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KITCHENS, ANITA NARVARTE
AN APPROACH TO RELIEVING ANXIETY IN THE MATHEMATICS CLASSROOM.

THE UNIVERSITY OF NORTH CAROLINA AT GREENSBORO, ED.D., 1979

University Microfilms International

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AN APPROACH TO RELIEVING ANXIETY IN THE MATHEMATICS CLASSROOM

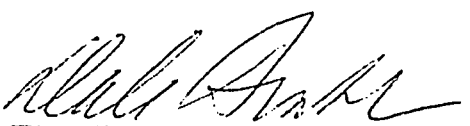
by

Anita Narvarte Kitchens

A Thesis Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Greensboro
1979

Approved by



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APPROVAL PAGE

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June 14, 1979
Date of Acceptance by Committee

June 14, 1979
Date of Final Oral Examination

KITCHENS, ANITA NARVARTE. An Approach To Relieving Anxiety in the Mathematics Classroom. (1979)
Directed by: Dr. Dale Brubaker. Pp. 144.

Scholarly research as well as commercial writing indicates that math anxiety and test anxiety are serious problems in our society. Some educators and psychologists, having become more aware of math anxiety, are increasing their efforts to study it.

This dissertation addressed debilitating anxiety (a form of neurotic anxiety) in contrast to facilitating anxiety. The experiment performed consisted of using Stress Inoculation Training and Cognitive Restructuring to reduce debilitating anxiety and to improve performance of students in a randomly selected developmental math class at Appalachian State University during the fall term of 1978.

According to the instructor, Stress Inoculation Training was easily incorporated into the class activities, and the students' response was favorable. The findings of the study, however, demonstrated that statistically the experimental class did not show significantly more stress reduction or higher grades than did the control classes. Perhaps the lack of stress reduction in the experimental class was due in part to the fact that, in all three classes in the experiment, much emphasis was placed on learning the math, a skill which had previously evaded these students. Being successful at learning is, in itself, stress reducing and perhaps more so than having a strategy for managing stress.

Future studies could focus on stress reduction also by addressing the following three areas: first, the development of a strong mutual concern among class members; second, the incorporation of school work

into the students' meaning system; and third, the development of methods for more efficient learning. In this way debilitating anxiety could perhaps be eliminated from the classroom.

ACKNOWLEDGEMENTS

This dissertation is dedicated to my mother who is a constant source of love and support.

I am grateful for a committee supportive of this dissertation from its conception. Dr. William Love helped particularly in his insightful remarks on the complex concept of anxiety as it refers to mathematics learning. He was also a source of encouragement from the beginning. Dr. William Powers was helpful in the design of the experiment and Dr. William Purkey gave careful attention to my writing style. Especially, I am thankful to my dissertation advisor, Dr. Dale Brubaker.

I thank Mr. Arnold McEntire for his ideas in the organization of this study and his valuable insight into the anxiety as it refers to learning. Mrs. Tracy Hurley was invaluable in her help with editing the manuscript. I am also grateful to the Trivette family for their support. Most of all I thank my husband, Dr. Larry Kitchens, for his help with the statistical analysis and his generous giving of time and energy, and also our baby boy, Christopher, who remained flexible to his mother's needs.

Finally, I thank Mrs. Lorna Paul for her courage in her recent illness. It is this courage which gave me perspective and helped me to endure to the completion of this dissertation.

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CHAPTER I

INTRODUCTION

Stress, tension, and anxiety have become part of the American way of life as evidenced by television commercials which capitalize on this notion by selling medication and devices for alleviating stress for adults; however, little attention has been focused on the classroom in helping students manage or cope with anxiety. Society has accepted the idea that schools heavily emphasize test results, time limits, and evaluations, though the adverse effects of these pressures on the students have usually been overlooked. Even when teachers recognize detrimental effects on some students, they generally have little educational training concerning the management of stress. Also, teachers are so involved with daily routine that they have little time for experimenting with any type of extra activity.

Math anxiety is a problem which, due to its nature and its magnitude, has been labeled a "phobia." The topic has been addressed by many sources including professional journals (Aiken, 1976; Dreger and Aiken, 1957; Kogelman, Nigro and Warren, 1978; Mitzman, 1976; Tobias, 1978a; Tobias and Donady, 1977), books such as Overcoming Math Anxiety (Tobias, 1978b) and Mind Over Math (Kogelman and Warren, 1978), and newspaper articles and popular magazines (Gallese, 1978; Kagen, 1974; Kaighen, 1977; Klein, 1978; and Stoelzle, 1978). Many mathematics educators, including the pure mathematicians, are also becoming aware of the problem. For instance, Sheila Tobias (1978b) in Overcoming Math Anxiety quotes Peter Hilton, a first vice-president of the Mathematical Association of America,

1978-79, as saying, "Mathematics anxiety is not just a clever slogan; it is a reality, affecting millions of people, handicapping them in their daily lives and reducing their job opportunities" (book cover jacket). Another mathematician, Mitchell Lazarus (1974) defined "mathephobia" as an "irrational and impeditive dread of mathematics--which involves an emotional and intellectual block making further progress in mathematics and closely related fields very difficult" (p. 51). As further evidence of the magnitude of the problem, some psychologists such as Richard Suinn, who has studied anxiety clinically (Suinn, 1968; Suinn, 1970; Suinn, Edie and Spinelli, 1970; Suinn and Hall, 1970), are also addressing math anxiety (Richardson and Suinn, 1972; Suinn, 1972; Suinn, 1976). Partly as a result of the attention given to math anxiety, teachers are beginning to incorporate specific techniques into their classrooms (Afflack, 1977; Davis, 1977; Stoelzle, 1978).

Statement of the Problem

This dissertation reports one teacher's efforts at incorporating techniques for managing stress in the mathematics classroom. These techniques were theoretically based in the area of Cognitive Behavior Modification, the specific approaches being Stress Inoculation Training and Cognitive Restructuring. The focus of Stress Inoculation Training was on making the students aware of their negative self-statements (what they tell themselves) and replacing them with positive self-statements. Cognitive Restructuring, on a deeper level, focused on changing a person's negative, irrational anxiety-causing beliefs which may be affecting his performance in the classroom.

The purpose of this research was to implement techniques in the math classroom for reducing anxiety and thus improve performance. Having

successfully held a one-week "Math Anxiety Clinic," the instructor modified the techniques used in the clinic to the classroom. In the clinic, through group process, the participants learned (a) to control their bodily reactions to stress; (b) to discover their self-imposed mental premises concerning mathematics which were affecting their performance; (c) to possibly re-set these premises, thus allowing the participants to function normally in a math related situation; and (d) to reinforce successful steps in anxiety reduction in the classroom (see Appendix B for a more detailed report). The differences in the two settings (clinic vs. classroom) made direct transfer of the techniques difficult, but the instructor was able to modify the techniques of the clinic and implement a strategy in the classroom.

Contrasts Between Clinic and Class

Some of the major differences between the two groups were the size of the groups, the size of the rooms, the furniture, the general attractiveness and comfort, and the homogeneity of the groups in purpose and attitude. In the clinic, each group was composed of six adults who enrolled specifically to lessen math anxiety which was, by self-admission, hindering their scholastic and/or career endeavors. The room was small (12' x 20'), carpeted, and furnished with bean-bag chairs and couches. The developmental math classes, on the other hand, were each composed of approximately 35 students, most of whom were freshmen with undeclared majors. Not having prerequisite skills for college math, they were required to take the course which gave one-hour credit for five hours per week in class plus homework (see Appendix A for course and placement description). Attitude varied among students in the developmental math class: some were taking the course only because it was required while others were

ready to learn the skills which they had not mastered while in high school.

Hypothesis of the Study

The hypothesis of this study is that a math instructor by incorporating Stress Inoculation Training and Cognitive Restructuring into the classroom can help students reduce math anxiety and improve performance.

Experimental Procedure of the Study

The study involved three developmental math classes, one of which was randomly selected to receive the experimental techniques. One instructor (Instructor A) taught the experimental class at 8:00 a.m. and one control class at 9:00 a.m., while the other instructor (Instructor B) taught a control class at 1:00 p.m.. These 50-minute classes ran for a total of 14 weeks, five days per week (see Appendix A). Instructor A was directly involved in offering the Math Anxiety Clinic and had researched the topic of math anxiety, while Instructor B had done no research in this area.

Anxiety was measured by a self-report, 98-item questionnaire, called the Math Anxiety Rating Scale (MARS) (Suinn, 1972) taken by each student at the beginning and end of the course (See Appendix C for MARS). The performance measures were the final average in the course, as well as the Cooperative Mathematics Test - Algebra I score (1962), given as part of the placement device and as a posttest.

The classes in the experiment used the same structure (see Appendix A for description) that had been used in teaching the developmental math class for the last three years; the same text, Beginning Algebra by Lial and Miller (1976); homework assignment sheets; tests and final exam

(written by the textbook authors); and supplementary sheets of various kinds. The only exception was that in the experimental class Instructor A allowed time away from the math to present an approach for managing math anxiety. Students in this experimental class were given supplementary material on managing math anxiety and had relaxation tapes available to them which the other classes did not. These activities, however, did not result in studying any less mathematics material than did the control classes.

The primary question to be answered was whether there was any significant reduction in anxiety in the experimental class which would result in improved performance.

Limitations of the Study

The majority of the limitations in this study dealt with the instructors. First, neither instructor had professional experience as a counselor or psychologist. Instructor A had done sufficient reading in the area to feel confident at presenting the techniques to the class. She also had worked with the participants in the Math Anxiety Cinic from which this study in the classroom evolved. This inexperience, however, was an expected part of the experiment which was to determine if a math instructor (not a professional counselor) could incorporate techniques into the classroom.

A second limitation was that it was the first time Instructor B had taught developmental math students. No specific problems resulted because Instructor B volunteered to teach the course, had experience teaching the freshmen math courses at Appalachian State University, and planned to organize and teach developmental math at another college the following semester.

A third limitation was the experimental contamination caused by Instructor A teaching the experimental class and one of the control classes. Originally the plan was to compare only the two classes taught by Instructor A. It was then decided to collect data on all three classes, since one could question whether the control class at 9:00 a.m. was influenced by Instructor A's newly found knowledge and enthusiasm. Therefore, all three classes were used in the comparison.

The last limitation involved the text. This was the first semester in which it had been used in the developmental math class, and the time allotted for teaching sections 8.1, 8.2, 8.3, 9.1, and 9.3 was insufficient for some students (this problem was told to the instructors by four students).

The Nature of Math Anxiety

In order to realize the serious nature of this study, it is helpful to consider the nature of math anxiety. It should be noted that anxiety in general is a learned response (Stuart, 1977) and that mathematics learning can be understood and studied in relationship to anxiety.

Anxiety increases as schooling continues. Preschoolers seldom experience stress. They equate learning with playing (Frost and Klein, 1979). With more school the children begin to associate learning with work, the antithesis of play, as teachers emphasize tests with evaluation and time limits (Hill and Sarason, 1966). Anxiety becomes more intense as school work becomes more difficult and, for some, grows with each experience of an unsatisfactory grade. If sufficiently intense, anxiety may lead to poor performance as it blocks one's ability to think and concentrate. Some students report specific situations

with specific teachers which mark the beginning of their fear and anxiety, while others acquire it gradually as tests, time limits, and evaluation begin to pressure them. Eventually, such anxiety leads to math avoidance, which is defined as withdrawing from any situation involving mathematics regardless of the consequences. Some teachers and students accept anxiety as an unavoidable part of the school setting. At the same time, however, some educators (Blum, 1975; Carpenter, 1978; Davis, 1977; Mitzman, 1977a; Tobias, 1974; Stoelzle, 1978) are beginning to realize that anxiety can be harmful in the classroom, and that the classroom itself provides an excellent setting for learning to manage anxiety or eliminating it.

Is eliminating anxiety desirable? Some anxiety is normal and in times of sudden trouble, for instance, can sharpen a person's reactions. In this case the anxiety is called "facilitating anxiety" and is helpful to the person in performance of the task. When anxiety is not helpful, it is called "debilitating anxiety." In this case, a person is sometimes not able to perform because of the anxiety which has interrupted his thoughts and affected his bodily state. In other cases of debilitating anxiety, the person can control his fear and act in spite of it. This anxiety, a learned response, can be unlearned (Stuart, 1977) through a conscious effort to react to a given anxiety-causing stimulus in such a way that one has control over the situation and is not hampered by anxiety. At best, one would like to use anxiety to improve performance, but, at the very least, it would be desirable to learn to control anxiety and work unimpeded by it.

Math Anxiety--Possible Reasons for Its Occurrence

All subject areas involve classroom activities such as testing, time limits, evaluation, and at times, poor student-teacher relations. Why is it, then, that in mathematics students report anxiety and fear with lasting detrimental effects?

As one possible reason, Mitchell Lazarus (1974) points out that in contrast to most other subjects mathematics tends to build on itself cumulatively. Thus a missed concept will affect the learning of other concepts. One way to rectify this situation is to locate and learn the concepts previously missed, a difficult and time-consuming process which may include the review of as much as twelve years of math. In this case, anxiety is caused by forcing the student to take a course knowing that his poor background will affect learning and performance and perhaps cause failure in the course.

Another reason for math anxiety is the increasing complexity in the process of learning mathematics. Problem solving begins to involve a series of logical steps instead of one or two steps. At that point, if one has studied primarily by memorizing procedures, then, as the complexity increases, the math problems become increasingly unworkable, causing an inability to perform and unpreventable anxiety. On the contrary, if one has acquired understanding of procedures instead of memorizing them, as the task increases in complexity, he can learn to control anxiety and perform the task.

One additional source of math anxiety occurs in the case of teachers who are themselves mathephobes with poor math backgrounds and a fear of and dislike for math.

Popular Assumptions Related to Math Learning

Popular assumptions of society are often detrimental to the learning of math. One of these assumptions is that either a person has ability in math or does not (Tobias, 1978b). One who does well in math is labeled a genius while another who does poorly is thought to be lacking in ability. Granted, ability is a factor in performance but it is not necessarily the primary factor. How one perceives his ability is sometimes more of a factor than his actual ability (Purkey, 1970). If a person believes he cannot perform a task, then most likely he cannot. Closely related to this concept is how the teacher perceives a student's ability. Rosenthal (1968) has shown that if a teacher believes a student is poor, then that student is likely to fulfill the teacher's expectations. Davidson and Lang (1960) have suggested further that a student will perform according to how he believes the teacher assesses his ability. A person's beliefs, part of one's self-concept, are sometimes the prime forces of performance. If the teacher would not so quickly attribute a student's poor performance in math to a lack of ability, then perhaps other factors causing the poor performance would surface.

The next assumption, that math is a male's domain, has deprived our society of the optimal development of mathematical talents. Parents, peers, and teachers forgive a girl when she does poorly at math. Some females, in fact, would sacrifice learning math for social prominence. In children's math books, word problems depict girls doing domestic tasks and boys doing analytical tasks. Toys advertised for boys are generally more mathematically oriented than those for girls. Whether a genetic sex difference in mathematical ability exists is currently a much debated issue (Goleman, 1978). Tobias (1978b), a feminist, admits that in the

area of spatial visualization (the capacity to visualize shapes moving through space), males generally develop better than females, but she considers that spatial visualization is an acquired skill (not genetic) and thus can be dealt with in women's developmental education. In short, popular assumptions of sexual attributes have limited the development of the mathematical talents in our society.

