. 57) puts it, "Math anxiety is a serious handicap. It is handed down from mother to daughter with father's amused indulgence." Lynn Osen (1974), in the preface of Women in Mathematics, states, "Many women in our present culture value mathematical ignorance as if it were a social grace." (cited in Burton, 1979, p.30). Butler and Austin-Martin (1981, p. 8) believe that math anxiety may be more affected by one's perception of what is the appropriate sex-role behavior than by math achievement or math background.

There is a myth believed by some that math proficiency is a male domain. Because of this masculine image, many women and girls are discouraged from studying mathematics (Benn & Burton, 1994, p. 244). Some start to believe that they are not capable of doing mathematics and develop mathematics anxiety from an expectation of failure (Fear-Fenn & Kapostasy, 1992, p.3). Not every female is going to reject mathematics because she believes that she can't be feminine and mathematical at the same time. But, as Kogelman and Warren (1978, p.23) point out, "if she is struggling with her identity, sees math as masculine, and gets reinforcement from parents, teachers, peers, and society, then math becomes something to be rejected."

There are those who believe that math anxiety is more related to poor preparation and negative experiences in mathematics than to gender (Flessati & Jamieson, 1991, p. 310). Those individuals, whether they be male or female, with poor or weak math backgrounds are much more likely to suffer from math anxiety than the general population of females. Research by Betz (1978) reported that math anxiety is a general problem among college students, not just females. Hendel and Davis (1978) suggest that "mathematics anxiety can be just as intense for adult men as for adult women." (p. 434). It may be that males underreport feelings of math anxiety because of the cultural expectation that weakness in mathematics is only acceptable in females. It may be that men have been socialized into not openly displaying their anxiety while women are actively encouraged to feel comfortable in admitting to their anxiety (Benn & Burton, 1994, p. 245). Flessati and Jamieson (1991) state, "the two findings that females are more self-critical of math anxiety in themselves, and are more self-critical of their performance in math could explain the gender difference in mathematics anxiety" (p. 311).

In summary, the research that has been conducted over the last 25 years has not resulted in a general consensus about the relationship between math anxiety and gender. It is the belief of this researcher that males suffer from mathematics anxiety as much as females, given similar math backgrounds. Females, however, may report higher levels of math anxiety, possibly because males are not as aware or as ready to admit to having mathematics anxiety. It was suggested that how well a person performs in math may be related to her or his mathematics anxiety.

Math Anxiety and Performance

Twenty-eight articles, papers and dissertations that reported on examinations of the relationship between mathematics anxiety and mathematics performance were found in the literature review. Two articles (Engelhard, 1990; Tocci & Engelhard, 1991) were written about the same research project; the

Second International Mathematics Study (SIMS) of over seven thousand 13 year-olds in the United States and Thailand. Both articles reported a significant relationship between math anxiety and math performance. Though both articles will be listed when categorizing the studies, they will be counted as one. Also noteworthy is the fact that the article by Hembree (1990) is a meta-analysis of 151 studies conducted on a total of over 10,000 students in grades one through twelve. Hembree concluded "mathematics anxiety depresses performance" (p. 44).

The research has been categorized in three different ways and then analyzed. First the studies will be split into two groups; those that found a significant relationship between mathematics anxiety and mathematics performance and those that did not. Next, the research will be categorized and analyzed according to sample population type: 1st-12th grade; undergraduate students; and graduate students. Third, the studies will be categorized by the type of measurement used to evaluate mathematics performance: a standardized test; a single "unstandardized" test; and an average of multiple tests. Analyzing the literature in these ways will give a clearer picture of what the research has found thus far.

The literature divides into two categories, those studies in which a significant relationship between math anxiety and math performance was found and those that did not find a significant relationship. Sixteen studies found a significant relationship between math anxiety and math performance (Adams & Holcomb, 1986; Bassarear, 1991; Betz, 1978; Clute, 1984; Dew, Galassi &

Galassi, 1984; Dwinell & Higbee, 1991; Engelhard, 1990; Frary & Ling, 1983; Green, 1990; Hadfield, Martin & Wooden, 1992; Hembree, 1990; Rapalje, 1987; Schumacher Morahan-Martin & Olinsky, 1993; Vance & Watson, 1994; Sime, Ansorge, Olson, Parker & Lukin, 1987; Tocci & Engelhard, 1991; Williams, 1994). In eleven studies, no significant relationship between math anxiety and math performance was found (Butler & Austin-Martin, 1981; Copper & Robinson, 1989; Fulkerson, Galassi & Galassi, 1984; Gliner, 1987; Llabre & Suarez, 1985; Lupkowski & Schumacher, 1991; Meece, Wigfield & Eccles, 1990; Resnick, Viehe & Segal, 1982; Rothenberg & Harrington, 1994; Rounds & Hendel, 1980; Siegel, Galassi & Ware, 1985).

The sample sizes in two studies (Hembree, 1990; Tocci & Engelhard, 1991) that did find a significant relationship between math anxiety and math performance are over 7,000. The largest sample size in the group of studies that did not find a significant relationship is 1,106 (Resnick, Viehe & Segal, 1982). From this standpoint the research seems to be more in favor of the existence of a significant relationship between mathematics anxiety and mathematics performance.

These 27 studies can also be grouped according to sample type; first through twelfth grades, undergraduate level and graduate level students. Seven studies researched the first through twelfth grade student population (Engelhard, 1990; Gliner, 1987; Hadfield, Martin & Wooden,1992; Hembree, 1990; Lupkowski & Schumacher, 1991; Meece, Wigfield & Eccles, 1990; Tocci & Englehard, 1991; Williams, 1994). Four studies have graduate student populations (Adams &

Holcomb, 1986; Rothenberg & Harrington, 1994; Rounds & Hendel, 1980; Schmucher, Morahan-Martin & Olinsky, 1993). The remaining 16 studies have undergraduate student populations. Since this present study has a community college population it seems appropriate to take a closer look at these 16 studies.

Two of the 16 studies (Cooper & Robinson, 1989; Resnick, Viehe, & Segal, 1982) have populations considerably different from the present study. Cooper and Robinson studied undergraduates that were identified as mathematics and science talented. Resnick, et al. researched students in Pre-Calculus through Calculus III. The population for this study is taken from students in Introductory Algebra and Basic College Algebra classes. Therefore, these two studies will be eliminated from this group of sixteen.

Only four studies of the fourteen studies investigating undergraduates did not find a significant relationship between mathematics anxiety and mathematics performance (Butler & Austin-Marten, 1981; Fulkerson, Galassi & Galassi, 1984; Llabre & Suarez, 1985; Siegel, Galassi & Ware, 1985). The remaining ten studies did find a significant relationship between mathematics anxiety and mathematics performance (Bassarear, 1991; Betz, 1978; Clute, 1984; Dew, Galassi & Galassi, 1984; Dwinell & Higbee, 1991; Frary & Ling, 1983; Green, 1990; Rapalje, 1987; Sime et al, 1987; Vance & Watson, 1994). Looking at these studies from a population classification perspective, the research supports evidence of the existence of a significant relationship.

Another way to analyze these 27 studies is to look at the way the measurement for the variable *mathematics performance/achievement* is measured. It is different across the research and quite possibly not equivalent. Three different types of measurements were used for this variable: a one time standardized test [ACT-Quantitative, California Test of Basic Skills (CTBS), Florida CLAST-MATH exam, SAT-Math]; a one time "in house" exam; and a combination of two or more mathematics tests (as in a course grade). Two studies are eliminated from this analysis. Hembree (1990) compiled 151 studies and therefore cannot be placed in one category. Rothenberg and Harrington (1994) is eliminated because math performance was measured by the average of two exams in a research design course. The exams covered some statistics, types of research, processes of research and critiquing of the literature, which are not mathematics topics and therefore not a true measure of mathematics performance.

Categorizing the 25 remaining studies by the way the mathematics performance variable is measured produces some interesting results. Seven studies used standardized tests; eight studies used a one time test, and ten studies used a combination of two or more tests. The percentage of each category that did find a significant relationship is as follows: 57% of the standardized test group; 63% of the one time test group; and 70% of the multiple test group. Once again the research lends support to the conclusion of a significant relationship.

It seems that a combination of multiple tests would be a better estimate of mathematics performance rather than a one time test. The measurement of mathematics performance for this study will be the final math course grade which is an average of multiple test scores. In this literature review there are six studies (Dew, Galassi & Galassi, 1984; Dwinell & Higbee, 1991; Frary & Ling, 1983; Green, 1990; Llabre & Suarez, 1985; Sime et al, 1987) that researched the undergraduate population and measured mathematics performance by multiple test grades. All but one study (Llabre & Suarez) found a significant relationship between mathematics anxiety and math performance. So, once again the preponderance of evidence from the literature is that a significant relationship between mathematics anxiety and mathematics performance exists.

In summary, there is considerable research to support both sides of the issue. However, the premise that mathematics anxiety does have a significant relationship to mathematics performance appears to have stronger evidence. Whether anxiety causes poor performance or the performance (exam) causes the math anxiety is unclear. It would seem that the level of a student's math performance, whether it be an exam or a standardized test, would be affected by the level of the student's math anxiety.

Math Anxiety and Learning Style

Relatively few research studies that explore the relationship between math anxiety and learning style surfaced in the literature review. Learning style is a complex phenomenon. James and Blank (1993) break learning style down into three dimensions: cognitive (information processing), affective (attitude and personality), and physiological (perceptual modes, time of day preference, noise level tolerance). The Dunn and Dunn (1993) learning style model breaks learning style down to five dimensions, which in turn, break down to a total of 21 elements. The five dimensions are: environmental, emotional, sociological, physiological, and psychological. Perceptual learning style mode is also an element under the physiological dimension in this model. The perceptual learning style mode refers to whether the student learns best by audio (hearing), visual (seeing), tactile (touching), or kinesthetic (doing).

Hadfield and Maddux (1988) explored the relationship between math anxiety and the cognitive learning styles of field dependence/independence. He found a significant relationship between math anxiety and field dependence. Hadfield, Martin and Wooden (1992) researched a relationship between math anxiety and eight learning style modes. The eight styles were: analytic (field dependent /independent), spatial, discrimination, categorizing, sequential processing, memory, persistence orientation and verbal-spatial response. The three dimensions of learning style that showed a significant relationship with math anxiety were: spatial skills, discriminatory skills, and persistence motivation.

Hinkle (1986) researched the relationship between math anxiety and cognitive learning style. The learning style modes could be summarized by the words "feeling, watching, thinking, doing" (p. 58). The learning styles were measured along a continuum of two dimensions: abstract-concrete and active-reflective. A significant positive relationship was found between reflective observation and math anxiety. A significant negative relationship was found between concrete experience and math anxiety.

Bessant (1995) investigated the relationship between math anxiety and a different dimension of learning style. He was interested in studying motives and strategy styles categorized as *deep, surface* or *achieving*. He was looking at cognitive and affective learning styles. Surface approach and surface motive showed significant positive correlations with math anxiety. The surface orientation practices utilitarian attitudes toward learning and centers on extrinsic rewards.

Only two articles have been found relating math anxiety and perceptual learning style. Hodges (1983) proposed that math anxiety and learning styles were interrelated. She believed that "...the perceptual element of learning style is the most important." of the physical elements of learning style (p. 19). McCoy (1990, 1992) conducted a study of 78 preservice and inservice elementary school teachers, most of whom were women. The purpose of the study was to examine the relationship between math anxiety and perceptual learning style preferences. The results of the study revealed a significant relationship between math anxiety and the tactile/kinesthetic mode. McCoy noted that she grouped the modes of tactile and kinesthetic into one mode "tactile/kinesthetic" as Cruikshank and Sheffield (1988) also did. The present study will also use this single classification.

In summary, there is a need for further investigation into the relationship between perceptual learning styles and mathematics anxiety. McCoy studied 78 teachers who were mostly women. Research is needed on a student population of males and females. The present study meets this need.

Summary

In conclusion, the research supports the idea that mathematics anxiety is an issue for adults. The jury is still out as to whether or not mathematics anxiety is more a female issue. There are contradictory research results for the issue of mathematics anxiety being related to mathematics performance. Very little has been done studying perceptual learning styles in relation to mathematics anxiety. The present study addresses these issues and provides evidence for a better understanding of how all the variables are related.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

Introduction

This study was comprised of two major components. In the first component perceptual learning style, gender and age were examined in relation to mathematics anxiety level. In the second component perceptual learning style, mathematics anxiety level, gender, and age were studied in relation to performance in a mathematics course.

Subjects

The participants in this study were 501 students of at least 18 years of age who were enrolled in mathematics courses at a public community college in southeast Florida. The participants were enrolled in one of two mathematics courses. The two mathematics courses were the remedial credit course Introductory Algebra (MAT0024) or the college credit course Basic College Algebra (MAC1102). The participants were enrolled in these courses during the spring term of 1997. There were 252 (50.3%) college credit participants and 249 (49.7%) remedial credit participants (Table 1). Participation was voluntary. The subjects for this study came from the class sections of those instructors who volunteered to participate.

Table 1
Descriptive Statistics for Total Sample

	#	%
Total	501	100.0
Female	324	64.7
Male	177	35.3
College Credit	252	50.3
Remedial Credit	249	49.7

Originally there were 560 students who filled out the questionnaire, but 59 were not able to be used. One instructor gave the questionnaire to 20 students in a course different from the ones being studied. These questionnaires were therefore eliminated. There were 39 students who left at least one item blank, so these questionnaires were also eliminated. The usable sample size was 501 students.

The sample was comprised of 324 (64.7%) females and 177 (35.3%) males (Table 1). The gender representation of the sample was similar to that of the community college population as a whole. The mean percentages of the community college population according to gender during the spring semester over the last three years (1994, 1995, 1996) were 61.8% females and 30.2% males (Table 2). For the spring 1997 semester the community college population was 62.6% females and 37.4% males (Table 2).

Table 2
Sample by Gender and Ethnicity

	% Female	% Male	% American Indian/ Alaskan	% Asian/ Pacific Islander	% Black Non Hispanic	% Hispanic	% White Non Hispanic
Spring '94	60.8	39.2	.6	1.2	12.0	3.6	82.6
Spring '95	64.4	35.6	.5	1.3	13.6	3.7	80.8
Spring '96	60.3	39.7	.2	1.5	14.1	4.8	79.4
Mean Over Last 3 Years	61.8	30.2	.4	1.3	13.2	4.0	80.9
Spring '97	62.6	37.4	.6	1.3	13.7	5.8	78.6
Study Sample	64.7	35.3	1.6	.6	11.3	6.1	78.8

The frequency of the distribution of participants in the eleven age categories is reported in Table 3. There were 218 (43.5%) in the total sample in the 18 - 20 years category and 230 (45.9%) in the categories ranging from 21 - 39 years. The mean age group of the total sample was 2.65. Age group 2 is 21 - 25 years and age group 3 is 26 - 29 years. The mean age of students enrolled in these two courses at the community college during spring semester over the last three years (1994, 1995, 1996) was 26.0 years (Table 4). The mean age of all students enrolled in these two courses during spring semester 1997 was 25.5 years (Table 4). This sample was therefore a good representation of the community college population during this time in terms of age.

Table 3
Frequency in Each Age Category for Different Groups

Age	Group	Total	Female	Male	College Credit	Remedial Credit
(18 - 20)	1	218	127	91	122	96
(21 - 25)	2	81	37	44	45	36
(26 - 29)	3	51	40	11	21	30
(30 - 34)	4	48	36	12	22	26
(35 - 39)	5	50	44	6	21	29
(40 - 44)	6	32	22	10	11	21
(45 - 49)	7	11	9	2	7	4
(50 - 55)	8	7	6	1	2	5
(55 - 59)	9	2	2	0	1	1
(60 - 64)	10	0	0	0	0	0
(65 - up)	11	1	1	0	0	1
Total		501	324	177	252	249

Table 4
Mean Age at the Community College for Different Groups

	College Credit & Remedial	College Credit	Remedial	Female	Male
Spring '94	26.0	25.0	27.5	26.8	24.9
Spring '95	26.7	25.5	28.5	27.2	25.5
Spring '96	25.5	24.4	27.3	26.4	23.9
Mean Over Last 3 Years	26.0	25.0	27.8	26.8	24.8
Spring '97	25.5	24.3	27.3	26.8	23.3

The mean age of students in the college credit math course over the last three spring semesters (1994, 1995, 1996) was 25.0 years (Table 4). For spring semester 1997 the mean age of all students enrolled in this course at the community college was 24.3 years (Table 4). The mean age group of the college credit participants in this study was 2.41.

The mean age of the students in the remedial credit math course over the last three spring semesters (1994, 1995, 1996) was 27.8 years (Table 4). The mean age of all students in this course during spring semester 1997 was 27.3 years (Table 4). The mean age group of remedial credit students in this study was 2.90.

The ethnic distribution (Table 2) over the last three spring semesters (1994, 1995, 1996) at the community college was 80.9% white, non Hispanic; 13.2% black, non-Hispanic; 4.0% Hispanic; 1.3% Asian or Pacific Islander; and .4% American Indian or Alaskan. The percentages for the study sample (Table 2) were similar: 78.8% white, non-Hispanic; 11.3% black, non-Hispanic; 6.1% Hispanic; 1.6% American Indian or Alaskan; and .6% Asian or Pacific Islander.

The number of participants from each ethnic category in each of the five groups (total, female, male, college credit participants, remedial credit participants) are found in Table 5. Some of the ethnic groups had very few participants. There were no male Asians or Pacific Islanders in the sample. There was only one Asian or Pacific Islander participant in the remedial course. There were only eight American Indians or Alaskans in the total sample. Though this is a representative sample of the community college population, generalizations about certain ethnic groups in the study would be inappropriate because of the small numbers in these groups.

Table 5
Frequency in Each Ethnic Category for Different Groups in the Sample

	Category	Total	Female	Male	College Credit	Remedial Credit
(White, Non-Hispanic Origin)	2	390	254	136	197	193
(Asian or Pacific Islander)	3	3	3	0	2	1
(American Indian or Alaskan Native)	4	8	6	2	4	4
(Hispanic)	5	30	16	14	11	19
(Black, Non Hispanic)	6	56	36	20	31	25
Other	7	8	6	2	4	4
Total		495	321	174	249	246

Procedure

Two field tests were run during the two summer sessions in 1996. The sample size in each field test was 33 and 55 respectively. The samples in both field tests were Basic College Algebra students.

During December 1996 those instructors who had at least one section of Introductory Algebra or Basic College Algebra for the spring 1997 term were contacted. Each instructor was invited to participate in a research study involving mathematics anxiety and learning styles.

Each participating instructor was given a packet and an Instructor Information Sheet (Appendix A). In the packet there was a cover letter that was to be read verbatim by the instructor to the students (Letter to Students) (Appendix B). This letter explained the purpose of the project, how each student could benefit from participating, the fact that participation was voluntary and the assurance of confidentiality. The letter also explained that each student who participated would receive a printout of her or his perceptual learning style profile and information on how to enhance these styles to help increase success in mathematics. It should be noted here that each participating instructor also received a printout of her or his perceptual learning style profile.

The packet also included a consent form (Appendix C) and a questionnaire for each participant. Every participant was given a personal code which was written on the consent form and the questionnaire. There was a roster page for the list of participants' names and corresponding codes. This roster was retained by the researcher until the end of the term.

In one of the first three class meetings of the spring term the students in the classes of the participating instructors were invited to participate in the study. At that time those students who volunteered to participate were given the questionnaire to complete during class. The instrument took about 30 minutes to complete. The questionnaire had three parts: first, the brief mathematics anxiety rating scale (BMARS) (Appendix D); second, the learning style inventory - adapted (LSI-A) (Appendix E); and third, a demographics survey (Appendix F). The questionnaire included items relating to sources or contexts of mathematics anxiety and learning preferences: visual, audio, or t/k.

The participating instructors were asked to complete the learning styles inventory and the demographic information. At the end of the term the instructors were given the roster sheets and filled out the final grades of the participants in each class. This list was then forwarded to the researcher.

Instruments

The questionnaire was comprised of three parts: the brief mathematics anxiety rating scale (BMARS); the learning style inventory - adapted (LSI-A), and a demographics survey. The mathematics anxiety scale has 25 items. The learning style inventory has 50 items and the demographics survey has 6 items. The questionnaire required 30 minutes to complete.

Brief Mathematics Anxiety Rating Scale (BMARS)

The instrumentation used to measure mathematics anxiety level is a subscale of the Mathematics Anxiety Rating Scale (MARS) developed by Suinn (1972). Fulkerson, Galassi and Galassi (1984, p. 378) stated that the MARS "...is the most commonly used of the math anxiety measures, and it has the greatest amount of psychometric, reliability, and validity data." The MARS is a 98 item five point Likert type instrument ranging from "not at all" (1) to "very much" (5). Each item refers to a situation or experience related to mathematics that may cause tension or anxiety for the individual. The items are summed, resulting in a single score scale. Suinn (1972) reported an internal consistency reliability of .97 and a test-retest reliability of .85 over a seven week period. Dew, Galassi and Galassi (1983) calculated a Cronbach alpha of .96 and a two-week test-retest reliability of .87.

The one drawback to the full version MARS is the length--98 items--which takes about 45 minutes to complete. A shorter version of this instrument was needed to allow enough time in one class period for the participant to complete a math anxiety scale, a learning style inventory and a demographics survey. Plake and Parker (1982) developed the Revised Mathematics Anxiety Rating Scale (RMARS) which is a shorter version of the MARS containing 24 items. The instrument was designed for college students in an introductory statistics class. The reliability analysis of the responses to the RMARS resulted in a coefficient alpha of .98, and the correlation between the scores on the RMARS and the MARS was .97. Plake and Parker (1982) concluded that the RMARS is a valid substitute for the full scale MARS for measuring course-related mathematics anxiety.

Over 40 research studies were found that used either the MARS or the RMARS to measure mathematics anxiety. Six studies were found that used the RMARS to measure mathematics anxiety (Atkinson, 1988; Foss & Hadfield, 1993; Llabre & Suarez, 1985; Plake & Parker, 1982; Royse & Rompf, 1992; Sime et al, 1987). Over 35 studies were found that used the MARS or some subscale of it. Since there are so many studies they will be categorized according to the decade in which the study took place.