One other assumption which is held by people who use little math is that those who do work with mathematics by choice do not suffer from math anxiety (Tobias, 1978b). Michael Lazarus (1975), however, points out that "even people who are good in math are comfortable only to a point" (p. 46). Aiken (1976) found in his review of the literature that "mathematics majors tend toward extremes on the anxiety variables. They are either unusually secure or severely anxious" (p. 297). The effect of this is that some students change academic fields, and other students who stay in mathematics are prevented from functioning more effectively because of the limiting effect of anxiety.

In summary, math anxiety is a serious problem which in the last four years has begun to receive the attention of some mathematics educators and psychologists. This study presents a method for managing the anxiety which irrationally accompanies the study of mathematics and test taking.

In the next chapter the definition of math anxiety applicable to this study, formulated from many definitions of anxiety, will be stated. The theoretical base for the study will be defined.

A more detailed description of the methodology will be presented in Chapter 4.

CHAPTER II

THEORETICAL BASIS FOR THE STUDY

The purpose of this chapter is twofold: (a) to investigate the concept of anxiety in order to formulate a definition of anxiety, and (b) to define and describe an approach for this study based on a particular theory of learning.

The Concept of Anxiety--Normal Anxiety, Neurotic Anxiety, Facilitating and Debilitating Anxiety

The concept of anxiety has been defined in many different ways and is difficult to define in a precise sense; therefore, a synthesis of various viewpoints will be presented.

Some authors define anxiety broadly. Spielberger in his research (1966b) defines anxiety as a "complex hypothetical construct" (p. 363). Lesse (1970) defines anxiety

> as a sociopsychophysiologic phenomenon experienced as a foreboding dread or threat to the human organism whether the threat is generated by internal, real, or imagined dangers, the sources of which may be conscious or unconscious (p. 13).

Some authors have written about anxiety in a positive sense. Kirkegaard, for instance, a philosopher of the 19th century, contends, "Anxiety is a better 'teacher' than reality for while reality situations may be temporarily evaded, anxiety is an inner function which cannot be escaped short of constriction on personality" (May, 1960, p. 43). An overwhelming body of research, however, defines anxiety in a debilitating sense. Freud viewed it as " . . . an affective state . . . most obviously unpleasurable character" (1936, p. 69), and " . . . as a signal indicating

the presence of a danger situation" (1933, p. 119).

In defining anxiety one must distinguish between "neurotic" anxiety and "normal" anxiety. Normal anxiety is commonly present in human development in the fact of uncertainty when one meets a challenge of unknown results, while neurotic anxiety results from the individual's failure to move ahead in a situation of normal anxiety (May, 1950). "The positive aspect of selfhood develops as the individual confronts, moves through, and overcomes anxiety-creating experiences" (May, 1950, p. 234). Therefore, normal anxiety is part of the development of every individual, whereas debilitating anxiety (a form of neurotic anxiety) occurs when anxiety begins to interfere or interrupt the functioning of the individual. Facilitating anxiety, on the contrary, is a help in the performance of a task. It is more than normal anxiety for it serves to increase the drive or motivation in a positive sense toward the successful completion of the task. It could be in the form of an eagerness to perform the task or in seeing the task as a challenge of which one is confident.

The anxiety state "may be viewed as a complex, largely internal, nonobservable response process that has both stimulus cue and stimulus drive properties" (Spielberger, 1966a, p. 363). The "cue" properties may be seen as Freud's "signal indicating the presence of a danger situation." These include the bodily changes at the perception of threat, such as a strong heartbeat, absence of appetite, deeper breathing, and a drop in the temperature of hands and feet. All of these symptoms can be based on the body protecting itself from the threat causing the anxiety (May, 1950, p. 62). The "drive" properties refer to the motivation as described by Mowrer, Spence, Mandler, and others. Mowrer and Spence both refer to anxiety as one of the central motivations of human

behavior (May, 1950). Spence explains the concept as follows: "High motivation makes more responses available and these compete . . . reducing effectiveness, and therefore interfering in performance of complex tasks" (Travers, 1977, p. 357). Mandler (Spielberger, 1966a) refers to anxiety in terms of Interruption Theory. He states:

> any situation which interrupts or threatens the interruption of organized response sequences and which does not offer alternate responses to the organism, will be anxiety producing . . . . If an individual has a good deal of control over situations he is much less likely to be interrupted. (p. 283)

Wine's (1971) research also centers on Interruption Theory. She states, "The individual tends to focus his attention on himself and to become preoccupied with how he is doing, what others will think, whether he can meet his goals" (p. 101). Thus, as Spielberger (1966a) suggests, there are two components of anxiety--the cognitive (affecting the mind, also referred to as the "worry component") and the autonomic (affecting the body, also called the "emotionality" component). The autonomic could act as a cue to the cognitive to react in such a way as to use anxiety in a facilitating sense.

Math Anxiety--A Formulated Definition

Math Anxiety in this study is defined as debilitating anxiety or neurotic anxiety which is a learned response to an adverse stimulus. Mathematics serves as the stimulus to which the body responds both autonomically and cognitively. Autonomically, one's heart rate may increase, the stomach may tighten, the temperature in the hands may be reduced, and the palms may become sweaty.

Cognitively, one's thought processes are interrupted by self-statements of two types: (a) those based in negative life premises which

are deeply set beliefs and a fundamental part of one's meaning system and self-concept, and (b) those based in poor study techniques which are not basic to one's belief system. First order change refers to an alteration which does not alter the basic structure, and in this context does not change one's basic life premises. Second order change refers to altering a deeply rooted life premise and is a significant change in self-concept.

Behavior Therapy

If a teacher is to help a student learn a particular concept, he can understand to some extent how the concept is best learned based on theories, research, and past classroom experiences. Depending on the particular concept being taught and the method by which it is supposedly best learned, an instructor can formulate a presentation for the classroom.

This section contains (a) background in behavior therapy, (b) a theoretical base for this study in Cognitive Behavior Modification, and (c) the approach of this study.

Behaviorists consider as relevant for study only that which is observable; they do not consider the working of the mind as relevant for it cannot be observed. They also believe that one's intelligence is completely determined by experiences (environmental factors) rather than by genetics. Learning occurs by changing the environmental factors. Given a stimulus and a response, learning occurs as the favorable responses are rewarded and the other responses are not.

An approach for managing anxiety can be taken from behavior therapy techniques. Meichenbaum (1977a) explains that:

> Behavior therapy techniques, as originally conceptualized and implemented, have overemphasized the importance of environmental events and, therefore, underemphasized and often overlooked how a client perceives and evaluates those events. Our research on cognitive factors in behavior therapy techniques has highlighted the fact that environmental events, . . . although important, are not of primary importance; rather what the client says to himself (cognitions) about those events influences his behavior and that these cognitions are explicitly modifiable by behavior therapy techniques . . . . (p. 108)

Thus, one notes that Cognitive Behavior Modification emphasizes modifying the cognitions which affect behavior and de-emphasizes modification of the environment as a means of affecting behavior. Within the area of Cognitive Behavior Modification are two techniques used in this study: (a) Stress Inoculation Training (Meichenbaum, 1975) which involves first order change, and (b) Cognitive Restructuring (Meichenbaum, 1977a) involving second order change.

Cognitive Behavior Modification--A Theoretical Base

The basic principle involved in Cognitive Behavior Modification is the augmentation of the technology of Behavior Therapy by strategies designed to affect the cognitive. It involves addressing three basic components of the individual: Cognitive Structure, Inner Speech, and Behavior. Cognitive Structure is defined as ". . . that organizing aspect of thinking that seems to monitor and direct the strategy, route, and choice of thoughts. . ." (Meichenbaum, 1977a, p. 213). Inner Speech is "nothing but speech to oneself, or concealed verbalization, which is instrumental in the logical processing of sensory data, in their realization and comprehension with a definite system of concepts and judgements" (Meichenbaum, 1977a, p. 211). The "definite system of concepts and judgements" refers to cognitive structure. The behavioral process involves three phases which can be summarized with a flow chart (see Figure 1).

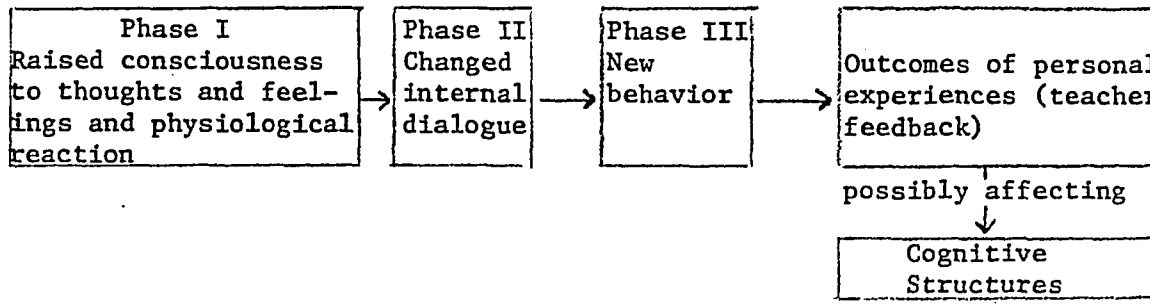

Figure 1. Theoretical Base in Cognitive Behavior Modification.

The function of internal dialogue is to attend to and appraise the cognitive and physiological reactions to stimuli. Wine (1971) and Meichenbaum (1977a) both point out that it is not the anxiety that leads to debilitated performance but rather the individual's reaction to the anxiety, that is, what a person is saying to himself. Thus it is the role of the instructor (or therapist) to help the individual develop a coping strategy consisting of all three phases to be implemented in each stressful situation.

The Approach of this Study Based in Cognitive Behavior Modification

In this study two approaches within Cognitive Behavior Modification were used: Stress Inoculation Training (Meichenbaum, 1975) on the level of first order change and Cognitive Restructuring (Meichenbaum, 1977a) on the level of second order change. Based primarily on the techniques used in the Math Anxiety Clinic (see Appendix B) in which Cognitive Restructuring was used extensively and on the technique described in "A Self-Instructional Approach to Stress Management (Meichenbaum, 1975)" in which Stress Inoculation Training was described, a model was formulated for use in this study (see Figure 2).

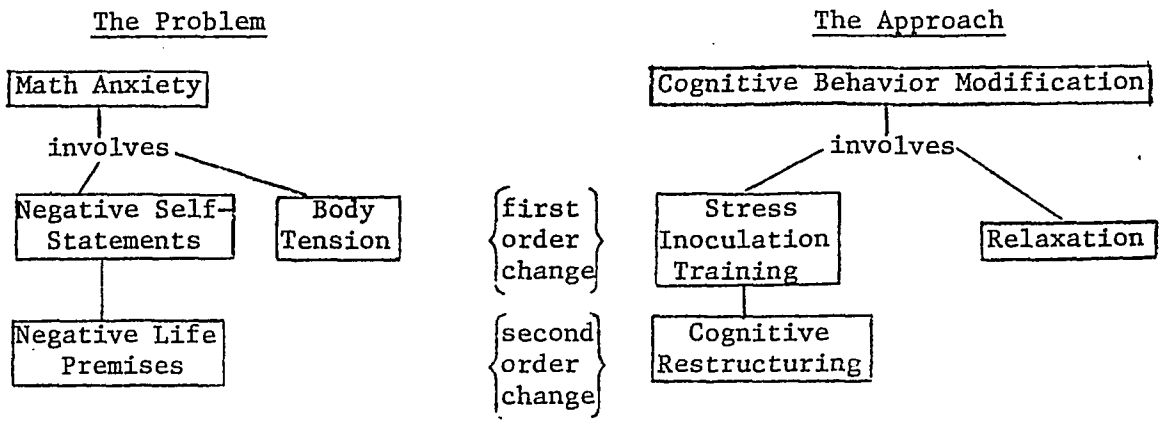

Figure 2. Model for Reducing Math Anxiety.

Stress Inoculation Training and Cognitive Restructuring will now be defined and described.

Stress Inoculation Training

The words "stress inoculation" refer to exposing the student (subject) to small doses of the anxiety-causing stimulus during which the subject experiences success at being in control of the situation and managing the anxiety. Gradually the doses are stronger and ideally the subject remains in control and manages the anxiety.

Stress Inoculation Training is defined as a process, the aim of which is to learn to manage the physiological and cognitive reactions to stress, thus remaining in control of the situation and being able to perform. It involves recognizing the early physiological reactions to stress and beginning at that point to relax and change one's internal dialogue. The immediate result is new behavior involving control of the situation (first order change). The long term result could be a change in one's cognitive structure or meaning system (second order change); for example, if a person learned to manage anxiety and perform on tests, the immediate result would perhaps be satisfaction in passing tests but would not necessarily result in changing one's basic premise about his mathematical

ability. Such second-order changes are usually long term. Perhaps, after having been successful in several settings, the person may then decide to change a basic premise concerning his ability. The focus of this study will be to implement Stress Inoculation Training in bringing about first-order change.

Operationally, Stress Inoculation Training involves three phases: the Educational Phase, the Rehearsal Phase, and the Application Phase. In the Educational Phase, the instructor (therapist) sets the stage for the entire study by first presenting a rationale for introducing techniques for stress management. Within this rationale he might discuss the nature of stress, the effects of worry and negative self-statements on performance, the bodily reactions to stress, and the role of relaxation in coping with stress.

The second phase, The Rehearsal Phase, includes having the student (client) become aware of the negative self-statements emitted in stressful situations and having him replace these with positive self-statements. Also, the student is provided with a "cafeteria style" list of coping statements (see Appendix C for the list used in this study) to employ at the first signs of stress. This list includes four sections involved in the process of confronting the stressor and managing the anxiety. The first section, "preparing for the stressor," is generally designed to give the person confidence to "psych himself up." The second section is composed of self-statements to use upon "confronting the stressor." The third section, dealing with the feeling of "being overwhelmed," is particularly applicable to test taking and gives the person a strategy to employ when he sees a problem that looks confusing, thus giving him alternate self-statements to replace statements of panic and self-degradation. The last section, statements "reinforcing oneself

for having coped," allows a person to mentally evaluate his performance and bring closure to the process. This internal dialogue allows one to concentrate and block out irrelevant and interrupting thoughts.

The Application Phase, the third phase, involves providing the student (client) with situations in which to test the coping skills. In a classroom environment such activities might be doing homework, answering in class, doing blackboard work, and in particular, taking tests.

In summary, the purpose of this study based in Stress Inoculation Training is to offer math students a reasonable explanation (other than in ability) for poor performance in math (the Educational Phase), to give them techniques for managing stress (the Rehearsal Phase), and to offer them many opportunities to practice the techniques (the Application Phase).

Cognitive Restructuring

Cognitive Restructuring the second technique in the approach of this study refers to:

> a variety of therapeutic approaches, whose major mode of action is modifying the patient's thinking and his premises, assumptions and attitudes underlying his cognitions. The focus of the therapy is on . . . the irrational inferences and premises. (Meichenbaum, 1977a, p. 186)

Operationally, due to its intense nature, this process is intended for individual or small group process and focuses on the second-order changing of one's basic life premises. Group process involves developing within members of the group a trust in one another and a freedom in sharing personal experiences in an effort to help each other discover the irrationality of the basic anxiety-causing premises in order that such premises might be changed.

"The cognitive therapist helps the patient to identify specific misconceptions, distortions and maladaptive attributions, and to test

their validity and reasonableness" (Meichenbaum, 1977a, p. 184).