Five studies were found that used the MARS during the 1970's (Mathison, 1979; Morris, Kellaway & Smith, 1978; Richardson & Suinn, 1972, 1973; Suinn & Richardson, 1971). Twenty four studies were found during the 1980's (Alexander & Martray, 1989; Adams & Holcomb, 1986; Battista, 1986; Cemen, 1987; Clute, 1984; Dew, Galassi & Galassi, 1983, 1984; Fulkerson, Galassi & Galassi, 1984; Gourgey, 1984; Hadfield & Maddux, 1988; Hendel, 1980; Hunsley & Flessati, 1988; Kelly & Tomhave, 1985; Kostka & Wilson, 1986; Lindbeck & Dumbrot, 1986; Lockie, 1989; McAuliffe & Trueblood, 1986; Mevarech & Ben-Artzi, 1987; Potts, 1989; Resnick, Viehe & Segal, 1982; Rounds & Hendel, 1980; Shodahl & Diers, 1984; Ulrich, 1989; Wigfield & Meece, 1988). Ten studies were found in the 1990's (Bessant, 1995; Bush, 1991; D'Ailly & Bergering, 1992; Ellman, 1991; Flessati & Jamieson, 1991; Hadfield, Martin & Wooden, 1992; Rothenberg & Harrington, 1994; Schneider & Nevid, 1993; Vance & Watson, 1994; Wadlington, Austin & Bitner, 1992).

Some of the items on the RMARS were not deemed appropriate for the sample of the present study. The items referred to statistics, chemistry, and using tables in the back of a textbook. A different 25 item version was developed for use in this study. This instrument, which will be referred to as the Brief Mathematics Anxiety Rating Scale (BMARS), contains all but ten of the items on the RMARS. The ten other items which were chosen from the full scale MARS seemed more appropriate for an Introductory Algebra and Basic College Algebra population. The numbers of the items on the BMARS which are changed from the RMARS are: 4, 7, 11, 12, 14, 15, 17, 19, 23, and 24. Two Cronbach alpha reliability studies of the BMARS were conducted by the researcher at the participating institution on Basic College Algebra students during both summer sessions in 1996. The reliability coefficient for each study reported alpha levels of .96 (n=33) and .94 (n=55). The BMARS, which is actually a subscale of the MARS, was used with written permission from Dr. Suinn (Appendix G).

Scoring for the BMARS is the same as for the MARS. The items are summed, resulting in a single-scale score. The range of possible scores is from a low of 25 to a high of 125. The higher the score the more intense the feelings of mathematics anxiety for the individual.

Learning Style Inventory-Adapted (LSI-A)

The instrument to measure perceptual learning style for this study is adapted from the Learning Style Inventory (LSI) (Brown & Cooper, 1993) which is adapted from the Center for Innovative Teaching Experience Learning Style Instrument (CITE-LSI) (Babich, Burdine, Albright & Randol, 1976). CITE was a Title III project for the Wichita Public School System. The project was conducted by the Murdock Teacher Center, Wichita, Kansas. During a telephone interview (Aug., 1996) Nolting (1990) reported a high face validity for the LSI and CITE-LSI based on using the instrument for eight years on over 5,000 community college students. Face reliability refers to a participant self report of the accuracy of the instrument--no actual numbers are recorded. The original target population for the CITE-LSI was junior high school students. Babich and Randol (1976) reported reliabilities for the CITE-LSI on this population, but the statistics could not be used because the population is different from the population for this study. A reliability study was necessary for two reasons: the population was different, and the instrument had been adapted.

The LSI (like the CITE-LSI) is a 45 item, four-point Likert type instrument ranging from "least like me" (1) to "most like me" (4). The items describe different ways of learning and the respondent reports how well the statement describes the way she or he learns. The LSI measures three types of learning styles: perceptual; social (group or individual learner); and expressive (oral or written).

This study is only concerned with the perceptual learning style scales of the instrument. The perceptual learning style for the LSI is divided into five categories: visual language; visual numeric; audio language; audio numeric; and tactile-concrete. Five items are assigned to each category. A score for each category or subscale is arrived at by summing the items and then doubling the sum.

The adapted version of the LSI (LSI-A) has 50 items. Five additional items were added by the researcher measuring the tactile/kinesthetic mode. It should be noted here that the LSI-A uses the terminology "tactile/kinesthetic." The LSI uses "tactile-concrete" and the original CITE-LSI used "audio-visual-kinesthetic." Tactile/kinesthetic is actually a combination of the two previous labels. As was mentioned earlier in the literature review, the term "tactile/kinesthetic" (t/k) has been used in the research (Cruikshank & Sheffield, 1988; McCoy, 1990, 1992).

When the reliability study was done maintaining the 5 categories of the LSI some of the reliability levels were unacceptable (alpha < .7). However, when combining both visual subscales into one visual mode and the two audio subscales into one audio mode, the reliabilities improved. The reliability levels for the three subscales were all above .7: audio (.71); visual (.72); and tactile/kinesthetic (.81). Each perceptual learning style subscale on the LSI-A contains 10 items. The number of the items assigned to each variable are: audio (3, 7, 11, 15, 19, 23, 31, 36, 39, 44); visual (5, 9, 13, 17, 21, 25, 29, 33, 37, 41); and tactile/kinesthetic (1, 18, 26, 34, 42, 46, 47, 48, 49, 50). The score for each subscale is arithmetic mean of the responses for each variable multiplied by two.

The scores will range from 2 to 8. The higher the score, the stronger the preference for that learning style.

A perceptual learning style profile was calculated for each participant. The profile consisted of the three scores; audio, visual and t/k respectively. Based on the high validity, acceptable reliability and ease of administration the LSI-A has been chosen to measure perceptual learning style for this study.

Demographics Survey

The demographics survey had six items. The participants were instructed to check the appropriate response for each statement. The first item refers to age group. The age groups were broken down into eleven categories: 18-20; 21-25; 26-29; 30-34; 35-39; 40-44; 45-49; 50-54; 55-59; 60-64; and 65 and up. The second and third items refer to ethnicity and gender respectively. The ethnic categories are the same categories that the participating institution uses on its admission form with the addition of an "other" category. The fourth item asked how many years of math the respondent took in high school at the Algebra 1 level or above. The fifth item asks for the number of years since the participant last took a math course. The sixth item asks the type of diploma the participant earned; regular or Graduate Equivalency Diploma (GED).

Data Analysis

The Statistics Package for the Social Sciences (SPSS) for Windows Version 6.1 software package was used to analyze the data. Ten multiple regression analyses were done in order to answer the ten research questions as they relate to five different groups. The five groups included the whole sample and four subgroups: females; males; the students in the remedial course (MAT 0024, Introductory Algebra); and the students in the college credit course (MAC 1102, Basic College Algebra).

For the first five research questions there were five predictor variables: perceptual learning style (audio level, visual level, t/k level), gender, and age. The criterion variable was mathematics anxiety level. For the last five questions there were six predictor variables: math anxiety level; perceptual learning style (audio level, visual level, t/k level); gender; and age. The criterion variable was performance in the mathematics course. The alpha level used for this study was .05.

CHAPTER FOUR

ANALYSIS OF THE DATA

Findings

The purpose of this study was to investigate the relationships among and between perceptual learning style (audio, visual, t/k), age, gender, math anxiety and math performance.

Under the heading of *Descriptive Statistics* the means for all the variables are presented. Any statistically significant differences between means are noted. The 'Correlations' section contains all the correlations between each of the variables studied. The ten multiple regressions that were performed are reported in the 'Regressions' section.

Descriptive Statistics

The means and standard deviations were calculated for math anxiety level, audio level, visual level, tactile/kinesthetic (t/k) level, and age for the following groups: total participants, females, males, participants in the college credit course, and participants in the remedial credit course. These values are reported in Table 6.

Table 6
Descriptive Statistics of Variables by Groups

		Math Anxiety Level		Auditory Level		Visual Level		Tactile/ Kinesthetic Level		Age	
	N	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Total	501	66.05	20.89	4.79	1.38	5.91	1.07	5.54	1.13	2.65	2.00
Female	324	68.56	21.66	4.77	1.40	5.98	1.06	5.49	1.16	2.95	2.07
Male	177	61.45	18.62	4.84	1.36	5.78	1.09	5.62	1.08	2.10	1.60
College Credit	252	65.97	21.59	4.76	1.40	5.92	1.11	5.56	1.18	2.41	1.84
Remedial Credit	249	66.13	20.22	4.83	1.37	5.90	1.02	5.51	1.08	2.90	2.05

Math Anxiety Level

The mean math anxiety level for the total sample was 66.05. The mean math anxiety level for males (61.45) was lower than the mean math anxiety level for females (68.56). There was a statistically significant difference between the mean math anxiety level for males and females, $F(1, 499) = 13.58$, $p < .001$. The mean math anxiety level for the college credit course participants (65.97) was slightly but not significantly lower than the mean math anxiety level for the remedial credit course participants (66.13).

Audio Learning Style Level

The mean audio level for the total sample was 4.79. The mean audio level for males (4.84) did not differ significantly from the mean audio level for females (4.77). The mean audio level for college credit participants (4.76) did not differ significantly from that of the remedial credit participants (4.83).

Visual Learning Style Level

The mean visual level for the total sample was 5.91. The mean visual level for males (5.78) was significantly different from the mean visual level for females (5.98). Females recorded a significantly higher visual level than males, $F(1, 499)= 4.20$, $p<.05$. There was not a significant difference between the college credit sample (5.92) and the remedial credit sample (5.90) for visual level.

Tactile/Kinesthetic (t/k) Learning Style Level

The mean t/k level for the total sample was 5.54. There was no statistically significant difference between the means for t/k level of males (5.62) and females (5.49). There was no statistically significant difference between the means for t/k level of college credit participants (5.56) and remedial credit participants (5.51).

Age

The mean age group for all the different subgroups was between groups two and three. Age group 2 was from 21 -25 years old. Age group 3 was from 26 - 29 years. The mean age group for the total sample was 2.65 (26 yrs.). The mean age group for males (2.10)(22 yrs.) was less than for females (2.95)(29 yrs.). There was a statistically significant difference between the mean ages of males and females, $F\ (1, 499) = 22.63$, $p < .0001$. The mean age group for the college credit sample (2.41)(24 yrs.) was less than for the remedial credit sample (2.90)(28 yrs.). There was a statistically significant difference between the mean ages of the college credit sample and the remedial credit sample, F (1, 499) = 7.73, p <.01.

Grades

Table 7 contains the means and standard deviations for the subgroup of the total sample who received letter grades from A - F in the math course. From the total sample size of 501 participants only 337 received letter grades from A - F. The remaining 164 participants received one of the following: withdrawal (W); incomplete (I); or no grade because their names were not on the final class roster because they had dropped the class during the first few meetings of the term which is the "drop - add" period.

Table 7
Mean and Standard Deviation of Grade of Subgroup of the Sample Who Received Letter Grades from A-F

	N	$\bar{x}$	sd
Total	337	2.65	1.26
Female	220	2.92	1.15
Male	117	2.15	1.32
College Credit	186	2.24	1.37
Remedial Credit	151	3.17	.88

The grades were computed on the typical 4.0 scale (A=4; B=3; C=2; D=1; F=0). The mean grade for the total subgroup of 337 was 2.65. The mean grade for males (2.15) was less than the mean grade for females (2.92). There was a statistically significant difference between the mean grades for males and females, F (1, 335) = 31.68, p < .0001. The mean grade for the college credit group (2.24) was less than for the remedial credit group (3.17). There was a statistically significant difference between the mean grades of the college credit group and the remedial credit group, $\underline{F}$ (1, 335) = 52.10, $\underline{p} < .0001$.