The approach in the classroom would involve an instructor's becoming familiar with each student's manner of thinking, feelings, and behaviors. This could be done by giving students the opportunity to express themselves orally in class and in writing, to describe their feelings and past experiences with mathematics, and to continue the dialogue intermittently throughout the semester. In this way an instructor could locate students with serious problems and help them individually or refer them to a counselor. Depending on the individuals in the class, class members may openly begin supporting one another in their feelings and develop a sense of caring among themselves. This was the first step in the changing of basic life premises in the Math Anxiety Clinic (see Appendix B). If such attitudes developed, one could follow the techniques used in the clinic, but considering the classroom setting such results would be difficult to achieve.

The approach of this study, therefore is to implement Stress Inoculation Training in the classroom stressing first-order change, and to use Cognitive Restructuring causing second-order change.

In conclusion, this chapter has presented the definition of facilitating anxiety (a form of normal anxiety) and debilitating anxiety (a form of neurotic anxiety). The key concepts of Stress Inoculation Training and Cognitive Restructuring have been defined and described in their relationship to the experiment. A model for reducing math anxiety has been proposed.

CHAPTER III

REVIEW OF RELATED LITERATURE

Math Anxiety--A Problem of Widespread Occurrence

As far back as 1957, Dredger and Aiken wrote that "many persons report in clinical sessions and in academic classes that they are emotionally disburbed in the presence of mathematics" (p. 334), yet little has been done to alleviate this condition until the late 1970's. Gallese (1978), in her article "A little Calculating and a lot of Terror Equals Math Anxiety," calls math anxiety a "persistent problem . . . that has probably existed for generations" (p. 14). In reference to education, Mitchell Lazarus (1974) points out that, by the time a student leaves school, the chances are good that he will have reached some level in his mathematical training beyond which he finds progress extremely difficult. Not until approximately 1974 did research on the topic of math anxiety begin Lazarus, 1974) and did mathematicians, counselors, psychologists, and even feminists begin dealing with the problem experimentally. In the last few years, descriptions of programs with their underlying philosophies and evaluations have been published.

Mathematics and Math Anxiety--A Sexist Issue

Currently a vast amount of research is being done on the topic of women and mathematics (Ernest, 1976). Many articles have been written in an effort to expose the myth of mathematics as a "man's domain" (Fox, 1977; Tobias, 1976) and its consequent effects as a "career filter" which keeps women out of college programs and careers which have math as part of the coursework (Ernest, 1976; Mitzman, 1977b; "Math Mystique," 1977;

Tobias, 1978b). An article by Lucy Sells (1973), citing the results of a 1973 survey at Berkeley, points out that 57% of the male first year students at Berkeley had taken four years of high school math, while only 8% of the females had done so. As a result, 92% of freshmen women could major in only five out of twenty available fields. Sells' results, quoted by many (Ernest, 1976; Gallese, 1978; Mitzman, 1977b; Tobias, 1978a), spurred concerned educators and particularly feminists into action. The Sells' findings were also supported by a study at the University of Maryland (Smolkin, 1979). In 1975 feminist Sheila Tobias instigated one of the first math anxiety clinics at Wesleyan University. In 1976 she began publishing results which brought hundreds of responses to the math program which she cited (Afflack, 1977). After having written Overcoming Math Anxiety and having made widespread appearances speaking on the topic, she, along with others, began a consulting firm based in Washington, D. C., called Overcoming Math Anxiety, Inc.

Another educator-mathematician, John Ernest, taught a seminar on "Women in Mathematics" in 1974 and compiled the findings in "Math and Sex," an extensive report centered around the concern of too few women in mathematics and related fields. He wonders if educators, parents, counselors, peers, and texts are responsible for discouraging women from becoming involved in math-related courses and thus many careers. Mitzman (1977b) points out that in "higher reaches of the mathematics profession, women are rare, earning less than 10% of all mathematics Ph.D's and comprising less than 5% of regular faculty at doctorate-granting mathematics departments, according to surveys by the American Mathematical Society" (p. 1). If it is true that there is no significant difference in men and women with regard to mathematics, then one cannot help but agree that

"this is a tragic waste of human resources" (Mitzman, 1977b, p. 1). Even in 1977 the Department of Health, Education, and Welfare published a 220-page document entitled Women and Mathematics Research Perspectives of Change written by Dr. Lynn Fox, Dr. Elizabeth Fennema, and Dr. Julia Sherman.

In conclusion, most of research on math and sex refers to the question, "Is there a basic difference between the sexes regarding mathematics ability?" A summary of the findings is as follows: (a) There is no sex difference in mathematics performance through the grades. (b) It is in high school that girls begin to choose not to take mathematics (Ernest, 1976; Fennema, 1977; Mitzman, 1977b; Sells, 1973) because of the sex stereotype presented by parents, teachers, counselors, and peers (Tobias, 1978b). (c) Little difference between females and males exists in most cognitive variables except for visual spatial skills (Fennema, 1977; Goleman, 1978; Mitzman, 1977b; Tobias, 1978b), and there is some disagreement about the actual relationship between spatial skills and learning math (Fennema, 1977; Tobias, 1978b). (d) Some of the differences between males and females are due to environmental learning, particularly games which boys play and girls do not. Tobias calls it "street mathematics" (Tobias, 1978b, p. 70). (e) The study of the brain lateralization regarding sex differences is most controversial (Gazzanica, 1976; Goleman, 1978, 1977; Maier, 1978; Nelson, 1978; Samples, 1976; Sperry, 1975). Is there a difference in the way the male and female brains are organized (Goleman, 1978)? Is there a difference in the timing of the separation of the two hemispheres of the brain in males and females and, if so, does this account for sex differences (Tobias, 1978b)? Some educators are experimenting in the classroom with trying to help

students make use of both hemispheres of the brain in learning (Brown, 1979; James, 1979; Miele, 1978; Papsdorf, 1978), but none could be found experimenting in the mathematics classroom.

There are several ways educators, and society as a whole, can overcome the detrimental effects of a sex bias. First, parents, teachers, counselors, and peers need to encourage all students, particularly females, to take more mathematics beyond minimum requirements (Ernest, 1976; Fennema, 1977). Secondly, programs should teach spatial skills to young girls (Tobias, 1978b) and develop self-instructional, programmed packages for increasing spatial skills in high school and college (Sherman, 1977). Furthermore, men "need to accept a woman [in math related fields] as an honest-to-goodness colleague rather than a curiosity" (Ernest, 1976, p. 14).

Sex bias is related to math anxiety because it is one of the factors generating anxiety which in turn leads to poorer performance in mathematics (S. B. Sarason et al., 1960). Thus one answer to treating math anxiety, besides encouraging the high school students to take more math, is to give teachers expertise in reducing or dealing with anxiety and in training students to do the same.

Techniques for Relieving Anxiety

Many popular magazines have described or reported on relaxation techniques as a method of reducing anxiety and improving health. An article "To Relax Try Jogging" (Gaylen, 1976) finds jogging as effective as desensitization and recommends it highly. In "War with Stress" Kobassa (1978) suggests that people can experience stress without becoming ill if they believe they have control over their lives and perceive change as an opportunity or challenge rather than as a threat.

Clinically, Systematic Desensitization is the most widely known method for treating anxiety (Lazarus, 1964; Mingler and Wolpe, 1967; Paul, 1966; Rachman, 1967) and specifically for treating test anxiety (Cohen and Sanford, 1968; Donner and Guerney, 1969, Laxer et al., 1976; McManus, 1968; Suinn, 1968; Suinn et al., 1973; Suinn and Hall, 1970). Developed by Joseph Wolpe in the early 1950's, Systematic Desensitization involves the formulation of a hierarchy of anxiety causing scenes and the treatment of using deep muscle relaxation, alternating it with imagined scenes from the hierarchy (Rachman, 1967). Davison (1965) and Rachman (1965) point to the importance of the relaxation component, while A. A. Lazarus (1964) cautions that the therapist directing the desensitization must have considerable expertise and suggests that unsuccessful research is probably due to improper usage of the process.

In an effort to make desensitization less time consuming for the therapist several studies have found group desensitization (A. A. Lazarus, 1961; Paul and Shannon, 1966; Robinson and Suinn, 1969; Suinn, 1968), short termed desensitization (Suinn, 1970), and automated desensitization (Donner and Guerney, 1969; Kahn and Baker, 1968; Mingler and Wolpe, 1967; Suinn and Hall, 1970) effective. Suinn (1976) has developed a series of math desensitization tapes for use with a counselor's direction. One surprising result in systematic desensitization (contradicting the theory of Cognitive Restructuring) is that it is possible to significantly reduce fear without changing the person's meaning system (Lang and Lazovik, 1963) or a person's basic attitudes (Rachman, 1967). In Cognitive Restructuring the person changes his meaning system, his basic life premises on which behavior is based (Meichenbaum, 1977a).

Another approach to be used along with the already proven effective systematic desensitization technique is the introduction of coping skills. For treating various phobias Meichenbaum (1977a) reports several studies emphasizing relaxation and self-talk as coping skills. Developing coping skills is the basis of Stress Inoculation Training, which has been used to reduce test anxiety (Hussian, 1977). For certain groups of high anxiety college students Mitchell and Ng (1972) showed a coping skills approach was superior to desensitization alone; and Meichenbaum (1977a) gives guidelines for the multifaceted, coping skills process.

Hassett (1978) suggests meditation, autogenic techniques and relaxation to relieve both anxiety and also high blood pressure. Relaxation has also been used to treat various phobias (Kremis, 1979), headaches (Miele, 1978), and anxiety in the classroom (Carpenter, 1977; Miele, 1978). Carpenter (1977) uses daily meditation and relaxation in her philosophy class with very favorable student evaluations. Miele (1978) and James (1979) report on the Lozanov method (also called "Suggestopedia") which involves relaxation and the use of both hemispheres of the brain in learning.

Anxiety As It Relates To Factors Affecting Performance In School

A large amount of the research has been done in reference to test anxiety in the academic context. Before analyzing test anxiety, however, it will be helpful to consider the factors relating to the problem of anxiety in school.

"It is apparent that college life is characterized by conditions and expectations which may heighten anxieties already present in students or may induce new anxieties" (Spielberger, 1962, p. 421). This problem of anxiety is highly complex and is related to at least four factors:

(a) intelligence, (b) the complexity of the task involved, (c) one's self-concept, and (d) the role of significant others, that is, those who are important to an individual. Intelligence and complexity are related and are studies together, as well as one's self-concept and the role of significant others.

Intelligence and the complexity of the task are related in the Yerkes-Dodson Law which states: "As tasks are increased in difficulty, the optimum level of motivation (anxiety) declines" (Travers, 1977, p. 351). Intelligence is also related implicitly in that it directly effects the degree of difficulty for each individual. With respect to learning, this law could be stated as follows: as the task increases in difficulty, the level of arousal at which optimum learning occurs declines. In reference to classroom learning, as the task increases in difficulty or complexity, the optimum level of anxiety declines. There is an optimum level of anxiety for learning a particular task--the optimum for simple tasks is higher than for complex tasks. Directly related to the degree of complexity of the task is intelligence or ability, which differs among individuals (Travers, 1977). For highly intelligent (HI) students, often high anxiety (HA) facilitates (Spielberger, 1966a) since perhaps the task is not complex to the HI. If the same task is given to Middle Intelligent (MI) or Low Intelligent (LI), high anxiety may be debilitating since the task is more complex (Spielberger, 1966a).

Many studies have been performed which support the Yerkes-Dodson Law (Denny, 1966; Gaudry and Fitzgerald, 1971; Katahn, 1966; Spielberger, 1966a). Studies by Katahn (1966) and Spielberger (1966a) have pointed out that LI implies low performance regardless of the anxiety level. The most detrimental effects of anxiety occur with the MI student

(Spielberger, 1966a). S. B. Sarason et al. (1960) describe the pattern. First, the higher the anxiety, the lower the I. Q. as demonstrated by intelligence tests. Secondly, the lower the I. Q., the greater the likelihood of difficulty and experienced failure in school. This failure then leads to higher anxiety, and the crippling circle continues throughout school. Bradshaw and Gaudry (1971) also found that test anxiety was due to a past history of failure. For HI students a large body of research reports that anxiety is generally facilitating (Spielberger, 1966a). S. B. Sarason et al. (1960) write, however, that even though these students have no trouble in attaining competence, they "cannot utilize their capacities fully or creatively because of a long standing struggle with anxiety" (p. 267).

In relation to mathematics, Mitchell Lazarus (1974) speculates that when the task is not complex, "it is easier for a student to get through just by memorizing formulas and rules long enough to write the examination" (p. 52). He explains that that is why mathephobia is not apparent in elementary school where the tasks are not as complex. As one progresses through school, "the memorization tactic becomes increasingly unworkable" (p. 52).

Some studies have reported the failure to find a relation between various measures of anxiety and intelligence (Dana, 1957; Klugh and Bendig, 1955; I. G. Sarason, 1956). Denny (1966) noted that studies which failed to consider both factors, intelligence and complexity of the task, when studying anxiety had results which were inconsistent.

Self-concept is another factor related to anxiety. The self, as defined by Purkey (1970), is a "complex and dynamic system of beliefs (referred to in this study as life premises) which an individual holds

true about himself, each belief with a corresponding value" (p. 7). The closer the belief is to the core of the 'self', the more firmly it is believed by the person and the harder it is to change. Purkey (1970), in his chapter "Growth of Self," points out that a tiny infant begins to "sense his value and worth as a human being. . . as he begins creating a 'self'" and that the "main forces which shape self are significant others" (p. 30)--parents, teachers, and peers. Also, next to the primary home environment, the school is the single most important force in shaping the child's self concept.

In so far as behavior is related to one's self-concept, anxiety, a form of behavior, is also related to self-concept. Several studies have demonstrated that the greater one's anxiety, the lower his self-esteem (Rosenberg, 1953). Also, Suinn and Hill found similar results on the college level (1964). Thompson (1972) describes several studies with highly significant correlations between anxiety and most of the variables on the Tennessee Self Concept Scale, in particular, self esteem, self respect, feeling of personal worth, and satisfaction with self.

In a study of the highly anxious student (HA), Gaudry and Spielberger (1971) suggest that such students develop self-derogatory attitudes which, in turn, lead to over concern with bodily adequacy (S. B. Sarason et al., 1960). In observing classroom work, S. B. Sarason et al. (1960) noted that the HA students blame themselves for their failure, are dependent on others, and have difficulty expressing hostility. According to Lighthall (1963), HA students admitted to worry as well as to hostility and feelings of inadequacy. The HA child sees himself as unadventurous and prefers a well known, stable, well articulated school routine (Penny, 1965). This one side effect of anxiety is that creativity is stifled

even in the most intelligent (S. B. Sarason et al., 1960).

The "significant others" of HA students--in particular, parents (Davidson, 1959) and teachers (Gaudry and Spielberger, 1971)--perceive HA children as less well adjusted. Teachers also characterize these students as "dependent, unaggressive or self-derogatory" (S. B. Sarason et al., 1960). In one study HA correlated positively with teacher ratings of maladjustments in the HA student (Gaudry and Spielberger, 1971). Parents saw their HA children as worriers (K. S. Davidson, 1959). Fathers (not mothers) saw them as less mature, less relaxed, and more dependent as compared to their less anxious children (S. B. Sarason et al., 1960). With regard to mathematics, Poffenberger and Norton (1959) concluded, however, that self-concepts are well established by the influences of the parents in the pre-and early school years, and that student attitudes with regard to mathematics are not necessarily determined by teacher attitude. Results are not consistent (Gaudry and Spielberger, 1971), however.

In a 1971 study by Gaudry and Spielberger, it was found that the opinion of peers, at times, had more of an effect on a child than his parent's attitude and that peers had a tendency to view the HA child in a critical light. For example, peers nominated the HA students for the roles of villains in plays. Also, it was discovered by Gaudry and Spielberger (1971) that the more anxiety a student displayed, the less popular he was regarded by peers.

Since anxiety is highly correlated with self-concept, one might ask if self-concept can be improved and if debilitating anxiety can be lessened, thus improving the atmosphere for learning? Purkey (1978) suggests that an inviting environment might lessen anxiety. As used

by Purkey, an invitation is a "summary description of messages--verbal and non-verbal, formal and informal--continuously transmitted to students with the intention of informing them that they are responsible, able, and valuable" (p. 3). What is important is the "spirit in which the work is done" (James, 1977, p. 63). Spielberger (1966b) considers it the role of the university to identify anxious students at the earliest possible time and offer them therapy in order to reduce the academic mortality rate.

Analysis of the Components of Test Anxiety

The effects of test anxiety on academic performance have been documented (Gaudry and Spielberger, 1971). Spielberger (1966a) has also indicated that the high drop-out rate is directly related to test anxiety in college. In 1952 Mandler and Sarason labeled test anxiety as an "habitual class of self oriented interfering responses in a student's response repertoir." Many researchers (Doctor and Altman, 1969; Liebert and Morris, 1967; Little and Jackson, 1974; Meichenbaum, 1972; Mitchell and Ng, 1972; Morris and Liebert, 1969, 1970) have analyzed anxiety as consisting of two components: (a) the worry component or cognitive component, which includes maladaptive and unrealistic self-perceptions, expectations, fears, attitudes, and academic behavior patterns, and (b) the emotional component, which is the physiological and affective aspect of anxiety directly related to autonomic arousal. Concerning the worry component, one commonality with anxious people is a self-centered focusing of attention on one's feelings, thoughts, and inability to cope with the problems of life (Sarason, 1957). Meichenbaum (1975) reports several studies which indicate a firm empirical foundation for the role of cognitive factors in anxiety. Several studies (Doctor and Altman, 1969;

Morris and Liebert, 1969; Wine, 1971) support the theory that the worry component directly causes a decrement in performance, while the emotional component seems to be less likely to interfere with performance of high test anxious students on cognitive tasks. "Worry is attentionally demanding and distracts attention from the task" (Wine, 1971, p. 100). Davidson (1968), Freeling and Shemberg (1970), Johnson and Sechrest (1968) and Little and Jackson (1974) concur that relaxation training addressing the emotional component does not significantly reduce test or general anxiety. On the other hand there are investigators who have found that addressing the emotionality component through autogentic training decreases anxiety (Reed and Meyer, 1974; Snyder and Oetting, 1966). Luther and Schultz (1969) in their book Autogenic Therapy also report many cases in education in which autogenic training has been used successfully to lessen anxiety. Autogenic training promotes the following physiological effects: "warmth and heaviness in extremities, cardiac and breath regulation, abdominal warmth, cooling of the forehead" (Reed and Meyer, 1974, p. 649). Carpenter (1977) leads muscle relaxation and meditation in her philosophy class every day and reports positive results and student evaluations.

Lazarus and Averill (1972) have suggested that even though both emotionality and worry can be identified independently, they interact as a single process in test anxiety. The studies of Allen (1973), Deffenbacher (1977), Finger and Galassi (1977), Meichenbaum (1972), Mitchell and Ng (1972), Osterhouse (1972), Paul (1969), and Snider and Oetting (1966) support the necessity of addressing the cognitive as well as the autonomic. Meichenbaum (1972) in particular suggests Stress Inoculation Training and Cognitive Restructuring, both of which focus on the cognitive component but also include addressing the emotionality

component. In reference to education, at the University of Rochester Medical Center, Cognitive Restructuring has been used by Kodes (Kremis, 1979) in conjunction with relaxation and biofeedback in a clinical setting in reducing test anxiety. Stress Inoculation Training has been used by Hussian (1977) to reduce test anxiety. The training, however, was performed outside of the classroom. No studies could be found which implement either of these techniques in the classroom, a fact verified by Meichenbaum (1978) in a phone conversation.

Neither are studies available which address the two aspects of anxiety (worry and emotionality) along with both complexity of the task and intelligence of the student as factors. This is important because, perhaps, if those studies which found no relationship between both emotionality and worry had considered task difficulty as a variable, they would have found a difference. One study by I. G. Sarason and Palola (1960) considered difficulty of the task as it related to test anxiety and general instructions, but "difficulty of the task" was a relative factor; that is, one task in the study was more difficult than the other but not necessarily difficult in itself.

Meichenbaum (1977a) suggests that study skills be considered a factor to be studied with test anxiety. One study was found which compared three groups of highly test anxious students (Osterhouse, 1972). One group was given desensitization, one was in study skills training, and one was the control group. The control group out-performed the experimental groups. In another study in which counselors were prepared for Cognitive Restructuring sessions with test anxious college students, the students were more interested in discussing study skills and problems relating to adjusting to college (Denny et al., 1962; Spielberger, 1966). Naylor

and Gaudry (1973) discovered that the measure of adjustment was significantly related to performance in mathematics for seventh graders after the effects of anxiety and intelligence were partialed out. According to a study at Vanderbuilt University (Katahn et al., 1966), advice and discussion were more helpful to students than desensitization.

Meichenbaum and Butler in a recent paper (1978), included one additional component to be considered along with worry and emotionality in studying test anxiety--the "meaning" component. How do the cognitions, which one learns, fit into one's "meaning system?" Meichenbaum and Butler also considered of equal importance the use of relaxation to enable a person to become more aware of and better understand his own meaning system by reducing the number of interfering stimuli. This theory fits well with the Self-Concept Theory as presented by Purkey (1970). In reference to this "meaning system" (part of one's cognitive structure) Averill (in press) states:

> Events are only meaningful to the extent that they can be assimilated into some existing cognitive model or structure; and if they cannot be assimilated, then the relevant cognitive structures must be altered to accomodate the environmental input. (p. 224)

Meichenbaum relates that the treatment techniques thus far employed have failed to deal with the broader personal meaning. Most factors deal only with a few factors simultaneously (Meichenbaum and Butler, 1978). Meichenbaum reports that all of the following are important in dealing with anxiety: meaning system (implying the use of Cognitive Restructuring), internal dialogue (used in Stress Inoculation Training), behavioral acts and interpretation of behavioral outcomes (implying the use of in vivo situations or imagery rehearsal).

Over and above test anxiety is math anxiety. Very little has been published addressing the psychological aspects unique to math anxiety. Thus, the same theories applying to other anxieties are assumed applicable to math anxiety.

Philosophies of Programs Dealing With Anxiety

In schools most current philosophies generally emphasize the importance of the counseling aspect of treating math anxiety. Either the teacher must become part counselor and encourage talking about math in the classroom or the teacher must work, in conjunction with a counselor, with groups meeting outside of class to work on the math anxiety.

A second emphasis of many philosophies is making math relevant in order to help a person accept it into his personal meaning system. The Mandalay Principle of teaching (James, 1977) suggests that one "teach from the center" (p. 55) in two respects: "(a) from the center of the learner, which is his interests and experiences, and (b) from the center of the subject matter, which is principles" (James, 1977, p. 60). Smolkin (1979) believes that the most important factors are that a program be comfortable rather than threatening, that feelings of the individual be more important than the subject matter, and that students discuss among themselves how to work problems. Tobias (1978b) feels "it is most important to eliminate anxiety-producing experiences, no tests, of course, no pressure to get the right answer, no competition with classmates, no put downs." This one positive math experience will go far toward reducing anxiety.

One very exciting experimentation today is the study of the two hemispheres of the brain, not as a sexist issue but in reference to learning.

The theory is that learning can occur much more efficiently if both hemispheres of the brain are used in learning. Students who have been trained to do so are learning at a phenomenal rate (Brown, 1979; James, 1977; Miele, 1978) with lasting comprehension. The theory is based in Brain Lateralization; the philosophy of it was expressed by Thomas Jay Hudson as early as 1892. He wrote (Hudson, 1892/1975) of the reasoning powers of the "two minds," the objective mind and the subjective mind.

> The objective mind is capable of reasoning by all methods--inductive, deductive, analytic, and synthetic (while) the subjective mind is incapable of inductive reasoning (p. 32) . . . . The subjective mind, untrammelled by its objective environment will be enabled to comprehend all the laws of nature, to perceive and to know all truth, independent of the slow, laborious process of induction. (Hudson, 1892/1975, p. 73).

Different programs using techniques based in the theory of Brain Lateralization may vary in philosophy. Papsdorf (1978), at the University of Michigan, bases his philosophy in the theory that anxiety triggers a "flip flop strategy," a physiological switchover from one brain hemisphere to the other. Counseling in Papsdorff's program deals with developing an approach to control this "flip flop" through self statements and relaxation.

On the other hand, Suggestopedia or the Lozanov Method (Brown, 1979; James, 1977; Miele, 1978), which has been used to teach languages, chemistry, basic mathematics, physics, or biology, concurs with Hudson's philosophy. The principle of learning is that both hemispheres are twice as effective in learning as one. In a traditional classroom, while the left hemisphere is working hard to absorb the material, the right hemisphere is unconsciously absorbing interfering signals. In Suggestopedia music is played while the teacher instructs. Students are told to listen to the music, leaving the right hemisphere "wide open to the experience.

The logical left is passive, permitting the language lesson to 'piggyback in' unobstructed by distraction" (Miele, 1978, p. 16). Brown (1979) reports that in using Suggestopedia at Burklyn, a two-year business course can be learned in six weeks with retention. The theory of Suggestopedia is pertinent since, if the subjective mind which stores "basic life premises" or one's "meaning system" (Meichenbaum, 1978a) emits positive statements, then negative self-statements and interruption statements are eliminated. Hudson (1892/1975) also states:

> the most perfect exibition of intellectual power is the result of the synchronous action of the objective and subjective minds; when this is seen in its perfection, the world names it 'genius'. (p. 50)

Another extremely important aspect, however, of Burklyn is that learning emphasizes the importance of a positive self-concept. A program by Thurber and De Porter was modeled after their real estate firm, which operates in an environment emphasizing the importance of the self worth of employees and clients (Brown, 1979), an atypical approach in our society. One student, after completing the course at Burklyn, commented: "I also understood that the only thing stopping me through my life had been my own self-imposed limitations. And that applied to my body as well as my mind" (Brown, 1979, p. 12). An instructor at Burklyn not versed in Suggestopedia commented: "People were actually getting it . . . their learning capacity was extra-ordinary. What a turn-on! The energy level was unbelievable" (Brown, 1979, p. 12). In addition to Suggestopedia, the other primary aim of the school is to provide "learning in an environment of love, support, and trust in which everyone could experience a sense of great personal power and self-worth" (Brown, 1979, p. 9).

Specific Programs Dealing With Math Anxiety

There are four major thrusts in the endeavor to eliminate math anxiety and math avoidance. Two of these thrusts answer the sexist myth of math being a man's domain: first, the Wellesley-Wesleyan Project (Tobias, 1976, 1978a) begun by Sheila Tobias in 1975 in the Connecticut-Massachusetts area for college students; and second, Math Science Network in California (Kreinberg, 1976), an organization working since 1974 to develop innovative math and science education programs for girls and women. The third project, the Oregon Mathematics Education Council's (OMEC) program (Mitzman, 1977a), active since 1972, has as its "first and foremost aim to strengthen teachers' preparation for teaching mathematics." Fourth, and in contrast to these school-related programs, is a program for math anxious adults, Mind Over Math (Kogelman, 1978). This was originated in the New York area, by Stanley Kogelman, a mathematician with a degree in psychology, and mathematician Joseph Warren.

The Wellesley-Wesleyan Project noted above (Wellesley-Wesleyan, 1977) is worth special attention. It has been widely publicized and evaluated as a highly successful program for students (primarily females) who, at the onset of their college careers, are satisfied to avoid all math courses. The goals of the program include informing the students of the fact that mathematics serves as a "career filter," offering a non-threatening discovery course in mathematics, and encouraging the students to take more math. At Wellesley College (Blum, 1975), "A Discovery Course in Elementary Mathematics and its Applications" involves a non-remedial, precalculus format in which the math instructors act as facilitators to discovery learning. The course is designed and taught by the math department to a class of approximately 20 or less, for four hours

and 20 minutes per week. A psychologist is not directly involved with the students in class but is available to and supportive of the program. One collaborating psychologist, Lorelie Brush (1978), has done an extensive evaluation of the program after two years of operation. Besides positive remarks by students, the program is particularly successful in changing student attitudes toward mathematics, in building student confidence, and in providing a pleasurable experience. There was no significant change in anxiety level, but students were not highly anxious at the onset, a fact perhaps explained by the high SATM averaging 628.18.

The Math Anxiety Clinic at Wesleyan University is a "joint effort by both counselors and math teachers to help students overcome emotional and acculturated impediments to learning or even trying to learn college-level math" (Tobias and Donady, 1977). Each student is interviewed and diagnosed according to math ability and math anxiety level. The student then chooses between a noncredit workshop or an algebra review class of which there are four levels of competency. Students are also invited to meet in an optional "psychology laboratory" with a counselor and mental health specialist. Other students too fearful to enroll in the course are encouraged to visit the counselor. This counselor, working with the math teacher, attends each math class and gives the teacher feedback. The main characteristic of this program is that counselors and teachers both work with the students--in class, out of class, and before entering the class, according to the needs of the student. Springing from this format is the consulting firm Overcoming Math Anxiety Inc., based in Washington, D. C..

A second of the four significant programs organized in answer to the sex-bias issue is Math Science Network, representing 400 educators, scientists, engineers, administrators, and community people from 30 colleges and universities, 20 school districts and numerous corporations, government agencies and foundations. This association has been working since 1974 to develop and conduct innovative math and science education programs for girls and women. The Math/Science Resource Center is the main clearing house and switchboard of the Network. The project directors are Lenore Blum (Director of Collegiate Programs), who has also begun the program "To Combat Math Avoidance at Mills College" (Blum, 1975), and Nancy Kreinberg (Director of Secondary Programs), who has begun "Math for Girls" at Lawrence Hall of Science (LHS), University of California, Berkeley. "Math for Girls" provides girls from six to 14 a nonthreatening environment in which to explore fundamental math concepts and applications. At the University of California in Berkeley, classes are taught by women students who are majoring in mathematics, math education, or computer science, and who are selected on the basis of ability in math and desire to provide role models for their students. "In 2 1/2 years more than 350 girls have taken the class (8 weeks 12 hours) and the total number of girls enrolled in other LHS math and science courses has doubled" (Kreinberg, 1976, p. 3).

The Mills College program prepares students for calculus in one semester, stressing also the importance of math for many careers. Since 1973, when the course began, enrollment in math and computer science classes has jumped from 331 to 853. Recently developed is a video math program entitled "Count Me In: Educating Women for Science and Math" which demonstrates that women can excel in math.