Correlations

The correlations between the variables: math anxiety level; audio level; visual level; t/k level; age; and gender for the different groups (total, females, males, college credit, remedial credit) are reflected in Tables 8 - 12. Because of the inconsistencies in meaning for Incompletes (I) and Withdrawals (W) across the two courses, it was necessary to look only at the students who received letter grades from A to F. The students who received I's and W's were eliminated from the sample in the second part of the study and the variable *grade in a math course* was added. The correlations between the variables: grade in a math course; math anxiety level; audio level; visual level; t/k level; age; and gender for the subgroups of the total sample who received letter grades A - F in the math course are reported in Tables 13 - 17.

Math Anxiety Level

Math anxiety level was significantly correlated (p<.001) with three variables: audio level (.193); t/k level (.223); and gender (.163) for the total sample (Table 8).

For the female participants (Table 9) math anxiety level had a statistically significant positive correlation (p<.001) with t/k level (.304) and a statistically significant positive correlation (p<.01) with audio level (.171). For the male

Table 8
Listwise Correlation of Variables of Total Group (N = 501)

	Math Anxiety Level	Age	Audio Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	.007					
Audio Level	.193***	-.123**				
Gender	.163***	.208***	-.025			
Tactile/ Kinesthetic Level	.223***	.026	.186***	-.057		
Visual Level	.050	.139**	-.537***	.091*	.050	

Note. *p < .05 **p < .01 ***p <.001

Table 9
Listwise Correlation of Variables for Female Group (N = 324)

	Math Anxiety Level	Age	Audio Level	Tactile/ Kinesthetic Level	Visual Level
Age	-.062				
Audio Level	.171**	-.087			
Tactile/ Kinesthetic Level	.304***	.038	.152**		
Visual Level	.020	.101*	-.605***	.040	

Note. *p < .05 **p < .01 ***p <.001

participants (Table 10) math anxiety level had a statistically significant positive correlation (p<.001) with audio level (.263) only.

The college credit group is reported in Table 11. Math anxiety level had a statistically significant positive correlation (p<.01) with audio level (.196) and gender (.157). There was a statistically significant positive correlation (p<.001) between math anxiety level and t/k level (.305) for the college credit sample.

Table 10
Listwise Correlation of Variables for Male Group (N = 177)

	Math Anxiety Level	Age	Audio Level	Tactile/ Kinesthetic Level	Visual Level
Age	.068				
Audio Level	.263***	-.205**			
Tactile/ Kinesthetic Level	.080	.041	.253***		
Visual Level	.066	.181**	-.412***	.086	

Note. *p < .05 **p < .01 ***p <.001

Table 11
Listwise Correlation of Variables for College Credit Group (N = 252)

	Math Anxiety Level	Age	Audio Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	.046					
Audio Level	.196**	-.135*				
Gender	.157**	.184**	-.034			
Tactile/ Kinesthetic Level	.305***	.094	.247***	-.061		
Visual Level	.066	.097	-.544***	.116*	.088	

Note. *p < .05 **p < .01 ***p <.001

For the remedial credit group (Table 12) math anxiety level had a statistically significant positive correlation ($p<.01$)with audio level (.190) and gender (.172).There was a statistically significant positive correlation ($p<.05$) between math anxiety level and t/k level (.125).

Math anxiety level did not significantly correlate with either visual level or age for any of the five subgroups.

Table 12
Listwise Correlation of Variables for Remedial Group (N = 249)

	Math Anxiety Level	Age	Audio Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	-.031					
Audio Level	.190**	-.120*				
Gender	.172**	.204**	-.022			
Tactile/ Kinesthetic Level	.125*	-.036	.118*	-.047		
Visual Level	.030	.187**	-.529***	.067	.004	

Note. *p < .05 **p < .01 ***p <.001

Table 13
Listwise Correlation of Variables for Total Subgroup with Grades A-F (N = 337)

	Grade	Age	Audio Level	Math Anxiety Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	.279***						
Audio Level	-.019	-.157**					
Math Anxiety Level	-.046	.000	.172**				
Gender	.294***	.249***	-.107*	.136**			
Tactile/ Kinesthetic Level	-.038	.021	.097*	.204***	-.093*		
Visual Level	.108*	.092*	-.476***	.065	.135**	.146**	

Note. *p < .05 **p < .01 ***p <.001

In Tables 13 - 17 the correlations between the variables are reported for the five subgroups who received letter grades ranging from A - F (total, females, males, college credit, remedial credit). No statistically significant correlation was reported between math anxiety level and grade in a math course for any of these groups.

Table 14
Listwise Correlation for Female Subgroup Receiving Grades A-F (N = 220)

	Grade	Age	Audio Level	Tactile/ Kinesthetic Level	Visual Level	Math Anxiety Level
Age	.233***					
Audio Level	.096	-.102				
Tactile/ Kinesthetic Level	-.049	.039	.036			
Visual Level	-.027	.071	-.518***	.180**		
Math Anxiety Level	-.086	-.057	.147*	.280***	.055	

Note. *p < .05 **p < .01 ***p <.001

Table 15
Listwise Correlation for Male Subgroup Receiving Grades A-F (N = 117)

	Grade	Age	Audio Level	Tactile/ Kinesthetic Level	Visual Level	Math Anxiety Level
Age	.210*					
Audio Level	-.117	-.213*				
Tactile/ Kinesthetic Level	.055	.065	.188*			
Visual Level	.228**	.040	-.384***	.122		
Math Anxiety Level	-.107	.026	.285**	.073	.032	

Note. *p < .05 **p < .01 ***p <.001

Table 16

Listwise Correlation of College Credit Sample Receiving Grades A-F (N = 186)

	Grade	Age	Audio Level	Math Anxiety Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	.282***						
Audio Level	-.007	-.178**					
Math Anxiety Level	-.056	.079	.212**				
Gender	.275***	.253***	-.091	.146*			
Tactile/ Kinesthetic Level	-.015	.078	.153*	.258***	-.087		
Visual Level	.130*	.091	-.499***	.016	.118	.158*	

Note. *p < .05 **p < .01 ***p <.001

Table 17

Listwise Correlation of Remedial Credit Sample Receiving Grades A-F (N = 151)

	Grade	Age	Audio Level	Math Anxiety Level	Gender	Tactile/ Kinesthetic Level	Visual Level
Age	.179*						
Audio Level	-.075	-.148*					
Math Anxiety Level	-.072	-.098	.117				
Gender	.216**	-.198**	-.144*	.118			
Tactile/ Kinesthetic Level	-.089	-.044	.015	.128	-.103		
Visual Level	.097	.099	-.446***	.130	.166*	.128	

Note. *p < .05 **p < .01 ***p <.001

Audio Learning Style Level

For the total sample (Table 8) audio level had a statistically significant positive correlation (p<.001) with math anxiety level (.193) and t/k level (.186). There was a statistically significant negative correlation (p<.001) between audio level and visual level (-.537). There was also a statistically significant negative correlation (p<.01) between audio level and age (-.123).

For the female participants (Table 9) audio level had a statistically significant positive correlation (p<.01) with math anxiety level (.171) and t/k level (.152). There was a statistically significant negative correlation (p<.001) between audio level and visual level (-.605) for the female participants.

For the male participants (Table 10) audio level had significant correlations with all variables. There was a statistically significant positive correlation (p<.001) between audio level and math anxiety level (.263) and t/k level (.253). There was a statistically significant negative correlation (p<.001) between audio level and visual level (-.412). There was a statistically significant negative correlation (p<.01) between audio level and age (-.205) for male participants.

For the college credit sample (Table 11) audio level had statistically significant correlations with all variables except gender. There was a statistically significant positive correlation (p<.01) between audio level and math anxiety level (.196). A statistically significant positive correlation (p<.001) was reported between audio level and t/k level (.247). There was a statistically significant negative correlation (p<.001) between audio level and visual level (-.544). There was also a statistically significant negative correlation (p<.05) between audio level and age (-.135) for college credit participants.

For the remedial credit group (Table 12) there was a statistically significant positive correlation (p<.01) between audio level and math anxiety level (.190). There was a statistically significant positive correlation (p<.05) between audio level and t/k level (.118). There was a statistically significant negative correlation (p<.001) between audio level and visual level (-.529). There was a statistically significant negative correlation (p<.05) between audio level and age (-.120). For the subgroups receiving letter grades from A - F in the math course, (Tables 13 - 17) there were no significant correlations between audio level and grade.

Visual Learning Style Level

Visual level had no significant correlation with math anxiety level for any group in this study. For the total sample (Table 8) there was a statistically significant negative correlation (p<.001) between visual level and audio level (-.537). There was a statistically significant positive correlation between visual level and age (.139, p<.01) and gender (.091, p<.05) for the total sample.

For the females (Table 9) there was a statistically significant negative correlation (p<.001) between visual level and audio level (-.605). There was a statistically significant positive correlation (p<.05) between visual level and age (.101).

For males (Table 10) there was a statistically significant correlation ($p<.001$) between visual level and audio level (-.412). There was a statistically significant positive correlation(.181, $p<.01$) between visual level and age.

For college credit participants (Table 11) there was a statistically significant negative correlation ($p<.001$) between visual level and audio level (-.544). There was a statistically significant positive correlation ($p<.05$) between visual level and gender (.116).

For remedial credit participants (Table 12) there was a statistically significant negative correlation ($p<.001$) between visual level and audio level (-.529). There was a statistically significant positive correlation ($p<.01$) between visual level and age(.187).

Where the variable *grade* was examined in addition to the previous variables mentioned (Tables 13 - 17), visual level was significantly correlated with grade for some of these groups. There was a significant correlation ($p<.05$) between visual level and grade for the total subgroup receiving letter grades (.108)(Table 13) and the college credit subgroup receiving letter grades (.130)(Table 16). There was a statistically significant correlation ($p<.01$) between visual level and grade for the male subgroup receiving letter grades (.228)(Table 15).

Tactile/Kinesthetic (t/k) Learning Style Level

In all the groups in Tables 8 - 12, t/k level was significantly correlated with audio level. In the groups receiving letter grades (Tables 13 - 17) only the females subgroup who received letter grades (Table 14) did not have a significant correlation between t/k level and audio level. There was a statistically significant positive correlation (p<.001) between t/k level and audio level for the following groups: total sample (.186)(Table 8); males (.253)(Table 10); and college credit participants (.247)(Table 11). For females (Table 9) there was a statistically significant correlation (p<.01) between t/k level and audio level (.152). A statistically significant positive correlation (p<.05) was found between t/k level and audio level for the remedial credit participants (.118)(Table 12).

Significant correlations between t/k level and math anxiety were found for all groups except males (Tables 8 - 12). There were statistically significant positive correlations (p<.001) between t/k level and math anxiety for the following groups: total sample (.223)(Table 8); females (.304)(Table 9); and college credit participants (.305)(Table 11). For the remedial credit participants (Table 12) there was a significant correlation (p<.05) between t/k level and math anxiety level (.125).

No significant correlations were found between t/k level and visual level (Tables 8 - 12). However, when looking at the subgroups that received letter grades (Tables 13 - 17), there were some significant correlations between t/k level and visual level. A statistically significant positive correlation (p< .01) was reported between t/k level and visual level for the total subgroup receiving letter grades (.146)(Table 13) and females receiving letter grades (.180)(Table 14). A significant positive correlation (.158, p<.05) was reported between t/k level and visual level for the college credit group receiving letter grades (Table 16).