The third thrust, primarily for adults, Mind Over Math, is another highly successful program founded and directed by Stanley Kogelman and Joseph Warren, based in the New York Area. No statistical evaluative research could be found, but the success of the program is based on the widespread publicity (Kaighen, 1977; Kogelman et al., 1978; Robertson, 1977), the continued popularity of the workshops, and the recently published book Mind Over Math. The procedure is group process involving five sessions of 80 minutes each in which participants learn many ways, both practical and emotional, to deal with deep-seated feelings. The workshop begins with participants sharing past experiences, beginning with very simple math problems. By the end of the workshop, students realize that math can be used in everyday life and that it is not all logical but does involve some intuition.

Another experiment by Kogelman in conjunction with Elaine Sorel at the Dalton High School (Kogelman et al., 1978) involved giving five one hour workshops, which met at regular class sessions to high school students in Algebra I. The same philosophy of discussing fears and feelings in a nonthreatening atmosphere had the support of students, teachers, and parents. This successful high school clinic was offered again with minor adjustments.

Finally, the last large scale project, the Oregon Mathematics Education Council (OMEC) (Mitzman, 1977a), consists of a group of Oregon teachers, administrators, college and business representatives directing a project to enhance mathematics education in the state. Begun in 1972, OMEC has attacked math anxiety in the elementary and high schools by trying to rid teachers of their long standing fear of math and helping them to see it as useful and enjoyable. The first phase of the project

has been to offer all day Saturday workshops voluntarily attended by the teachers, while the second phase has concentrated on establishing resource centers in schools and colleges where teachers may acquire information, advice, or instructional materials including books, magazines, slides, videotapes, games, puzzles, kits, tools, models, charts, and posters. The third phase provides circuit riding mathematics consultants who visit the schools conducting classroom demonstrations and in service courses (Mitzman, 1977a). The fourth and final phase is to evaluate and to report. "Math Learning Center Report" is sent free to anyone wishing to receive it. Evaluation consists of a 1976 survey of 5,000 teachers in Oregon which shows that "OMEC has touched large numbers of teachers. About 61% of all elementary teachers and 74% of all secondary teachers report that they have participated in at least two OMEC-sponsored or OMEC-supported workshops" (Mitzman, 1977a, p. 8). Teachers feel the workshops are "useful" and appear to implement what they learn in their classroom teaching. One criticism of the OMEC workshop is the price tag of three million dollars in federal tax money (other programs did not disclose the cost of funding).

Besides these large-scale projects, there are many programs, on a smaller scale or not highly publicized, similar in focus to at least one of these larger programs. At Baker Middle School in Marion, Ohio, the teachers strive to tear down the preconceived notion that mathematics is an "I can't do it" subject, to make it as relevant as possible and to make it fun (Iams, 1977).

Jeffry Mallow of Chicago's Loyola University has started a science anxiety clinic (Stoelzle, 1978) in which he encourages students to discuss fears among themselves, imagine their worst anxiety and relax,

and spot physical signs of tension. In the classroom he emphasizes logical deduction rather than memorization and reading the text slowly. He urges students "not to become infected by a professor's own anxiety that his course is too complex" (p. 96). Mr. Mallow's student evaluations are very positive.

At the University of Minnesota (Davis, 1977), a self-paced algebra course with psychological intervention was offered. In addition to the math class, there was a mandatory weekly therapy group session led by counseling psychologists who used desensitization, hypnosis, and cognitive restructuring. The results indicated a significant rise in math skills and self-confidence about mathematics abilities along with a decrease in self-reported anxiety about mathematics. In general, Davis (1977) divides her students into three classes depending on the apparent degree of math anxiety (determined by an initial interview) and varies her technique from talking to using desensitization and relaxation techniques.

One other program designed for teachers is Ruth Afflack's Program (1977), "Math Ideas for Teachers." Programs designed for women with basically the same philosophy are Ruth Afflack's "Math for Ms.," and Introductory Mathematics at the University of Missouri at Kansas City. At the University of Wisconsin at Madison (Carretta, 1979) a kit of materials is being developed on women and mathematics. Entitled "Multiplying Options and Subtracting Bias," there are four versions of a videotape aimed at reaching four audiences most influential in a high school girl's life--parents, teachers, counselors, and peers.

Similar programs aimed at adults are Ruth Afflack's "Mathephobia," a 15-hour stimulation weekend course exploring basic concepts using fun and challenging materials. At Sarah Lawrence College (Klein, 1978),

a Math Clinic (10 hours, 5 sessions, composed of an informal program solving workshop, is taught by a math faculty. Also offered at Sarah Lawrence College is a 12 week course (three hours a week) called "Math Review for Adults," which develops arithmetic and algebraic skills.

No program could be found specifically designed to treat Math Anxiety modeled in a similar fashion to Burklyn (Brown, 1979). This would seem to be a desirable direction for programs because Burklyn's philosophy includes highly efficient learning by use of Suggestopedia, physical fitness, relaxation, proper diet, and an atmosphere of love fostering a positive self-concept.

In summary, from the variety of references it is clear that anxiety is affecting a large population and that an optimal strategy for managing such stress has not been determined. Some studies have separated the effects of anxiety on the body from the effects on the mind, but many studies (Allen, 1973; Deffenbacher, 1978; Finger and Galassi, 1977; Meichenbaum, 1972; Mitchell and Ng, 1972; Osterhouse, 1972; Paul, 1969; and Snider and Oetting, 1966) are showing the importance of treating both aspects--the cognitive (that affecting the mind) and the autonomic (that affecting the body). Meichenbaum and Butler (1978) have recently added a third component--the meaning component, closely associated with one's self-concept. As has been illustrated, some school systems are now focusing on reducing anxiety in conjunction with learning, but much progress still needs to be made in this area.

CHAPTER IV

METHODOLOGY OF THE STUDY

The theory and approach for this study, based in Stress Inoculation Training and Cognitive Restructuring, were defined and described in Chapter 2. The purpose of this chapter is to present the details of the experiment. Some descriptions will include the methodology in all classes followed by the additional activities done only in the experimental class.

Subjects

The subjects in this study were 117 randomly selected students at Appalachian State University who registered for one of the three developmental math sections during the Fall Semester of 1978. On the basis of a placement test, the students were required to take a developmental course before registering for any college math course. In general, these students had not been successful at math in the past and therefore experienced anxiety in dealing with it.

Apparatus

Evaluation of the experiment incorporated the use of two measures of mathematical performance, the Cooperative Mathematics Test-Algebra I (1962), forms A and B; and one measure of math anxiety, the Math Anxiety Rating Scale (Suinn, 1972). Student evaluations, although not measurable by statistical analysis, were also considered important. The Cooperative Mathematics Test-Algebra I (1962), form A, was given during orientation as part of the placement device (see Appendix A for complete description

of placement); form B was used as posttest in the course.. To measure anxiety the Math Anxiety Rating Scale (MARS) was given on the second day and on the last day of class (see Appendix C for the MARS). In this 98-item questionnaire students rated on a scale from 1 to 5 the extent to which they were frightened when confronted by a particular situation involving math.

Devices for getting to know the students included an attitude questionnaire, a math autobiography, and diaries. The attitude questionnaire (see Appendix C for actual form) consisted of six questions primarily asking students their personal objectives in taking the course, the extent to which they wanted to learn the material, and their rough estimate of the amount of time they would invest in the course. With the results of this questionnaire the instructor could advise those students whose expectations seemed unrealistic based on their own time constraint. The math autobiographies composed by each individual were helpful in establishing communication between the instructor and student. In the autobiographies students generally shared their past experiences in math classes and made a commitment to try to do well in the course. Students were encouraged to continue communication through daily diaries which contained evaluations of their progress as well as of class activities.

The text used in all classes was Beginning Algebra (Lial and Miller, 1976). An optional Study Guide for Beginning Algebra (Lial and Miller, 1978) was available at the bookstore for $5.00. The entire text was covered except section 5.7, examples 4 and 5, and problems 19-34 on page 182; section 5.8, examples 3 and 4, and problems 13-22 on page 241; and sections 8.4, 8.5, 8.6, 8.7, 9.2, 9.4, 9.5, 9.6 and the appendix.

In the experimental class, diary forms (see Appendix C for actual form) were distributed and collected daily for the first two weeks. These forms included questions on the use of the thermometers, on study techniques, and on evaluating the class activities. Each student was given a finger thermometer to use in becoming aware of his bodily reactions to stressful situations. These thermometers, three inches in length, taped on the tip of the middle finger, recorded a high temperature when the person was relaxed and dropped in temperature when the person was confronted by a stressful situation. Throughout the semester brief questionnaires and explanatory handouts were given to the experimental class as periodic feedback in conjunction with the experiment (see Appendix C for actual forms). The experimental class also had the opportunity to listen to four audio tapes on relaxation (Lowinstein, 1977) which were available from 8:00 A.M. to 5:00 P.M. daily. The tapes consisted of progressive relaxation, self-directed relaxation, guided imagery, and breathing relaxation.

Design

The overall experiment consisted of three phases: the Educational Phase, the Rehearsal Phase, and the Application Phase. The Educational Phase, presented in the first two weeks, gave the students the rationale involved in Stress Inoculation Training. This involved presenting the nature of stress, the effects of worry and negative self-statements on performance, bodily reactions to stress and the role of relaxation in coping with stress. The Rehearsal Phase consisted of referring to the principles presented in the Educational Phase and of assisting students in developing coping strategies. It also included rehearsing techniques for managing stress in blackboard experience and in taking pop tests.

Lastly, the Application Phase consisted of applying the experimental techniques in taking the eight major tests given in the course. These phases will be described in detail in the sections which follow.

The analysis consisted of performing a multivariate analysis of covariance on the three classes. These classes, randomly determined, were the experimental class taught by Instructor A, the control class taught by Instructor A, and the control class taught by Instructor B. There were two control classes to eliminate the dependence of the results on the variable "Instructor." The dependent variables were The Cooperative Mathematics Test-Algebra I, form B (1962) given three days prior to the end of the semester (Post-Place); the final average in the course (Grade); and the Math Anxiety Rating Scale given at the end of the semester (Post-MARS). The covariables were The Cooperative Mathematics Test-Algebra I, form A (1962), administered prior to the beginning of the semester (Pre-Place) and the Math Anxiety Rating Scale administered on the second day of class (Pre-MARS). The independent variable was Class. The multivariate analysis of covariance compared the three classes in terms of the three dependent variables by first removing the effect of the covariable on the dependent variables.

Procedure--All Classes

Because the experimental activities were performed in conjunction with nonexperimental activities common to all classes, the nonexperimental activities will be described separately.

Throughout the semester study sheets were made which correspond to each chapter including assigned problems, due dates, and test dates. Review Sheets for each test, composed of sample test problems, were given to the classes. The eight tests (given approximately bimonthly)

and a comprehensive final exam composed by the textbook authors were used. Three of the tests were modified slightly to conform more closely with subject matter emphasis, and tests increased in degree of difficulty as the semester progressed. The final grade was an average of eight chapter test grades, one lab grade, one post placement test grade, and the final exam grade counting three times.

Each instructor had five instructional assistants per class who held a day lab on alternate days in conjunction with class. Neither instructor attended lab except to observe occasionally (see Appendix A for complete description).

During the first three days of classes, students were told the course objectives, structure, and grading procedures (see Appendix A for description). They introduced themselves, learned each other's names, wrote a math autobiography, and were encouraged to submit their feelings about the course at any time. Testing involved taking the Pre-MARS, the attitude questionnaire, and a diagnostic test covering four chapters in the text. A spirit of cooperation rather than competition was encouraged by pointing out the benefits of working together and by assuring students that they would not be competing for grades and that, in fact, all who tried could learn the material. More specifically, students were told that grading would not be based on the Normal Curve, but rather on the individual's performance on the tests as well as on participation in lab. Thus, if the entire class made A's and B's, those would be the grades given. The instructor also explained that it was her philosophy in teaching the course that all persons attending the university were capable of learning high school algebra (the course content). To foster cooperation the instructor explained that in teaching

a concept to another person, one achieves a level of learning higher than the competency required to simply work the problems. Therefore, cooperating in an effort to help each person learn was also beneficial to the person explaining the concept. Furthermore, cooperation among students helped the lab instructors devote more individual attention to students having serious difficulties.

Procedure--Experimental Class

The semester consisted of 52 days of 50-minute classes nine of which were test days, and 28 lab days. (The numbering of the days, Day 1, Day 2, etc., included class days and lab days).

The Educational Phase

The focus of the first two days was first order-change as defined in Chapter 2. The Educational Phase began on Day One, Thursday, August 24, 1978, with the statement of the additional course objective: i.e. to learn to manage anxiety. Two topics were introduced: the effect of worry as a component of anxiety and the interruption of the thought process caused by negative self-statements and nonrelevant thoughts while doing homework and particularly in taking tests. Specific diary forms were distributed on which students were asked to write all thoughts experienced while doing homework, to record the amount of time spent on the assignments and to give reactions to class activities. It was emphasized that one can learn to manage debilitating anxiety (25 minutes). An explanation of course structure and student introductions took 25 minutes. In the last minute of class, the homework (to read section 1.1 and work the odd numbered problems) was assigned.

On the second day, Friday, each student was given a finger thermometer (described in the section "Apparatus") and was told that the purpose of wearing it was to become aware of one's bodily reactions to stress. In fact, in many instances, people learned to use it as a cue to relax and manage the anxiety. Another reason for controlling one's bodily arousal was to save the energy that would have been used in tightening of the muscles for performance of a task (15 minutes). Diary forms included questions asking students to record their temperature three times: before beginning homework, upon encountering a difficult problem, and at the completion of the assignment. Section 1.1 was discussed briefly (5 minutes), autobiographies were collected, section 1.2 was assigned for homework, and the remainder of the time was spent in taking the MARS and the attitude questionnaire.

Day 3, Monday, was primarily designated for the life premise presentation. The "Basic Hypotheses" of the Math Anxiety Clinic (see Appendix B) were the concepts emphasized. Prompted by statements in the autobiographies, the instructor pointed out examples of negative statements which could be based in negative life premises and their possible adverse effect on learning and performance. Such premises, it was pointed out, could be re-set, and the instructor noted his personal objective of helping students discover and re-set these premises. Students were told that these life premises could trigger avoidant thought and self-statements which, in turn, negatively affected performance. Each student was then asked to identify in his autobiography any stated life premise, or to rewrite the autobiography, analyzing in it life premises which might be affecting performance in math (25 minutes). Math sections 1.3 and 1.4 were covered after first discussing the study technique of reading a

math text effectively (25 minutes).

On Day 4, Tuesday, the first lab day, the lab instructors and the students introduced themselves and the lab instructors checked homework 1.1 - 1.4.

On Day 5, Wednesday, the instructor made reference to the life premise presentation. Since minimal student reaction followed, the instructor chose not to pursue a discussion. Autobiographies were collected, and forty-three minutes were spent covering math sections 1.5 and 1.6.

In Thursday's lab, Day 6, lab instructors checked homework and after answering questions, asked students to put on their thermometers and record temperatures before, during, and after a small quiz.

Day 7, Friday, the instructor began class by asking students to observe their temperatures and by putting these two problems on the board: "Simplify: (a) -5 + (1 - 5) and (b) -4 + (12 - 1) - (-1 - 9)." Students then recorded their temperatures. After finishing the quiz, temperature was recorded again and students wrote negative self-statements and nonrelevant thoughts which occurred while doing the problems. The discussion following emphasized the interrupting effect of the self-statements and nonrelevant thoughts. Also, the instructor reminded students again of the bodily reactions to stress, deep breathing for relaxation, and concentration involving eliminating negative self-statements (20 minutes total).