There were no significant correlations between t/k level and grade or age for any of the groups studied. The only significant correlation (-.093, p<.05) between t/k level and gender was a negative one for the total subgroup who received letter grades (Table 13).

Age

Age was not significantly correlated with math anxiety level or t/k level for any of the groups studied. There was a statistically significant positive correlation (p<.001) between age and gender for the total sample (.208) (Table 8). There was a statistically significant positive correlation (p<.01) between age and gender for college credit participants (.184)(Table 11) and remedial credit participants (.204)(Table 12).

There were statistically significant positive correlations (p<.01) between age and visual level for the following groups: total sample (.139)(Table 8); males (.181)(Table 10); and remedial credit participants (.187)(Table 12). For females (Table 9) there was a significant correlation (p<.05) between age and visual level (.101).

Age was found to have statistically significant negative correlations (p<.01) with audio level for the total sample (-.123)(Table 8) and for males (-.205) (Table 10). There were also significant negative correlations (p<.05) reported between age and audio level for the college credit group (-.135)(Table 11) and the remedial credit group (-.120)(Table 12).

Age was significantly correlated with grade in a math course for all groups. There was a statistically significant positive correlation ($p<.001$) between age and grade for the following groups: total subgroup receiving letter grades (.279)(Table 13); females receiving letter grades (.233)(Table 14); and college credit group receiving letter grades (.282)(Table 16). There were statistically significant positive correlations ($p<.05$) between age and grade for males receiving letter grades (.210)(Table 15) and remedial credit receiving letter grades (.179)(Table 17).

Gender

Gender was significantly correlated to math anxiety level for all groups studied with the exception of the remedial credit group receiving letter grades (Table 17). For the total sample (Table 8) there was a significant correlation ($p<.001$) between gender and math anxiety level (.163). A statistically significant positive correlation ($p<.01$) was found between gender and math anxiety level for the college credit sample (.157)(Table 11) and the remedial credit sample (.172)(Table 12).

The only statistically significant correlations ($p<.05$) between gender and audio level were found for the total subgroup receiving letter grades (-.107)(Table 13) and the remedial credit subgroup receiving letter grades (-.144)(Table 17).

There were statistically significant positive correlations ($p<.05$) between gender and visual level for the total sample (.091)(Table 8) and the college credit sample (.116)(Table 11). The only significant correlation (-.093, p<.05) between gender and t/k level was for the total subgroup receiving letter grades (Table 13).

Gender was significantly correlated to age for all groups studied. There was a significant correlation (p<.001) between gender and age for the total sample (.208)(Table 8). There were statistically significant positive correlations (p<.01) between gender and age for the college credit sample (.184)(Table 11) and the remedial credit sample (.204)(Table 12).

Gender was significantly correlated to grade for all subgroups. There were statistically significant positive correlations (p<.001) between gender and grade for the total subgroup receiving letter grades (.294)(Table 13) and the college credit sample receiving letter grades (.275)(Table 16). A significant correlation (.216, p<.01) was reported between gender and grade for the remedial group receiving letter grades (Table 17).

<u>Grade (Math Performance)</u>

Grade was significantly correlated to age and gender for all groups. There were statistically significant positive correlations (p<.001) between grade and age for the following groups: total subgroup receiving letter grades (.279)(Table 13); females receiving letter grades (.233)(Table 14); and college credit group receiving letter grades (.282)(Table 16). There were significant correlations (p<.05) between grade and age for males receiving letter grades (.210)(Table 15) and remedial credit students receiving letter grades (.179)(Table 17).

Grade and gender were significantly correlated (p<.001) for the total subgroup receiving letter grades (.294)(Table 13) and the college credit group receiving letter grades (.275)(Table 16). In Table 17 there was a significant correlation (p<.05) between grade and gender for the remedial credit group receiving letter grades (.216).

Grade was not significantly correlated to audio level, t/k level, or math anxiety level for any of the groups. Grade was significantly correlated (p<.05) to visual level for the total subgroup receiving letter grades (.108)(Table 13) and the college credit sample receiving letter grades (.130)(Table 16). Grade was significantly correlated (.228, p<.01) to visual level for males receiving letter grades (Table 15).

Multiple Regressions

Ten multiple regressions were performed. Each of the regressions corresponds to one of the null hypotheses in this study. There were two regression models which were performed on each of five different groups. The five different groups are: total sample; females; males; college credit participants; and remedial credit participants.

The results of the first multiple regression model are reported in Tables 18 - 22. This model had the predictor variables: audio level; visual level; t/k level; age; and gender. Note that gender was not a predictor variable in the regressions where the samples are females (Table 19) and males (Table 20). The criterion variable was math anxiety level.

In the regression for the total sample (Table 18) R^2 was .12, $\underline{F}$ (5, 495) = 13.9, $\underline{p}<.0001$. All variables, with the exception of age, contribute significantly to the model. If age were omitted, no statistical significance would be lost.

In the regression for the female sample (Table 19) R^2 was .13, $\underline{F}$ (4, 319) = 11.41, $\underline{p}<.0001$. Audio level, visual level and t/k level contribute significantly to the model. Age does not contribute significantly to the model. Age could be eliminated from the model without losing any statistical significance.

In the regression for the male sample (Table 20) R^2 was .13, $\underline{F}$ (4, 172) = 5.75, $\underline{p}<.001$. The only significant contributors to the model are audio level and visual level. Age and t/k level do not contribute significantly to the model.

In the regression for college credit participants (Table 21) R^2 was .15, $\underline{F}$ (5, 246) = 8.94, $\underline{p}<.0001$. Audio level, gender and t/k level all make significant contributions to the model. Age and visual level do not make significant contributions to the model.

In the regression for the remedial credit participants (Table 22) R^2 was .10, $\underline{F}$ (5, 243) = 5.49, $\underline{p}<.001$. Audio level, gender, and visual level all contribute significantly to the model. Age and t/k level do not make significant contributions.

Table 18
Multiple Regression for Total Sample (Criterion Variable: Math Anxiety Level)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	-.265	.465	-.025	-.570	.569
Audio Level	3.737	.783	.247	4.775	.000
Gender	7.404	1.892	.170	3.914	.000
Tactile/ Kinesthetic Level	3.297	.807	.179	4.087	.000
Visual Level	3.153	.999	.161	3.156	.002
(Constant)	-.243	9.067		-.027	.979

Table 19
Multiple Regression for Female Sample (Predictor Variable: Math Anxiety Level)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	-.718	.552	-.069	-1.301	.194
Audio Level	3.293	1.046	.213	3.149	.002
Tactile/ Kinesthetic Level	5.021	1.001	.268	4.989	.000
Visual Level	2.982	1.372	.145	2.174	.031
(Constant)	9.582	12.181		.787	.432

Table 20
Multiple Regression for Male Sample (Criterion Variable: Math Anxiety Level)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	1.287	.861	.110	1.494	.137
Audio Level	5.219	1.154	.380	4.523	.000
Tactile/ Kinesthetic Level	-.661	1.306	-.038	-.506	.614
Visual Level	3.545	1.387	.207	2.555	.012
(Constant)	16.713	11.847		1.411	.160

Table 21
Multiple Regression for College Credit Sample (Criterion Variable: Math Anxiety Level)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	.096	.715	.008	.134	.893
Audio Level	3.380	1.167	.219	2.895	.004
Gender	7.038	2.636	.161	2.670	.008
Tactile/ Kinesthetic Level	4.516	1.166	.247	3.874	.000
Visual Level	2.793	1.422	.144	1.964	.051
(Constant)	-3.076	12.361		-.249	.804

Table 22
Multiple Regression for Remedial Sample (Criterion Variable: Math Anxiety Level)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	-.643	.624	-.065	-1.030	.304
Audio Level	3.907	1.073	.264	3.642	.000
Gender	8.296	2.793	.185	2.970	.003
Tactile/ Kinesthetic Level	1.860	1.150	.099	1.617	.107
Visual Level	3.344	1.438	.169	2.326	.021
(Constant)	4.893	13.635		.359	.720

The second multiple regression model is reported in Tables 23 - 27. The predictor variables were: math anxiety level; audio level; visual level; t/k level; age; and gender. Again, for those regressions in which the sample was all females (Table 24) or all males (Table 25), gender was not a predictor variable. The criterion variable was grade in a math course. The samples for each of the five regressions come from that subgroup of the total sample who received letter grades A - F in the math course. Participants who received incompletes or withdrawals were not studied in these regressions.

In the regression for the total subgroup receiving letter grades (Table 23) R^2 was .15, F (6, 330) = 9.86, p<.0001. Age, audio level, gender and visual level made significant contributions to the model. Math anxiety level and t/k level did not make significant contributions to the model.

Table 23
Multiple Regression for Total Subgroup with Grades A-F (Criterion Variable: Grade)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	.141	.033	.226	4.274	.000
Audio Level	.119	.059	.121	2.002	.046
Math Anxiety Level	-.006	.003	-.103	-1.918	.056
Gender	.649	.142	.245	4.560	.000
Tactile/ Kinesthetic Level	-.033	.061	-.029	-.535	.593
Visual Level	.159	.078	.122	2.039	.042
(Constant)	.254	.687		.370	.712

In the regression for the female subgroup receiving letter grades (Table 24) R^2 was .08, F (5, 214) = 3.74, $p<.01$. Only age and audio level contributed significantly to this model. Visual level, t/k level, and math anxiety level did not make significant contributions to the model.

In the regression for the male subgroup receiving letter grades (Table 25) R^2 was .11, F (5, 111) = 2.73, $p<.05$. Age and visual level make significant contributions to the model. Audio level, t/k level and math anxiety level do not make significant contributions.

Table 24

Multiple Regression for Female Subgroup Who Received Grades A-F (Criterion Variable: Grade)

Independent Variables in the Equation

Variable	B	SE B	BETA	t	p
Age	.134	.036	.243	3.676	.000
Audio Level	.148	.072	.163	2.059	.041
Tactile/ Kinesthetic Level	-.050	.071	-.050	-.716	.475
Visual Level	.065	.096	.054	.677	.499
Math Anxiety Level	-.004	.004	-.084	-1.215	.226
(Constant)	1.990	.817		2.436	.016

Table 25

Multiple Regression for Male Subgroup Who Received Grades A-F (Criterion Variable: Grade)

Independent Variables in the Equation

Variable	B	SE B	BETA	t	p
Age	.168	.072	.216	2.323	.022
Audio Level	.061	.109	.061	.560	.577
Tactile/ Kinesthetic Level	.012	.119	.000	.101	.920
Visual Level	.328	.135	.246	2.439	.016
Math Anxiety Level	-.010	.007	-.138	-1.452	.149
(Constant)	.130	1.137		.115	.909

Table 26
Multiple Regression for College Credit Subgroup Who Received Grades A-F (Criterion Variable: Grade)

Independent Variables in the Equation					
Variable	B	SE B	BETA	t	p
Age	.189	.053	.256	3.540	.001
Audio Level	.192	.089	.184	2.161	.032
Math Anxiety Level	-.009	.005	-.142	-1.93	.055
Gender	.617	.201	.223	3.068	.003
Tactile/ Kinesthetic Level	-.041	.088	-.035	-.469	.639
Visual Level	.250	.115	.180	2.177	.031
(Constant)	-.788	.979		-.805	.422

In the regression for the college credit subgroup receiving letter grades (Table 26) R^2 was .16, $\underline{F}$ (6, 179) = 5.86, p<.0001. Age, audio level, gender, and visual level contribute significantly to the model. Math anxiety level and t/k level do not make significant contributions.

In the regression for the remedial credit subgroup receiving letter grades (Table 27) R^2 was .08, $\underline{F}$ (6, 144) = 2.10, p>.05. The multiple regression model did not have statistical significance.

Table 27
Multiple Regression for Remedial Subgroup Who Received Grades A-F (Criterion Variable: Grade)

Independent Variables in the Equation

Variable	B	SE B	BETA	t	p
Age	.052	.034	.126	1.522	.130
Audio Level	.012	.064	.017	.186	.852
Math Anxiety Level	-.004	.004	-.085	-1.015	.312
Gender	.366	.168	.184	2.185	.031
Tactile/ Kinesthetic Level	-.055	.070	-.065	-.788	.432
Visual Level	.074	.085	.081	.870	.386
(Constant)	2.405	.796		3.021	.003

Tests of Hypotheses

Each hypothesis was tested at the .05 alpha level.

1. H_0: The set of predictor variables (audio level, visual level, tactile/kinesthetic level, age, gender) predicts math anxiety level no better than chance for the total sample.

Hypothesis 1 was rejected. The multiple regression model predicted math anxiety level significantly better than chance ($p<.0001$) for the total sample.

2. H_0 :The set of predictor variables (audio level, visual level, t/k level, age) predicts math anxiety level no better than chance for the female sample.

Hypothesis 2 was rejected. The multiple regression model predicted math anxiety level significantly better than chance (p< .0001) for the female sample.

3. H_0 : The set of predictor variables (audio level, visual level, t/k level, age) predicts math anxiety level no better than chance for the male sample.

Hypothesis 3 was rejected. The multiple regression model predicted math anxiety significantly better than chance (p< .001) for the male sample.

4. H_0 : The set of predictor variables (audio level, visual level, t/k level, age, gender) predicts math anxiety level no better than chance for the college credit sample.

Hypothesis 4 was rejected. The multiple regression model predicted math anxiety level significantly better than chance (p<.0001) for the college credit sample.

5. H_0 : The set of predictor variables (audio level, visual level, t/k level, age, gender) predicts math anxiety level no better than chance for the remedial credit sample.

Hypothesis 5 was rejected. The multiple regression model predicted math anxiety level significantly better than chance (p<.001) for the remedial credit sample.

6. H_0 : The set of predictor variables (math anxiety level, audio level, visual level, t/k level, age, gender) predicts math performance for grades A - F no better than chance for the total sample.

Hypothesis 6 was rejected. The multiple regression model predicted math performance for grades A -F significantly better than chance ($p<.0001$) for the total sample.

7. H_0 : The set of predictor variables (math anxiety level, audio level, visual level, t/k level, age) predicts math performance for grades A - F no better than chance for the female sample.

Hypothesis 7 was rejected. The multiple regression model predicted math performance for grades A - F significantly better than chance ($p<.01$) for the female sample.

8. H_0 : The set of predictor variables (math anxiety level, audio level, visual level, t/k level, age) predicts math performance for grades A - F no better than chance for the male sample.

Hypothesis 8 was rejected. The multiple regression model predicted math performance for grades A - F significantly better than chance ($p<.05$) for the male sample.

9. H_0 : The set of predictor variables (math anxiety level, audio level, visual level, t/k level, age, gender) predicts math performance for grades A - F no better than chance for the college credit sample.

Hypothesis 9 was rejected. The multiple regression model predicted math performance for grades A - F significantly better than chance ($p<.0001$) for the college credit sample.

10. H_0 : The set of predictor variables (math anxiety level, audio level, visual level, t/k level, age, gender) predicts math performance for grades A - F no better than chance for the remedial credit sample.

Hypothesis 10 was not rejected. The multiple regression model did not predict math performance for grades A - F significantly better than chance ($p=.056$) for the remedial credit sample.

CHAPTER FIVE

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Conclusions and Implications

This research explored possible relationships between and among perceptual learning style (audio, visual, t/k), age, gender, math anxiety and math performance. A questionnaire was assembled to measure math anxiety level and perceptual learning style. Questions 1 - 50 came from the LSI-A, an adaptation of the CITE-LSI which measures learning style. The BMARS, a subscale of the MARS which measures math anxiety level, comprised the next 25 questions.

It was hypothesized that learning style (audio, visual, t/k), age, and gender would predict math anxiety level. It was also hypothesized that learning style, math anxiety level, age, and gender would predict math performance.

The findings revealed that math anxiety level has a significant positive correlation with audio level, t/k level, and gender for the total group. Also, for the total group, all three perceptual learning styles (audio, visual, t/k) and gender significantly contributed to the regression model to predict math anxiety level. It was found that females had significantly higher math anxiety levels than males.

For the female group math anxiety level was significantly positively correlated with t/k and audio learning styles, and all three learning styles significantly contributed to the regression model to predict math anxiety level. The model accounted for 12.5% of the variance in math anxiety level. For the male group math anxiety level was significantly positively related only to audio learning style. However, both audio level and visual level significantly contribute to the regression model for predicting math anxiety level, which accounted for 11.7% of the variance in math anxiety level.

Looking at the groups by course, math anxiety level was significantly correlated with audio level, t/k level, and gender for both the college credit group and the remedial credit group. The regression models for both courses have two learning styles and gender as significant contributors. The college credit course has the learning styles audio and t/k as significant contributors and the remedial credit course has audio and visual as significant contributors.

These findings suggest that even though different learning styles were significant for different groups, learning styles do play a significant role in math anxiety levels. Educators need to consider the learning style preferences of the students. If a teacher is aware of her or his learning style and that of the student, then attempts can be made to adapt the teaching style to provide teaching approaches compatible with a variety of student learning styles. This will help prevent a rise of math anxiety level. Individual tutoring or assistance could also be more effectively designed to accommodate the student's learning style.

The most preferred learning style for the participants in this study was the visual mode, followed closely by t/k; audio was a distant third. It seems mandatory to complement the lecture mode, which matches with the least preferred learning style, with techniques that will match or enhance the visual and t/k modes. This can be done by the use of graphics calculators, interactive computer programs and math manipulatives where the students can work hands on or see visual demonstrations.

Math anxiety causes discomfort with learning. When a learner is uncomfortable she or he may give up or avoid the situation to eliminate the discomfort. This then contributes to the retention issues that colleges are already battling. Educators need to be aware of the students' comfort level with the material being presented.

The finding that age was not significantly correlated to math anxiety levels for the subjects in this study was not anticipated by the researcher. One possible explanation for this might be that those older people in either course may have started at the community college in the lowest level remedial credit course where time is spent on math study skills and test taking techniques which help a person with math anxiety. Therefore, by the time the older student reaches the levels of the courses being evaluated for this study, intervention strategies taken by instructors in the lower level courses may have already had an impact on the student's level of math anxiety. There was no question on the survey about whether or not this was the first math course that they were taking at the community college. This information may have put a different light on the results.

The other possible explanation for age not being significantly related to math anxiety level may be due to the level of courses that were studied. These were low level math courses. Even the college credit math course is an entry level course for those who had not mastered Algebra 1 and Algebra 2 in high school. So, it would be reasonable to assume that these younger students right out of high school would be more anxious than those students who had placed into precalculus. Perhaps it would have been more appropriate to look for age to be a significant factor in the higher level classes rather than the lower level ones which were chosen for this study.

The other idea that was hypothesized was that perceptual learning style (audio, visual, t/k), math anxiety level, gender, and age would predict performance in a math course. The findings revealed that grade was significantly positively correlated to visual level, age, and gender. The audio and t/k learning styles were not significantly correlated to grade for any group. In the multiple regression model for the total group who received letter grades (Table 23) age, audio level, gender and visual level made significant contributions to the model. Math anxiety level and t/k level did not make significant contributions to the model for any group.

The fact that math anxiety level did not significantly correlate to grade and was not a significant contributor to the model was not expected by the researcher. Part of this may be due to the possibility that those with higher math anxiety levels did not survive the course to get a letter grade but rather withdrew or received an incomplete. Since visual learning style played a significant role in relation to performance, then educators need to take care that students "see" and understand the mathematics.

The fact that age had a significant positive correlation with grade has some interesting implications. One implication may be that maturity may in fact be a factor in looking at math performance. Older students returning to school are more goal oriented and therefore likely to be more persistent in their math performance efforts. Younger students coming right out of 12th grade and placing into these low level classes have probably not experienced a great deal of success in mathematics. They may come to the course with lower expectations and may not see these math courses as stepping stones to some educational or career goal which they may or may not have at this stage of their lives.

The females in this study received higher math grades, had higher math anxiety, and were older than the males. There is a certain level of stress or anxiety that promotes better performance as opposed to no stress. Being more anxious, and older, females may have worked harder in their courses and as a result received better grades. Since math anxiety was not significantly correlated to grade, then there has to be much more going on here. It might help to look at the math anxiety levels in relation to the grade received, including I's and W's. As has been mentioned, it is probable that those who did not complete the course had high levels of math anxiety.

Of the ten multiple regressions, only one regression, on the remedial credit group receiving letter grades A-F, was not significant. The multiple regression correlations ranged from 6.9% to 16.4%. It is interesting to note the highest R^2

was found with the college credit group. In the regression which was the model to predict math anxiety level for the college credit participants, the model accounted for 15.4% of the variance in math anxiety level. In the regression which was the model to predict math performance for the college credit group receiving letter grades from A-F, the model accounted for 16.4% of the variance in grade in a math course. These percentages are too low for practical significance, but they are important for theoretical significance. Something is going on here that needs to be investigated further. Using a more comprehensive learning style instrument that would measure more styles than just three, such as the 21 elements of learning style of the Dunn and Dunn model, may give a clearer indication of the relationships that exist between learning styles and math anxiety or math performance. Perhaps another way to evaluate math performance, instead of using the grades A - F, I and W would reveal more insightful results.

The one multiple regression that was not significant was performed on the subgroup of remedial credit participants who received letter grades A - F. Perhaps this model was not significant because of the different meaning of the grades in this course. In this course if a student is producing D or F level work but has good attendance and is working consistently, then this student will receive an incomplete (I) for a final grade. This fact certainly may have affected the results.

Comparison of Findings with Existing Literature

Math Anxiety and the Adult Learner

No significant correlation between age and math anxiety was found for any group in this study. This finding conflicts with the conclusions of Betz (1978) and Gourgey (1984). In Gourgey's study the sample was considerably different from this study. This study's sample was from Introductory Algebra and Basic College Algebra. In Gourgey's sample more than half of the students (mostly younger) had taken Pre-Calculus or Calculus and 12% (mostly older students) had taken only high school Algebra or General Mathematics. Also, in Gourgey's study there were 4.75 times more females than males, which may have resulted in the age issue being confounded by the gender issue. The finding that no correlation exists between math anxiety level and age supports the findings of Benn and Burton (1994), Heher (1988), and Ulrich (1989).

Math Anxiety and Gender

Female participants reported significantly higher math anxiety levels than male participants in this study. This finding agrees with the conclusions of much of the existing literature (Benn & Burton, 1994; Bernstein, 1992; Betz, 1978; Burton, 1979; Dew, Galassi & Galassi, 1983; Ernest, 1976; Foss & Hadfield, 1993; Hembree, 1990; Llabre & Suarez, 1985; Skiba, 1990; Tobias, 1976, 1980, 1981). This finding contradicts other research that found no significant gender differences in levels of math anxiety (Cooper & Robinson, 1989; Flessati &

Jamieson, 1991; Gressard & Lloyd, 1987; Resnick, Viehe & Segal, 1982; Schumacher, Morahan-Martin & Olinsky, 1993; Whigham, 1988).