After 25 minutes of math, a test was announced for the following Friday with suggestions for study and preparation. The instructor asked students to be able to work all types of problems while thinking of the concept involved in each one, to replace negative self-statements with positive ones, and to try to eliminate worry and nonrelevant thoughts

while studying and while taking the test (5 minutes).

On Day 8, Monday, relaxation was discussed. Students were told that, as math becomes more complex, one's anxiety level must become lower in order not to interrupt performance. Deep Breathing, a process of taking deep breaths and consciously thinking words like "relax" or "calm" (Lowinstein, 1977), was the only relaxation technique mentioned, and students were encouraged to listen to the relaxation tapes (15 minutes). Also on Day 8, presenting the new math material, the instructor called on individuals. Most students, wearing their thermometers, saw their own reaction to the anxiety caused by being addressed in class. They were encouraged to take a deep breath and momentarily relax before answering (30 minutes). In reference to the upcoming test, students were encouraged to breath deeply and relax upon confronting an unfamiliar problem. If the procedure for the problem did not become clear, they were told to skip it and come back to it (5 minutes).

Day 9, Tuesday, was a lab day in which lab instructors checked homework and reviewed for the upcoming test.

On Day 10, Wednesday, the last section of Chapter 1 was presented. The instructor answered questions on the math from the class and selected problems for students to work as a review for the test (35 minutes). Suggestions for preparing for the test, which included the first-order change suggestions given in previous classes, were summarized for the class. Students were reminded (a) to replace negative self-statements with positive ones, (b) to try to eliminate worry and nonrelevant thoughts while studying, (c) to take deep breaths and relax at any feeling of being overwhelmed by the test, and (d) upon confronting a problem causing anxiety, to take deep breaths and/or skip it and come

back to it (15 minutes).

Day 11, Thursday, was a lab day in which work was checked and students were given more review.

Day 12, Friday, was the first major test covering Chapter 1.

These seven class days, one test day, and four lab days concluded the Educational Phase. At this point both classes were at the same place in the book and continued as such.

The Rehearsal Phase and The Application Phase

The Rehearsal Phase and the Application Phase were implemented throughout the remainder of the semester and were applied simultaneously.

On Day 16, seven days prior to the second test, students were asked to become aware of the moment at which they began feeling nervous, thinking about the upcoming test. The strategy presented was to consciously begin relaxing at that point by taking deep breaths each time they thought about the test. The idea of developing a cognitive strategy for each type of problem that one could anticipate on the test was mentioned three times prior to test two. At the time of returning test two, on Day 23, students in the experimental class were given a questionnaire asking to what extent they developed a strategy for working the math problems (see Appendix C for questionnaire). The verbalization of strategies for working math problems became a daily activity in class. On Day 25 reference was made to the discussion of Day 16, and bodily reactions to tests were listed: queazy stomach, warm flush all over the body, tensed muscles, and nervousness. Students were asked to watch for these bodily reactions in anticipation of the next test and to note their own response to the first bodily indication of anxiety. The instructor told the students they could counter their anxiety by reasoning,

"I am studying properly and I will be ready for the test, and I will do well." The instructor emphasized that if the student did not know the material, no strategy for reducing anxiety would help. Taking deep breaths to relax was again mentioned as one strategy to counter stress. The tapes on specific means of relaxation were again recommended. On Day 33, following test 3, students were given a handout concerning their strategy for handling bodily reactions to stress attempted in conjunction with test 3. Two people shared their feelings with the class voluntarily. In the next two weeks three references were made to bodily reactions to stress.

On Day 46 the instructor summarized stress reduction techniques and the techniques for developing strategies for working problems. It seemed also to be an excellent time to present the list of coping statements for dealing with a stressor. Therefore, on Day 50 (prior to test 5) students received a two-page handout (see Appendix C) which suggested the importance of having a strategy for each type of problem. The handout also summarized the previously presented concepts referring to first-order change and gave (for the first time) the four-part approach for handling test anxiety. The four-part list of cafeteria-style statements was as follows: (a) preparing for a stressor, (b) confronting the stressor, (c) coping with the feeling of being overwhelmed, and (d) reinforcing self-statements (see Appendix C for list). After test 5, on Days 53 and 55, students were asked to evaluate these strategies and discuss their successful strategies for managing anxiety (10 minutes each day). This exercise led to presenting the concept of anxiety being, at times, facilitating instead of debilitating. The idea the class was reminded of was that it could be beneficial for an athlete to be

anxious prior to an event and that was the same facilitating anxiety that was desirable in the classroom. The point was made, therefore, that the goal is not necessarily to eliminate anxiety but rather to remain in control by relaxing at the first bodily reaction to stress, using it as a cue to cope. The ideal would thus be to use the anxiety in a positive sense.

On Day 61 students were asked for an interpretation of the phrase "developing a tolerance for ambiguity." After several opinions were expressed, the instructor noted that, when one does not immediately understand a concept presented in class, he should keep his mind open to instruction. One student mentioned that his first reaction to unfamiliar material was to panic. This admission led to mentioning the effects of panic: (a) blocking explanation from being heard or seen, (b) breaking the continuity of thought, and (c) reaffirming one's self-expected inability to do math. To manage this panic the instructor suggested using the panicky feeling as a cue to taking deep breaths and saying to oneself, "listen" or "open." It was pointed out that it is more a matter of what we <u>let</u> ourselves learn and what we tell ourselves rather than what we are <u>capable</u> of learning (15 minutes).

Finally, muscle relaxation was discussed. On Day 65 a 10-minute deep muscle relaxation (Paul, 1966) was presented. This aspect of relaxation was addressed only once and was not considered instrumental in the experiment. The concept of relaxing by taking deep breaths was the only aspect of relaxation used substantially.

Over the course of the last twelve weeks, students were asked to go to the blackboard twice and were given problems to work simulating a small quiz, seven times. They were encouraged to use the Stress

Inoculation Techniques in performing these tasks.

The experiment concluded with all classes taking the post-placement test, the post-MARS, and a two-hour comprehensive final exam.

In the next chapter, the data collected from all three classes are analyzed to see if anxiety was reduced significantly more in the class receiving the experimental techniques.

CHAPTER V

RESULTS

This chapter reports the statistical analyses which were made in comparing the experimental class with the control classes. A total of thirteen analyses were performed to determine whether the techniques for reducing anxiety were effective.

Definition of Variables:

The dependent variables used to compare the classes are listed below:

Post-Place: the score at the end of the semester on the Cooperative Mathematics Test-Algebra I, form B (1962).

Post-MARS: the score at the end of the semester on the Math Anxiety Rating Scale (see Appendix C for Rating Scale).

Grade: the final average in the course obtained by averaging eight test scores, the final exam counting three times, a lab grade, and dropping one grade.

The covariables were as follows:

Pre-Place: the score at the beginning of the semester on the Cooperative Mathematics Test-Algebra I, form A (1962).

Pre-MARS: the score at the beginning of the semester on the Math Anxiety Rating Scale (see Appendix C for Rating Scale).

The independent variable was Class:

Class 1: the experimental class taught by Instructor A.

Class 2: the control class taught by Instructor A.

Class 3: the control class taught by Instructor B.

The Analyses

Of the thirteen analyses performed, two yielded significant results. First, the anxiety level in all classes was significantly reduced. Second, there was a statistically significant difference among the three classes in anxiety at the end of the course as measured by the Post-MARS, having adjusted for Pre-MARS, with class 2 showing the significantly greatest anxiety reduction.

The primary analyses comparing the experimental class with the control classes were divided into two parts: the univariate analyses and the multivariate analysis. Additional analyses were also performed, prompted by the fact that the groups were not highly anxious but were of average anxiety. This is supported by a comparison with normative data. The mean of all the students on the Pre-MARS was 212 with a standard deviation of 57.4. The normative data on 397 randomly selected college students at a large university in Missouri, had a mean of 215.4 with a standard deviation of 65.3 (Richardson and Suinn, 1972). These analyses involved limiting the sample to only those subjects of above average anxiety. Since the experimental technique was used to reduce high debilitating anxiety, perhaps a significant reduction could be found in comparing only those who were above average in anxiety.

Analysis I: Anxiety Reduction in All Classes

Null Hypothesis I: There was no significant difference among classes in Pre-MARS and Post-MARS.

Research Hypothesis I: There was a significant reduction in anxiety among all three classes.

Result I: A paired difference t-test comparing Pre-MARS and Post-MARS was performed on all students using BMDP3D (Dixon, 1975). The finding was a significant difference in Pre-MARS and Post-MARS ($p < .0001$).

Analyses II through VI: A Comparson of the Classes by Univariate Techniques

Preliminary analyses revealed a statistically significant difference among classes in Pre-MARS and Pre-Place; therefore, Analysis of Covariance was used with the two variables as covariables. Five univariate tests were performed using BMDP2V (Dixon, 1975).

Null Hypothesis II: There was no significant difference in Post-Place among the three classes having adjusted for Pre-Place.

Research Hypothesis II: There was a significant difference in Post-Place among the classes having adjusted for Pre-Place.

Result II: Analysis of Covariance with Pre-Place as the covariate and Post-Place as the dependent variable yielded insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference among the classes in Post-Place scores adjusting for Pre-Place (see table 1).

Null Hypothesis III: There was no significant difference in Post-Place scores among the classes having adjusted for Pre-Place and Pre-MARS.

Research Hypothesis III: There was a significant difference in Post-Place scores among the classes having adjusted for Pre-Place and Pre-MARS.

Result III: Analysis of Covariance with Pre-MARS and Pre-Place as covariables and Post-Place as the dependent variable yielded

TABLE 1

Univariate Comparison of Post-Place Adjusting for Pre-Place

	Class 1	2	3	Total
Pre-Place				
M	14.71	13.33	15.10	14.40
SD	2.97	4.88	2.44	
Post-Place				
M	24.54	25.30	25.17	25.00
SD	4.01	4.01	5.33	
n	28	27	29	84
M (adjusted)	24.41	25.72	24.90	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"*p* value"
Class	22.99	2	11.49	.62	.542
Pre-Place	156.57	1	156.57	8.39	.005
Error	1492.15	80	18.65		

insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference among the classes in Post-Place scores adjusting for Pre-Place and Pre-MARS (see table 2).

Null Hypothesis IV: There was no significant difference in Grade among the classes having adjusted for Pre-Place.

Research Hypothesis IV: There was a significant difference in Grade among the classes having adjusted for Pre-Place.

Result IV: Analysis of Covariance with Pre-Place as the covariable and Grade as the dependent variable yielded insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference among classes in Grade adjusting for Pre-Place (see table 3).

Null Hypothesis V: There was no significant difference in Grade among the classes having adjusted for Pre-Place and Pre-MARS.

Research Hypothesis V: There was a significant difference in Grade among the classes having adjusted for Pre-Place and Pre-MARS.

Result V: Analysis of Covariance with Pre-MARS and Pre-Place as covariables and Grade as the dependent variable yielded insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference in Grade among classes adjusting for Post-Place Post-MARS (see table 4).

Null Hypothesis VI: There was no significant difference in Post-MARS among the classes having adjusted for Pre-MARS.

Research Hypothesis VI: There was a significant difference in Post-MARS among the classes having adjusted for Pre-MARS.

Result VI: Analysis of Covariance with Pre-MARS as the covariable and Post-MARS as the dependent variable yielded significant results to reject

TABLE 2

Univariate Comparison of Post-Place Adjusting for Pre-Place and Pre-MARS

	Class 1	2	3	Total
Pre-Place				
M	14.92	13.32	15.11	14.47
SD	2.45	4.72	2.52	
Pre-MARS				
M	207.89	229.96	211.70	216.28
SD	47.46	59.04	55.47	
Post-Place				
M	24.89	25.52	25.37	
SD	3.91	4.06	5.48	
n	26	25	27	
M (adjusted)	24.74	25.93	25.13	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	17.51	2	8.76	.45	.641
Pre-Place	130.25	1	130.25	6.65	.012
Pre-MARS	2.40	1	2.40	.12	.727
All Co-variates	130.44	2	65.22	3.33	.041
Error	1428.75	73	19.57		

TABLE 3

Univariate Comparison of Grade Adjusting for Pre-Place

	Class 1	2	3	Total
Pre-Place				
M	14.74	12.77	14.71	14.43
SD	3.02	4.40	2.82	
Grade				
M	79.15	81.46	76.97	79.06
SD	9.87	10.50	12.85	
n	27	26	31	84
M (adjusted)	78.78	82.22	76.64	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	438.41	2	219.20	1.96	.147
Pre-Place	1300.61	1	1300.61	11.64	.001
Error	8942.11	80	111.78		

TABLE 4

Univariate Comparison of Grade Adjusting for Pre-Place and Pre-MARS

	Class 1	2	3	Total
Pre-Place				
M	14.96	13.79	14.69	14.50
SD	2.49	4.17	2.90	
Pre-MARS				
M	204.76	232.21	213.52	216.46
SD	45.62	59.20	56.45	
Grade				
M	79.32	81.50	76.41	78.91
SD	10.05	10.10	13.05	
n	25	24	29	
M (adjusted)	79.01	82.02	76.25	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	426.82	2	213.41	1.79	.174
Pre-Place	1116.49	1	1116.49	9.38	.003
Pre-MARS	97.40	1	97.40	.82	.369
All Co-variates	1132.62	2	566.31	4.76	.011
Error	8685.76	73	118.98		

the Null Hypothesis, thus establishing the Research Hypothesis that a significant difference ($p < .04$) among classes in Post-MARS existed. Class 2, however, was the class in which anxiety was reduced to the greatest degree (see table 5).

Analysis VII: A Compairson of the Classes using Multivariate Techniques

Multivariate Analysis of Covariance (Clyde, 1969) was performed with Pre-Place and Pre-MARS as covariables and Post-Place, Grade, and Post-MARS as dependent variables.

Null Hypothesis VII: There was no significant difference among the classes based on Post-Place, Grade, and Post-MARS having adjusted for Pre-Place and Pre-MARS.

Research Hypothesis VII: There was a significant difference among the classes based on Grade, Post-Place, and Pre-MARS, having adjusted for Pre-Place and Pre-MARS.

Result VII: The data yielded insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference among the classes based on Post-Place, Grade, and Post-MARS having adjusted for Pre-Place and Pre-MARS. The Wilkes Lambda Criterion yielded $F(6,136)=1.53$, $p < .335$.

Analyses VIII through XIII: A Comparison of the Classes Using Students Who Were Above Average in Math Anxiety

Experiments II through VII were repeated omitting subjects of less than 212 (average) Pre-MARS scores. The analyses yielded basically the same results (see tables 6 through 10). The Multivariate Analysis with reduced sample size yielded $F(6,58)=1.311$, $p < .267$ which was insufficient evidence to reject the Null Hypothesis.

TABLE 5

Univariate Comparison of Post-MARS Adjusting for Pre-MARS

	Class 1	2	3	Total
Pre-MARS				
M	204.76	229.96	214.56	216.38
SD	45.62	59.04	58.05	
Post-MARS				
M	177.24	167.40	187.52	177.65
SD	48.86	34.52	71.57	
n	25	25	27	77
M (adjusted)	184.38	159.06	188.64	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	12696.81	2	6348.41	3.42	.038
Pre-MARS	83498.13	1	83498.13	44.96	.000
Error	135587.75	73	1857.37		

Analysis VII: A Comparison of the Classes using Multivariate Techniques

Multivariate Analysis of Covariance (Clyde, 1969) was performed with Pre-Place and Pre-MARS as covariables and Post-Place, Grade, and Post-MARS as dependent variables.