Gender was a significant contributor to the regression model to predict math anxiety for all groups in the study. Not only did females report higher math anxiety levels, but females also performed significantly better in the math course. These findings agree with those of Llabre and Suarez (1985). As has been mentioned in the literature review, it may be that males underreport feelings of math anxiety because of the cultural expectation that weakness in mathematics is only acceptable in females. It may be that men have been socialized into not openly displaying their anxiety while women are actively encouraged to feel comfortable in admitting to their anxiety (Benn & Burton, 1994, p. 245). Flessati and Jamieson (1991) state, "the two findings that females are more self-critical of math anxiety in themselves, and are more self-critical of their performance in math could explain the gender difference in mathematics anxiety" (p. 311).

Math Anxiety and Learning Style

McCoy (1990, 1992) was the only study found in the literature that was specifically looking for a relationship among audio level, visual level, t/k level and math anxiety. McCoy found that t/k level contributed significantly to a regression model for predicting math anxiety. In this study a significant relationship between math anxiety level and t/k level was found for all groups except males. McCoy's subjects were mostly females. All groups except males and the remedial credit participants had t/k level as a significant contributor to the regression model predicting math anxiety level. These findings basically agree with those of McCoy.

In this study math anxiety level was significantly correlated with audio level for all groups. Audio level was a significant contributor to the regression model predicting math anxiety level for all groups. These findings disagree with McCoy's, where audio level was not a significant contributor.

Math anxiety and visual level were not significantly correlated with each other for any group in this study. Visual level was a significant contributor to the regression model predicting math anxiety level for all groups except for the college credit participants. These findings disagree with McCoy's (1990, 1992), where visual level was not a significant contributor to the regression model.

Math Anxiety and Performance

There were no significant correlations between math anxiety and performance for any of the groups in this study. There were six studies found in the literature that had undergraduate samples and also measured math performance by more than one test (Dew, Galassi & Galassi, 1984; Dwinell & Higbee, 1991; Frary & Ling, 1983; Green, 1990; Llabre & Suarez, 1985; Sime et al, 1987). The findings of this study conflict with the results of all of these studies except one (Llabre & Suarez, 1985). Though the two studies took place 12 years apart, there are numerous similarities between this study and that of Llabre and Suarez worthy of note. The studies took place in similar geographic regions within 150 miles of each other. Both studies measured math anxiety by using subscales of the MARS. Both studies used the final grade in the math course for the measure of math performance. The sample was taken from students in Introductory Algebra for the Llabre and Suarez study and in this study the sample was taken from students in Introductory Algebra and Basic College Algebra. Both studies reported that females had higher anxiety and higher grades than males in addition to finding no significant correlation between math anxiety and performance.

Taking a closer look at the five studies that this study conflicted with (Dew, Galassi & Galassi, 1984; Dwinell & Higbee, 1991; Frary & Ling, 1983; Green, 1990; Sime et al, 1987) may be appropriate. Three of the studies had samples smaller than 65 (Dew, Galassi & Galassi; Dwinell & Higbee; Sime et al). One study looked at students from a variety of majors: social sciences, engineering natural sciences, and architecture (Frary & Ling). This type of sample could considerably affect the results. One study took place in a math lab setting as opposed to a regular class setting (Green). It seems that there were enough differences in the study to warrant a clear possibility for different results.

Limitations of the Study

There were several limitations which may have affected the findings of this study.

1. Since many of the classes filled out the questionnaire during the first or second class meeting of the term, some students were lost because they dropped or transferred out of the class during the drop - add period. Therefore, their

names did not appear on the class roster at the end of the term. These students may have transferred to another section of the same course and received a letter grade but the researcher would not receive this information.

2. Since letter grades do not have the same meaning for college credit math classes as for remedial credit, some of the statistics about grades could be deceiving. An A, B, or C in either course means the same. However, if a student has good attendance and is completing assignments in the remedial course but has a D or F average, this person will receive an incomplete (I) at the end of the term rather than the actual average. If this same student were enrolled in a college credit course instead, the final grade would reflect the actual final average; therefore, discrepancies arise when looking at the D's and F's in each course and the mean grade for each course for the different groups.

3. It would have been useful to know if this was the first math class being taken at the college. This question was not on the questionnaire. Perhaps some of the math anxiety levels are lower because of the time instructors spend in the lowest level remedial course on math study skills and math test taking techniques.

Suggestions for Further Research

There were many significant findings in this study that may warrant further investigation. Gaining a clearer understanding of learning styles, math anxiety, and math performance and the relationships of these variables with each other will equip educators with valuable information that could enhance learning, reduce math avoidance, math anxiety, and retention problems.

It would be beneficial to conduct a similar study, but change the sample to students in the lowest entry remedial math course and see how the variables are affected. Another good possibility for a change in sample would be picking two courses that have a greater gap in the level of difficulty (PreAlgebra and PreCalculus). Further study into the relationship between math anxiety and certain letter grades would be beneficial. Is there a level of math anxiety that promotes success or failure?

Since a person's learning style is as unique as her or his fingerprint, looking at only three learning styles could severely limit the accuracy of what is actually occurring between and among learning styles, math anxiety, and math performance. Further research is needed using a more comprehensive learning style inventory which looks at more modes of learning. The Productivity Environmental Preference Survey (PEPS) (Dunn, Dunn, & Price, 1986, 1990, 1991, 1993), which evaluates 20 elements of learning style, would be an appropriate tool for such a project. This may give educators a clearer picture of the relationships between and among learning styles, math anxiety, and math performance.

Intervention programs can often improve learning effectiveness. It would be valuable to develop an intervention program which incorporates information about math anxiety and learning styles and observe the effects on math anxiety levels and performance.

This study has provided information which can help community colleges, educators, and learners enhance a student's learning efficiency in mathematics by considering an individual's learning style preference and level of math anxiety. Many statistically significant relationships were found in this study, demonstrating that learning styles do have an impact on the mathematics classroom and therefore deserve the attention of the educational community.

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APPENDIX

Appendix A **INSTRUCTOR'S INFORMATION SHEET**

Thank you for agreeing to participate in this study for my doctoral dissertation. I truly appreciate it.

FOR STATISTICAL PURPOSES PLEASE FOLLOW THESE GUIDELINES:

1. Administer the questionnaire **during one of the first three classes.**

2. Administer the questionnaire at **the beginning of the class period** (should take between 30 - 40 minutes).

3. Before administering the questionnaire please **read the "Letter to Students" aloud** to the whole class.

4. Please require those students who do not wish to participate to remain (quietly) in class during the time the others are filling out the questionnaire.

5. It is of utmost importance that each participating student **PRINT and sign** their name of the consent form which is the first page of the questionnaire.

6. Please fill out the instructor's learning styles inventory and the demographics questionnaire.

7. **Please return everything as soon as possible** through campus mail in the envelope provided.

NEAR THE END OF THE TERM I WILL BE SENDING YOU THE FOLLOWING:

1. A final grade form for all participating students.

2. An envelope for each participating student containing the results from the learning styles inventory.

3. An envelope for you, the instructor, with the results of your learning styles inventory and a printout graphing your dominant learning styles compared to the dominant learning styles of your class.

KEEP THIS SHEET FOR YOUR INFORMATION

I can be reached anytime throughout the term by either leaving a message at my office number on main campus: 462-4592; or at my home: 465-3808.

Thanks so much.

Sincerely,
Bobbi Parrino Cook

Appendix B **LETTER TO STUDENTS**

(Instructor, please read this letter aloud to your class before asking for volunteers)

Dear student:

You have been chosen to be given the opportunity to participate in a research study looking at the relationship among: the way a person learns (learning style); a person's math anxiety level; and success in a math course.

The study is designed to provide information that will help students do better in math.

Only those of you who volunteer to participate will receive a free copy of your learning styles analysis and information on techniques to enhance these styles. This information and analysis will be distributed at the end of the term.

All you need to do is answer the questionnaire, which should take about 30 minutes. There are no math problems on this questionnaire. All answers are correct there are no wrong answers. The items relate to how you learn best and your reactions to situations connected with mathematics classes. Don't give the items much thought--write down your first impression.

All information is confidential.

Please consider participating. You will benefit personally and you will have made a contribution to the advancement of knowledge in mathematics education.

Thank you.

Sincerely,

Bobbi Parrino Cook

Appendix C personal code_____

CONSENT FORM

I agree to participate in the research entitled "The relationship between learning styles and math anxiety level of community college students" which is being conducted by Roberta P. Cook, department of Educational Leadership at FAU, phone: 561 - 462 - 4592. I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty or loss of benefits and have the results of the participation, to the extent that it can be identified as mine, returned to me, removed from the research records, or destroyed.

The following points have been explained to me:

1) The reason for the research is to gain information that can help students perform better in mathematics by making them aware of learning styles and the issue of math anxiety. The research results could be incorporated into initial teacher training and teacher development programs.
   The benefits that I may expect from the research are: a printout of an analysis of my learning style preferences and information on how to enhance the effectiveness of my studying in my dominant style.

2) The procedures are as follows:
   Near the beginning of the term I will be given a questionnaire by my instructor to be filled out and returned. The questionnaire will be asking about my reactions to math instruction and whether I prefer to learn by seeing, hearing, or doing. At the end of the term my final grade will be collected as added information for research.

3) No discomforts or stresses are foreseen.

4) There is little or no risk foreseen.

5) The results of this participation will be confidential, and will not be released in any individually identifiable form without prior consent, unless otherwise required by law.

6) The investigator will answer any further questions about research, now or during the course of the project. If I have any questions I can also call Elisa Gaucher from the Institutional Review Board at 561-367-2310.

7) I am 18 years of age or older.

Name of Participant (please print)________________________________

________________________ ________________________

Signature of Investigator Date Signature of Participant Date

Appendix D personal code______

BRIEF MATH ANXIETY RATING SCALE (BMARS)

The items in this questionnaire refer to things that may cause fear or tension. **There are no right or wrong responses**, only the way you feel about the statement. Place the number before each item that best describes how much you would be made anxious by the situation.

1	2	3	4	5
NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH

Write the response that first comes to mind. Don't think about it too much.

___ 1. Watching a teacher work an algebraic equation on the blackboard.
___ 2. Buying a math book.
___ 3. Reading and interpreting graphs and charts.
___ 4. Signing up for a math course.
___ 5. Listening to another student explain a math formula.
___ 6. Walking into a math class.
___ 7. Receiving your final math grade in the mail.
___ 8. Starting a new chapter in a math book.
___ 9. Walking on campus and thinking about a math course.
___ 10. Picking up a math textbook to begin working on a homework assignment.
___ 11. Opening up a math book and seeing a page full of problems.
___ 12. Doing a word problem in Algebra.
___ 13 Listening to a lecture in math class.
___ 14. Watching someone work with a calculator.
___ 15. Not knowing the formula needed to solve a particular problem.
___ 16. Being given a homework assignment of many difficult problems which is due the next class meeting.
___ 17. Thinking about an upcoming math test one week before.
___ 18. Thinking about an upcoming math test one day before.
___ 19. Thinking about an upcoming math test one hour before.
___ 20. Solving a square root problem.
___ 21. Taking an examination [quiz] in a math course.
___ 22. Getting ready to study for a math test.
___ 23. Being asked to explain how you arrived at a particular solution for a problem.
___ 24. Realizing you have to take a certain number of math classes to fulfill requirements.
___ 25. Being given a "pop" quiz in a math class.

Appendix E personal code______

LEARNING STYLE INVENTORY-ADAPTED (LSI-A)

The numbering of the responses is as follows:

1	2	3	4
LEAST LIKE ME			MOST LIKE ME

The items in this questionnaire refer to the way you prefer to learn. Place the number before each item that best agrees with how you feel about the statement. Remember, there are no right or wrong responses, only the way you feel about the statement.

Write the response that first comes to mind. Don't think about it too much.

****

___ 1. Making things (projects, models) for my studies helps me to remember what I have learned.

___ 2. I can write about most of the things I know better than I can tell about them.

___ 3. When I really want to understand what I have read, I read it softly to myself.

___ 4. I get more done when I work alone.

___ 5. I remember what I have read better than what I have heard.

___ 6. When I answer questions, I can say the answer better than I can write it.

___ 7. When I do math problems in my head, I say the numbers to myself.

___ 8. I enjoy joining in on class discussions.

___ 9. I understand a math problem that is written down better than one that I hear.

___ 10. I do better when I can write the answer instead of having to say it.

___ 11. I understand spoken directions better than written ones.

___ 12. I like to work by myself.

___ 13. I would rather read a story than listen to it read.

___ 14. I would rather show and explain how a thing works than write about how it works.

___ 15. If someone tells me three numbers to add, I can usually get the right answer without writing them down.

___ 16. I prefer to work with a group when there is work to be done.

___ 17. A graph or chart of numbers is easier for me to understand than hearing the numbers said.

___ 18. Writing a spelling word several times helps me remember it better.

___ 19. I learn better if someone reads a book to me than if I read it silently to myself.

___ 20. I learn best when I study alone

___ 21. When I have a choice between reading and listening, I usually read.

___ 22. I would rather tell a story than write it.

PLEASE TURN THE PAGE FOR THE REST OF THE INVENTORY

personal code_____

1	2	3	4
LEAST LIKE ME			**MOST LIKE ME**

___ 23. Saying the multiplication tables over and over helps me remember them better than writing them over and over.

___ 24. I do my best work in a group.

___ 25. I understand a math problem that is written down better than one I hear.

___ 26. In a group project, I would rather make a chart or poster than gather the information to put on it.

___ 27. Written assignments are easy for me to follow.

___ 28. I remember more of what I learn if I learn it alone.

___ 29. I do well in classes where most of the information has to be read.

___ 30. I would enjoy giving an oral report to the class.

___ 31. I learn math better from spoken explanations than written ones.

___ 32. If I have to decide something, I ask other people for their opinions.

___ 33. Written math problems are easier for me to do than oral ones.

___ 34. I like to make things with my hands.

___ 35. I don't mind doing written assignments.

___ 36 I remember things I hear better than things I read.

___ 37. I learn better by reading than by listening.

___ 38. It is easy for me to tell about the things that I know.

___ 39. It makes it easier when I say the numbers of a problem to myself as I work the problem out.

___ 40. If I understand a problem, I like to help someone else understand it too.

___ 41. Seeing a number makes more sense than hearing a number.

___ 42. I understand what I have learned better when I am involved in making something for the subject.

___ 43. The things I write on paper sound better than when I say them.

___ 44. I find it easier to remember what I have heard than what I have read.

___ 45. It is fun to learn with classmates but it is hard to study with them.

___ 46. I learn better if I can practice it in real life experiences.

___ 47. I learn better if I can get involved and do things with my hands.

___ 48. I learn better if I can pace the floor, shift positions a lot, or rock back and forth as I study.

___ 49. When I study I need to take frequent breaks and get up and move around.

___ 50. I learn math best if I can work with "hands on" examples and touch and manipulate what I am studying.

Adapted from the CITE-LSI by Babich, Burdine, Albright, and Randol and also from the LEARNING STYLES INVENTORY Educational Activities, Inc., Freeport, NY 11520 (1-800-645-3739)

Appendix F personal code______

DEMOGRAPHICS SURVEY

PLEASE CHECK THE APPROPRIATE SPACE FOR EACH:

1. The **AGE GROUP** you are in:

___ 18-20 ___ 21-25 ___ 26-29 ___ 30-34

___ 35-39 ___ 40-44 ___ 45-49 ___ 50-54

___ 55-59 ___ 60-64 ___ 65 and up

2. The **ETHNIC GROUP** to which you belong:

___WHITE, NON-HISPANIC ORIGIN

___ASIAN, OR PACIFIC ISLANDER

___AMERICAN INDIAN OR ALASKAN NATIVE

___HISPANIC

___BLACK, NON-HISPANIC ORIGIN

___OTHER-SPECIFY______________________________

3. **GENDER**: ___ FEMALE ___MALE

4. The **NUMBER OF YEARS** that you took math in high school at the Algebra I level or higher:

___0 ___1 ___2 ___3 ___4 ___Other-specify__________

5. The **NUMBER OF YEARS** it has been since you last took a math class:

___less than 1 ___1-5 ___6-10

___11-15 ___16-20 ___more than 20

6. The **TYPE OF DIPLOMA** you have from high school:

___regular H.S. diploma ___GED (Graduate Equivalency Diploma)

___Other-specify______________________

Bobbi Parrino Cook

3808 Promenade Way
Ft. Pierce, Fl 34982

Telephone 561-465-3808
Fax 561-462-4796

October 9, 1996

Dear Dr. Suinn,

I have spoken with you by phone a few times over the past eight months. I am working on my dissertation exploring the relationship between mathematics anxiety levels and perceptual learning styles. I am interested in using twenty-five items from the MARS for part of my instrument. During our phone conversation you said that it would not be a problem for me to use them. My committee chair has required that I obtain your written permission.

I appreciate your attention to this matter. I have enclosed a stamped self-addressed envelope to expedidite the process.

Sincerely,

Bobbi Parrino Cook

Bobbi Parrino Cook

****

Bobbi Parrino Cook has my permission to:

1. Use exerpts from the MARS for her dissertation research

   YES ✓ NO_____

2. Reprint the 25 item subscale of the MARS in her dissertation which will be submitted to Dissertation Abstracts International

   YES ✓ NO_____

Approval contingent upon: a) items as used be sent to Dr. Suinn, b) any raw data on distribution of scoees, means, SD, frequency, % of sample be sent, and c) each test page print the following at bottom: Items used by permission of Dr. Richard M. Suinn, Psychology, Colorado State University, Ft. Collins, CO 80523 and are copyrighted by Dr. Suinn.

SIGNATURE:

Permission granted for #1 & #2 contingent on the above agreement - Richard M Suinn

10/21/96

APPENDIX H

Approval Letters

INDIAN RIVER COMMUNITY COLLEGE

OFFICE OF THE PRESIDENT

August 27, 1996

Dr. Brett Laursen
IRB Chair
Florida Atlantic University
Boca Raton, FL

Dear Dr. Laursen:

I am writing to express my approval for Ms. Bobbi P. Cook to conduct research involving human subjects at Indian River Community College. This research will be in conjunction with her dissertation "An Exploration of Math Anxiety and Learning Styles Among Adult Learners."

If there is any additional information required for institutional approval, please contact me, (561) 462-4701.

Sincerely,

Edwin R. Massey, Ph.D.
President

cc: Ms. Bobbi Parino Cook

INDIAN RIVER COMMUNITY COLLEGE

3209 VIRGINIA AVENUE • FORT PIERCE, FLORIDA 34981 - 5599
TELEPHONE 407-462-4704

• VICE PRESIDENT OF ACADEMIC AFFAIRS

August 23, 1996

Ms. Bobbi Cook
Mathematics Department
Indian River Community College
Ft. Pierce, FL 34981-5599

Dear Bobbi:

I am writing this letter to express support for your research associated with the doctoral dissertation in your studies at Florida Atlantic University.

It is my understanding that you intend to identify factors impacting success in lower level mathematics courses. In order to do so, it will be necessary to ask students to complete informational surveys and to make an analysis of resulting success rates in their math classes.

I support this endeavor as long as students and their instructors are voluntarily participating in the project. You will need to keep a file of written approvals by the students involved.

Please share your results with me and with Dr. Considine. If I can assist you, let me know.

Sincerely,

Jack Maxwell

Jack Maxwell, Ph.D.
Vice President, Academic Affairs

INDIAN RIVER COMMUNITY COLLEGE

3209 VIRGINIA AVENUE•FORT PIERCE, FLORIDA 34981-5599
TELEPHONE 407-462-4700

August 22, 1996

Institutional Review Board
Florida Atlantic University

Bobbi Cook has requested permission to conduct research at Indian River Community College for data to be used in her dissertation "An Exploration of Math Anxiety and Learning Styles among Adult Learners." The research would be conducted in the spring 1997 semester and would involve students in Introductory Algebra and Basic College Algebra classes. All research would be conducted with the permission of the instructors of the courses mentioned and would be voluntary on the part of the students.

I support Bobbi Cook's research in this area, and I believe her research will benefit IRCC by providing information that will improve retention rates and success rates in mathematics classes.

Sincerely,

Raymond H. Considine

Raymond H. Considine
Associate Dean of Arts and Sciences

INDIAN RIVER COMMUNITY COLLEGE
3209 VIRGINIA AVENUE • FORT PIERCE, FLORIDA 34981-5599
TELEPHONE 561-462-4207

Associate Dean of Developmental Education

August 23, 1996

Dr. Brett Laursen
Institutional Review Board
The Division of Sponsored Research
Florida Atlantic University

Dear Dr. Laursen:

It is with pleasure that I write this letter in support of Bobbi Parrino Cook's doctoral research exploring math anxiety and learning styles. As a developmental educator, directly responsible for the MAT0024 students that would be included in Ms. Cook's study, I believe that we need to explore all barriers to student success. This research provides just such an opportunity.

Ms. Cook has indicated that the students and their instructors will be voluntarily participating in the project. It will be necessary for her to keep a file of written approvals from the students involved.

I am available to assist Ms. Cook as she moves forward in her research and whole-heartedly support her efforts.

Sincerely,

Dottie Vandegrift
Associate Dean of Developmental Education

VITA

Name: Roberta (Bobbi) Parrino Cook

Education:

Ed.D. Educational Leadership
Florida Atlantic University
Boca Raton, Florida 1997

Sp.Ed. Curriculum and Instruction
Florida Atlantic University
Boca Raton, Florida 1977

M.Ed. Curriculum and Instruction
Florida Atlantic University
Boca Raton, Florida 1973

B.A. Mathematics, Queens College
City University of New York
Queens, New York 1972

Experience:

Associate Professor of Mathematics
Indian River Community College
Fort Pierce, Florida 1982-present

Mathematics Workshop Facilitator for K-12 teachers on topics including: teaching with math manipulatives, graphing calculators, and math anxiety prevention and management
St. Lucie County, Florida 1976-present

Mathematics Teacher
Fort Pierce Central High School
Fort Pierce, Florida 1973-1980

Graduate Teaching Assistant
Mathematics Department
Florida Atlantic University
Boca Raton, Florida 1972-1973

Mathematics Teacher
7th and 8th grade
St. Anastasia School
Queens, New York 1971-1972