Null Hypothesis VII: There was no significant difference among the classes based on Post-Place, Grade, and Post-MARS having adjusted for Pre-Place and Pre-MARS.

Research Hypothesis VII: There was a significant difference among the classes based on Grade, Post-Place, and Pre-MARS, having adjusted for Pre-Place and Pre-MARS.

Result VII: The data yielded insufficient evidence to reject the Null Hypothesis. Thus there was no significant difference among the classes based on Post-Place, Grade, and Post-MARS having adjusted for Pre-Place and Pre-MARS. The Wilkes Lambda Criterion yielded $F(6,136)=1.153, p < .335$.

Analyses VIII through XIII: A Comparison of the Classes Using Students Who Were Above Average in Math Anxiety

Experiments II through VII were repeated omitting subjects of less than 212 (average) Pre-MARS scores. The analyses yielded basically the same results (see tables 6 through 10). The Multivariate Analysis with reduced sample size yielded $F(6,58)=1.311, p < .267$ which was insufficient evidence to reject the Null Hypothesis.

TABLE 6

Univariate Comparison of Post-Place Adjusting for Pre-Place With Reduced Sample

	Class 1	2	3	Total
Pre-Place				
M	14.67	12.93	14.50	13.97
SD	2.80	4.75	2.75	
Post-Place				
M	23.75	25.79	25.33	25.00
SD	3.14	3.89	4.05	
n	12	14	12	38
M (adjusted)	23.37	26.35	25.05	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	55.11	2	27.55	2.68	.083
Pre-Place	135.96	1	135.96	13.23	.001
Error	349.31	34	10.27		

TABLE 7

Univariate Comparison of Post-Place Adjusting for Pre-Place and Pre-MARS on Reduced Sample

	Class 1	2	3	Total
Pre-Place				
M	14.67	12.93	14.50	13.97
SD	2.81	4.75	2.75	
Pre-MARS				
M	250.42	273.29	263.33	262.92
SD	29.25	38.14	36.27	
Post-Place				
M	23.75	25.79	25.33	25.00
SD	3.14	3.89	4.05	
n	12	14	12	38
M (adjusted)	23.53	26.23	25.04	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	42.11	2	21.06	2.03	.148
Pre-MARS	136.08	1	136.08	13.09	.001
Pre-Place	6.34	1	6.34	.61	.440
All Co-variates	142.29	2	71.15	6.85	.003
Error	342.98	33	10.39		

TABLE 8

Univariate Comparison of Grade Adjusting for Pre-Place With Reduced Sample Size

	Class			
	1	2	3	Total
Pre-Place				
M	14.73	12.93	14.00	13.816
SD	2.94	4.75	3.19	
Grade				
M	80.00	82.50	74.77	79.13
SD	12.02	8.21	12.71	
n	11	14	13	38
M (adjusted)	78.95	83.52	74.56	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	533.38	2	266.69	2.52	.095
Pre-Place	663.23	1	663.23	6.27	.017
Error	3594.57	34	105.72		

TABLE 9

Univariate Comparison of Grade Adjusting for Pre-Place and Pre-MARS With Reduced Sample

	Class			
	1	2	3	Total
Pre-Place				
M	14.73	12.93	14.00	13.82
SD	2.94	4.75	3.19	
Pre-MARS				
M	247.18	273.29	266.23	263.32
SD	28.34	38.14	36.26	
Grade				
M	80.00	82.50	74.77	79.13
SD	12.02	8.21	12.71	
n	11	14	13	38
M (adjusted)	79.44	83.22	74.46	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	510.19	2	255.09	2.37	.109
Pre-Place	676.83	1	676.83	6.29	.017
Pre-MARS	40.89	1	40.89	.38	.542
All Co-variates	704.12	2	352.06	3.27	.051
Error	3553.67	33	107.69		

TABLE 10

Univariate Comparison of Post-MARS Adjusting for Pre-MARS With Reduced Sample Size

	Class 1	2	3	Total
Pre-MARS				
M	247.18	273.29	269.75	264.38
SD	28.34	38.14	35.48	
Post-MARS				
M	202.18	181.64	227.33	202.57
SD	56.41	34.74	87.28	
n	11.	14	12.	
M (adjusted)	215.06	174.97	223.31	

ANALYSIS OF COVARIANCE

SOURCE	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	"p value"
Class	17104.13	2	8552.06	2.60	.089
Pre-MARS	22888.14	1	22888.14	6.97	.013
Error	108412.81	33	3285.24		

CHAPTER VI

DISCUSSION

There was neither a greater reduction in the anxiety level nor an improvement in performance of those students in the experimental class, where Stress Inoculation Training and Cognitive Restructuring were used, as compared to those students in the control classes. A significant reduction in anxiety, however, did occur in all classes.

The purposes of this discussion are threefold: (a) to consider the results of the experiment and possible reasons for the significance (as well as the lack of significance) of the data, (b) to summarize the evaluations, and (c) to cite the unexpected difficulties experienced in the experiment.

Interpretation of the Results

One result of this study is that the experimental class did not show greater performance than the control classes as measured by the final grade in the course and the post-placement test. This finding concurs with the research of Finger and Galassi (1977) who found that "newer behavioral approaches in reducing test anxiety have been successful in improving performance in only 16 out of 54 (29.6%) of the studies" (p. 280).

It is possible to suggest one reason for the lack of significance in Grade and Post-Place (Analyses II through V), also for the significant difference in Post-MARS, with Class 2 showing the anxiety reduction (Analysis VI). Positive experiences with math, involving understanding of the concepts, can be important in reducing anxiety (Tobias, 1978b).

In this study the experimental techniques used were secondary to the primary objective of helping students to develop the process of thinking through a problem and understanding it. In working a problem this process involves having an initial strategy, performing each step supported by reasons, and concluding the last step realizing that the solution is complete. Rather than using a process of this sort, students often work problems based on memorized patterns. Mitchell Lazarus (1974) relates that temporary success on tests is possible as long as solutions involve only a few steps; however, as the math becomes more complex, with an increase in the number of possible responses, the memorization becomes increasingly unworkable. In the developmental math class a high priority is given to recognizing this learning difficulty in students and helping them begin to base their thinking on understanding instead of memorization. As students begin to experience success in learning (sometimes for the first time), anxiety is often reduced (Tobias, 1978b). Perhaps the anxiety-relief caused by understanding the math was instrumental in Class 2's showing significantly more reduction in anxiety than the other two classes.

The other result, a significant reduction in anxiety, was found in all classes based on Pre-MARS and Post-MARS (see Analysis I). The primary reason for this result is thought to be the effect of a caring instructor on the class. Such a conclusion is supported by Gaudry and Spielberger (1971) and also by the Math Anxiety Clinic evaluations (see Appendix B). Clinic participants wrote that their anxiety was lessened because their instructors cared about them as individuals, regardless of their ability in math.

Student Evaluation

The same evaluation forms were given to all classes (see Appendix C) at the end of the semester, and there were no direct questions concerning the Stress Inoculation Training. The majority of students wrote that they felt better about their capacity to do math. They attributed the success of the course in general to the personal attention and caring attitude of the instructors and clear explanations. Many expressed that for once, this math, which had been meaningless before, made sense. In class they felt unpressured and free to speak.

Three weeks prior to the end of the semester, students in the experimental class were given a separate form to evaluate the handout, "Strategy for Preparing For and Taking a Test" (see Appendix C). The evaluation indicated that the students felt the handout was helpful and informative and they implemented the four steps recommended in the handout in preparing for tests. In response to question six, most of the students chose one of the following responses: "The tenseness I feel used to hurt me, but I have learned this semester to use the tenseness in a positive sense," or "The tenseness does not bother me as much as it used to, but I would like to continue working on it."

From personal conversations with the students in the experimental class, the instructor felt that, even though they used the Stress Inoculation Techniques, their more significant accomplishment was in learning the math which had evaded them in high school and feeling confident with it.

There were two students in the experimental class, however, who made A's but who stated that they did not feel confident at the conclusion of the course. They expressed a fear of taking another math course.

At the beginning of the following semester, one of these students, unable to understand her instructor, in tears changed instructors. Her success with the second instructor emphasized even more emphatically the importance of a caring teacher with whom students can communicate.

Teacher Evaluation

Stress Inoculation Training (Meichenbaum, 1975) was a sensible approach toward the management of stress; therefore, explaining the approach to the students and incorporating it into the classroom was done with ease. Discussing strategies for managing stress blended well with strategies for working problems. The test situations provided a natural experience for students to implement both types of strategies in a task-oriented fashion, and the time involved in presenting the concepts of Stress Inoculation Training was minimal.

The most striking contrast of the experimental and control classes taught by Instructor A was that student-teacher rapport was more quickly established in the experimental class. When the students felt that the math teacher cared about them in presenting topics related to their own bodily and mental health, they were supportive. This favorable student response to class activities encouraged the instructor, and a reciprocal caring atmosphere was created, as evidenced by the fact that the instructor learned the names of the students in the experimental class more quickly than those in the other class.

The diaries were instrumental in giving the instructor insight into personal matters which might be affecting the students' school work, feelings which the students hesitated to express in class, and feedback concerning the success of the experiment--information especially helpful with students whose facial expressions were difficult to interpret.

The autobiographies were also helpful in two respects: (a) informing the instructor of the students' past and (b) giving the students the opportunity to relate their past experiences and express their present intentions.

Difficulties in the Implementation of Cognitive Restructuring and Stress Inoculation

Various difficulties were encountered in the implementation of Cognitive Restructuring and Stress Inoculation. These problems will be discussed in the material which follows.

One obstacle for the students was their discomfort in sharing with others their basic life premises, the foundation of a meaning system, and subsequent actions based on these values and attitudes. This aversion was probably due in part to the students' hesitancy to discuss their personal experiences in such a large group. In the diaries the students expressed surprise at the presentation of nonmathematical concepts: their primary purpose for being in the class was, after all, to learn math skills. This attitude was similar to Spielberger's finding (1960) in which highly test-anxious college freshmen gathered specifically to reduce anxiety were more interested in discussing problems related to college adjustment and study skills rather than to the sources of their anxiety.

The concept of Stress Inoculation Training, along with strategies for studying, was very well received by the students, yet there seemed to be one small difficulty specifically related to the students in developmental math. For some students the tests (stressors) did not increase gradually in intensity. For these students, the material in the course suddenly became more difficult (even though there was no

sudden increase in complexity). This experience is not uncommon for developmental math students who reach a point in the course where the material is no longer familiar from high school, creating a sudden increase in difficulty. Also, students who memorize procedures are successful only until the problems become more complex and more dependent upon previous understanding of the concepts. From past experience in the course, test grades in these cases drop suddenly. Unfamiliarity is caused in the first case by sudden increase in difficulty and, in the second case, by inappropriate learning skills. Thus, for some students the stress caused by the tests did not increase in gradual increments.

Class-Related Difficulties

Absenteeism was high in all classes beginning half way through the semester, thus breaking the continuity of the presentation of the math concepts as well as the experimental concepts. The entire class, however, was present for the Educational Phase of the experiment.

Students who felt they were doing too much work for the academic credit were not well motivated. They earned only one hour of credit and were expected to attend, for 5 hours per week, a mandatory class which they did not enjoy (as stated in evaluations).

Another difficulty arose from the fact that the experimental class met at 8:00 a.m. and the control class, taught by Instructor A, at 9:00 a.m. Some students were hardly awake during class (observation by instructor).

Instructor-Related Difficulties

The instructor was nervous in presenting the life premise discussion and the muscle relaxation exercise. The life premise discussion as presented in the clinic (see Appendix B) was dependent upon two factors: the participants' feeling free to express themselves within a caring atmosphere and the expertise of the three group leaders in facilitating the discussion. The tenseness of the instructor was due to the feeling of not as yet having developed a sense of mutual caring in the class of 35 students. Being alone in facilitating the discussion was intimidating and inexperience was regarded as a noticeable disadvantage.

In preparing to introduce the muscle relaxation, the instructor unintentionally procrastinated and failed to allow enough class time to present the techniques. Upon doing the exercise with the class, however, the instructor felt excitement at having presented an experience foreign to most math classes. By that time, however, there was not sufficient time left in the semester to develop the muscle relaxation process fully, so the instructor decided to focus instead on the other technique for relaxation, deep breathing exercises.

The Difficulty of Attitudes: School Work vs. Interesting Work

The subjects in the study were primarily college freshmen, directly out of high school, who, as a carry-over from high school, made the distinction between "school work" and "interesting work." "School work" is defined as that which is done in the classroom, with attached homework, of which one does, at a maximum (in a mechanical fashion) only that which is assigned. It is neither interesting nor likely to become a part of one's meaning system. "Interesting work," on the other hand, involves learning concepts outside of the classroom, for instance, on

the ball field, in playing cards, in grocery shopping. These skills and techniques are understood (not memorized), for they are vital to winning the ball game or card game or saving money. Maier (1978) refers to this idea specifically with regard to mathematics and calls the two areas school math and folk math. In this study the thermometers were given to the students in the classroom, and as "school work," even though the students seemed generally interested, they used them only to the extent that they were assigned. Although students were encouraged to use the thermometers in various settings in order to become aware of their bodily reactions to various situations, they forgot to do so.

Another example of students' attitudes toward required school work and optional, more interesting activities can be demonstrated from the diaries. Students in the experimental class, having been given specific forms on which to write their diaries, submitted them faithfully until the forms ran out. After that, even though the instructor encouraged students to turn in diaries, they did so rarely: it was no longer required. Also, the control class was encouraged to submit diaries but was not given forms, and very few students submitted comments to the instructor.

The relaxation tapes proved another example of this attitude. Only three students listened to one of the four tapes. Even two students to whom the tapes were personally recommended did not use them.

Making school work interesting and meaningful may be one of the most difficult tasks an instructor has. It will be addressed again in the next chapter in implications for the future.

CHAPTER VII

SUMMARY AND IMPLICATIONS FOR FURTHER STUDY

In this chapter the study performed will be analyzed to point out contrasts in the clinic and class which have a bearing on future direction, to give implications for further study, and to present conclusions.

Summary

The purpose of this study was to employ a technique for relieving math anxiety in the classroom. Having held a Math Anxiety Clinic for adults, the instructor hoped to modify the techniques used in the clinic to accommodate two major differences in the class situations. First, the week of the clinic group process was not a part of the classroom experience, while the study was presented in conjunction with a college class. If indeed there is a distinction between "school work" and "interesting work" (presented in Chapter VI), then that may have had some bearing on the interest of the people involved. The second difference was in the personal objectives of and rewards for the individuals involved. The participants were self-admitted math-anxious adults who, prior to the clinic hoped to manage their math anxiety. They were selected to participate and were given stipends for their commitment to the project. In contrast, the students in the developmental math class were required to take this remedial course for which they received one hour credit for five hours in class.

The primary technique used in the classroom was Stress Inoculation Training (Meichenbaum, 1975). This involved becoming aware of one's

cognitive and physiological reactions to stress. The cognitive relates to worry and negative self-statements which interrupt performance. The physiological refers to bodily characteristics such as the lowering of temperature in the fingers, upset stomach, sweaty palms, and other symptoms which accompany stress. The strategy presented was to use the first bodily sign of stress as a cue to begin emitting positive self-statements and relaxing. In test-taking the self-statements would continue through four stages: (a) preparing for the stressor (test), (b) confronting the stressor, (c) possibly being overwhelmed, and (d) reinforcement for having coped.

The plan for implementing the three phases of Stress Inoculation Training was to present the Educational Phase (explaining the concepts to the class) in the first two weeks, the Rehearsal Phase (referring to the use of the techniques presented in the Educational Phase) and the Application Phase (using the strategies in test situations) throughout the semester. The concept of Cognitive Restructuring (Meichenbaum, 1977a), which was used extensively in the clinic (in which participants possibly changed their anxiety-causing life premises), was also presented during the Educational Phase.

The sample for the study consisted of 117 students at Appalachian State University who registered for the Developmental Math Class in the Fall of 1978. There were three sections of the class: the 8:00 section being randomly chosen as the experimental class (Class 1), and two control classes, one taught at 9:00 by the same instructor (Class 2), and one at 1:00 by a different instructor (Class 3).

The hypothesis of the study was that anxiety could be reduced and performance improved in the classroom when students have a systematic

approach for managing anxiety.

The instrument used to measure anxiety was the Math Anxiety Rating Scale, a 98-item self-report measure (see Appendix C for Rating Scale).. Performance was measured by the students' grade in the course and also the score on the Cooperative Mathematics Test-Algebra I, form B (1962).

Analysis of the data indicated that anxiety was reduced significantly in all classes and that there was a significant difference in anxiety in the classes at the end of the course as measured by the Post-MARS. Class 2 (the control class taught by the same instructor of the experimental class) was the class with the biggest anxiety reduction. The results of the analyses did not indicate that anxiety was reduced more in the class which had the systematic approach for managing anxiety.

Reflections

Even though the analysis of the data did not show significant results from using the Stress Inoculation Training in the classroom, the instructor felt that Stress Inoculation Training was a workable and effective approach for classroom use. Strategies for stress management very well complement and enhance strategies for working math problems, and testing provided an authentic situation for students to apply the techniques of anxiety reduction.

Some contrasts between the clinic and the class based on observation and student comments were valuable in pointing out some of the serious problems that seemed to exist in the classroom setting. The first difficulty involved the individual's willingness to perform the suggested activities and openness in sharing feelings. For instance, in the clinic an atmosphere of mutual caring developed as participants openly discussed their pasts and helped one another discover their anxiety-causing life premises. In an effort to learn the relaxation techniques,

they listened to the tapes, took them home, and commented daily concerning their effectiveness. They also reported incidences in which they used their thermometers to monitor their bodily reactions to stress and their success at relaxing. In contrast, the students in the developmental math class, after listening in class to the concepts of relaxation and bodily reactions to stress and even after expressing interest through their diaries, did not use the thermometers any more than they were assigned (reported in class). Only three people listened to the tapes (according to the sign out sheet in the language lab where the tapes were kept). Students in the experimental class rarely expressed their feelings in class. In the second week of the clinic in which participants were moved to a classroom situation, support for one another was demonstrated when participants spoke out in defense of those unable to understand the concept and volunteered to help whenever possible. Cooperation based on sincere caring came naturally. In the study support among class members was not as intense. The emphasis on cooperation instead of competition was made by describing the personal benefits derived from helping others, namely in learning the concepts more thoroughly.

In summary, the differences in the clinic and class indicate that it would be desirable to destroy the "school work" stigma in the classroom, thus allowing students to become interested in learning. The experience with the thermometers (it was puzzling that sutdents did not become involved in using them) suggests that making school work more stimulating is a major task. How, then, can an instructor excite students about learning?

Secondly, the rapid development in the clinic of a group of individuals who genuinely care for one another suggests another area for development in the classroom, that of forming support groups, groups of students who

mutually care.

Implications for Further Study - Techniques Used at Burklyn

In the Math Anxiety Clinic, the life premise discussion was used to quickly develop a very strong support group of six people. At Burklyn (Brown, 1979), a six-week business school, nontraditional techniques have been successful in the forming of support groups of sixty people. The originators of Burklyn, Thurber and DePorter, have done this by introducing what they call the "new games philosophy" with a follow up by a psychologist. Below are recorded remarks of their students:

> "Here we were," recalls a student, "some sixty people who had never met, making up brand new crazy games and playing them like a bunch of kids. That brought us all to a level of feeling good about each other."
>
> A few days later, psychologist Will Shutz led everyone in a workshop that picked up where the new games left off.
>
> "The result," recalls another student, "was a feeling of love, support, and self-esteem, the likes of which I'd never known." (p. 11)

In this study, to a small extent cooperation rather than competition was demonstrated by some students who offered to help one another. Still, students dropped out of class who perhaps would not have done so in an atmosphere of caring and support.

Attaining this goal of support in the classroom involves overcoming many problems that presently exist. For instance, some students think cooperation means copying homework and cheating on tests. Also, the attitude of doing as little as is needed to "get by" is still embedded in the concept of "school work." Extremely detrimental are the social attitudes which prevent students from working together. There is pressure not to initiate a conversation with one of the opposite sex for fear of being considered forward and, even as the instructor observed, with

students of the same sex for fear of being thought to be homosexual. Thus, it is no small task to create a spirit of concern and sharing in the classroom. Perhaps, if "making up brand new and crazy games and playing them like a bunch of kids" (Brown, 1979, p. 11), followed by group process, could create a feeling of love, support, and self-esteem" (Brown, 1979, p. 11), then there is value in such an activity.

At Appalachian State University, some math faculty members are puzzled by the lack of graduates and undergraduates alike who do not perform up to their instructor's expectations. To some extent, in mathematics, notation makes the transfer of concepts difficult, particularly from theoretical math to applications. But, according to Hudson (1892/1975), it is a problem of not using the brain to its full potential. As mentioned in Chapter 3, at Burklyn students are actually taught techniques in using both sides of the brain in learning. Thurber's philosophy is:

> . . .when two people are aligned, they can produce four times the results. . .three can produce nine times. And when it comes to the human brain, two aligned hemispheres can accelerate the learning process. (Brown, 1979, p. 11)

Other classroom programs implementing Suggestopedia are based on using both sides of the brain in learning (Miele, 1977; James, 1977). The technique involves keeping the right brain "open" while the left brain is free to learn, unimpeded by interruptions from the right side.

The split-brain theory is not totally unrelated to the techniques used in this study. The negative self-statements are emitted by the right hemisphere, interrupting the logical left and making learning more difficult (Hudson, 1975). With both hemispheres involved, the right hemisphere emits positive statements such as "open" or "keep listening" or "stay relaxed," instead of panicking at the first indication of ambiguity, especially in the presentation of unfamiliar concepts in the

classroom lecture. From the instructor's viewpoint, in the presentation of new material "verbal (brain) war" is evidenced from the facial expressions of some students: their logical left is struggling to understand as they furiously take notes while their right brain is perhaps emitting statements like "you'll never have time for this," "she's going too fast," "this is just like before, you'll never be able to understand this." The student is in turmoil. Relaxation and learning are impossible. On the other hand, in the same class another student who is relaxed (sometimes late), taking hardly a note, asking questions freely, joking a little and unintentionally aggravating the struggling student is listening and understanding the material. The right brain of the struggling student is interrupting while that of the relaxed student is open and working cooperatively with the left brain.

In this study emitting positive self-statements was beginning in the proper use of the right brain. At Burklyn the right brain, in addition, became an active part of the learning process.

> One of the exercises (used) was a unique form of note-taking which was done in patterns and colors instead of conventional linear sentences. This "mind-mapping," as it was called enabled the students to absorb and recall an awesome amount of technical material and study more effectively. . .Burklyn's accounting classes were as similar to a conventional graduate school as chalk is to cheese. . .In the initial exercises the students actually used play-blocks instead of numbers to prepare a complete financial statement.
>
> "Once they learned to do it that way," says Thurber, "they were able to progress to the most sophisticated accounting imaginable. . .and could absorb complicated financial statements and business prospectuses in no time." (p. 12)

The experiences at Burklyn are unorthodox according to our standards of "school." As related by students and teachers at Burklyn, however, the procedures emphasizing more efficient use of the brain worked

very well. It seems that educators should begin learning from those who are using these techniques and begin implementing them in the classroom.

Conclusions

At Appalachian State University, students, remedial and math majors alike, indicated that their math courses, instead of being a fulfilling experience, are a continual source of frustration. Students report that they find it difficult to picture the concepts clearly and draw the implications which, to the instructor, seem quite obvious. The learning does not become a part of their own meaning system, making transfer to other courses a struggle. It is also common for students to report having difficulty using the vocabulary of the course in conversation. In mathematics, a field of abstraction, even the better students labor over problems only to fall short of the instructor's expectations. The natural reaction of many instructors is that the student does not have the ability and should not be in college or graduate school. Other instructors are bewildered since they know that many of the students who have ability still struggle with learning. The thinking of a few educators, however, is that students have ability but do not know how to use it. If this is true, then the implications for education are clearly and directly aimed at the educator's responsibility for helping students learn how to learn.

The implementation of a plan of action would involve educators implementing techniques to develop both hemispheres of the brain experiencing learning in this fashion. Also, it would be desirable for educators to experience being a member of a support group in learning in order to develop an appreciation of the value of such an experience.

The management of math anxiety has a beginning in the techniques such as those used in this study, but its future direction seems clearly to be that of learning through utilization of both hemispheres of the brain and in the loving atmosphere of students and teachers genuinely concerned for one another. Math anxiety would then be extinct in the classroom, for debilitating anxiety could not exist in such an atmosphere.

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APPENDIX A

MATHEMATICS PLACEMENT PRACTICES AND THE DEVELOPMENTAL MATH COURSE AT APPLACHIAN STATE UNIVERSITY--A DESCRIPTION

Objective

The Developmental Math Course at Appalachian State University is a one (1) credit hour course (MAT 0010) in the Department of Mathematical Sciences designed to prepare students for the college math course required by their major. The course content is high school algebra; and the text is Beginning Algebra by Lial and Miller (1976). The word "developmental" refers to a process of preparing students which involves more than remediation: it involves student development. Therefore, the primary objective of the instructor is to discover with each student personal difficulties in the learning of mathematics whether it involves poor study habits, poor self concept, anxiety, or adjustment to college; and help him mature personally in the learning of mathematics.

Placement

The mathematics placement test is the Cooperative Mathematics Test-Algebra I (1962). Based on their score on this test students are advised which mathematics course they should take first. The test, therefore, is a placement test in that it not only screens for those students needing developmental mathematics but also advises students about weaknesses they may need to be remediated before they take calculus. Required or recommended placements are based on the number correct out of 40 problems on the test and are partitioned as follows:

Score	Placement
18 or below	Developmental Math 0010 (1 s.h.)
19 - 27	Introductory Math 1010 (4 s.h.) or Algebra and Trigonometry 1020 (4 s.h.)
28 - 31	Calculus with Business Applications 1030 (4 s.h.)
32 - 40	Calculus with Analytic Geometry 1110 (4 s.h.)

Those students who test into Math 0010 are required to take Math 0010 before registering for one of the four-semester hour mathematics courses. However, students are given the option of retaking the test one time; the placement test is given on the first and third day of registration each semester. Students are allowed only one retest. Students testing into Algebra and Trigonometry whose majors require a calculus course are strongly recommended to take Math 1020 before attempting calculus but they are not required to do so. Most of the students who place into Math 1010 or 1020 are required to take only one math course and either of these will satisfy graduation requirements.

Structure

In that this course is a preparation for a traditional college course, MAT 0010 had many characteristics in common with the other math courses at ASU. One instructor meeting three hours per week, textbook, rigid pace, realistic demands, hour exams and a comprehensive final exam, and traditional grading. A non-traditional aspect of the course held in conjunction with the class is Day Lab taught totally by six 6) Instructional Assistants per class in an 7-1 student to Instructional Assistant ratio. In lab, homework is checked, study techniques discussed, and students work together for further understanding of the material. (The instructor supervises the instructional assistants but does not attend lab.) For a maximum of four (4) hours per week total, including any activities relating to the course, the Instructional Assistant earns one hour credit. Activities of the Instructional Assistants other than Day Lab includes meetings with the instructor, reading daily objectives posted by the instructor, studying the text, attending the initiation workshop, and helping students outside of lab.

Philosophy of the Course

MAT 0010 is grounded in the assumption that every student who has been admitted to Appalachian State University, has the ability to do arithmetic and high school algebra. Therefore, it is apparent that factors other than ability are hindering the students from succeeding in math. All parties involved--instructor, instructional assistants and student--work together in detective fashion to discover and eliminate these barriers to learning, for each student.

Recruitment and Training of Instructional Assistants

The instructional assistants are students with a basic understanding of high school algebra who are interested in helping other students. In teaching the lab, they solidify their own algebra skills, learn alternate explanations, and are introduced to a variety of learning difficulties.

Recruitment begins in the semester prior to the semester in which they work in the project, so that they can attend an orientation workshop and be ready to hold the first lab during the first week of classes.

The workshop which initiates the instructional assistants, consists of: (1) unifying the group in a common effort; (2) discussing the course structure and responsibilities of the instructor and assistants and signing contracts, and (3) discussing anticipated difficulties that students, having poor backgrounds and poor self concepts may have, giving suggestions for dealing with these problems based in counseling techniques. (4) Also discussed are tutoring techniques and specific problem areas of the text.

After the semester begins, the instructor meets with the instructional assistants once every three weeks to discuss particular students

having difficulties and possible strategies for working with each one individually.

Instructor Comments

The excitement and challenge of teaching the developmental math course is based in the instructor being instrumental in (1) the sociological and psychological development of students; and (2) facilitating the instructional assistants in gaining experience in working with students.

In addition to preparing students for their freshmen course, a developmental mathematics course challenges an instructor to change the attitudes of students from dislike and mistrust of math to confidence and appreciation of math. The day-to-day experience is more than one of teaching and learning math. It is also a day-by-day observation and analysis of both student attitude and progress to determine what factors trigger the students' dislike and mistrust of math. This analysis involves the insight of the teacher, the student, and the instructional assistant, as to reasons for lack of student progress in math. We have found that math difficulties are not necessarily a matter of lack of ability, but rather may originate psychologically or sociologically. Realizing this gives the student added hope. He is not a "victim" of an incontrollable factor--ability, but rather he has some control over his performance.

Another challenge facing an instructor is to choose the pace for the course and the material to be covered. It is exciting to discover that the pace in the developmental math course can be rapid enough to cover all of arithmetic and high school algebra in one semester. This pace in developmental math is also excellent preparation for the rapid

pace in other college courses. Students generally find the developmental math course difficult, but in mastering a task of significant difficulty, the student realizes that he CAN do math, and his self concept is improved as a result. If the course were not a significant challenge, its mastery would mean very little.

An important opportunity of the instructor which exists in the developmental math course is the experience of working with instructional assistants who are helping the developmental math student. Often the psychological problem working with students who do not always respond to one's efforts is puzzling and discouraging. The experiment of working with these students is valuable for students who plan to teach math in the future.

Evaluation

The following results are based on performance of 1821 students who had taken the placement test in 1976, 1977, spring of 1978. In 1976, MAT 0010 was not mandatory, and the data used based on two groups: (a) students who took 0010, followed by 1010, 1020, or 1030 (i.e. 0010 1010, 0010 1020, 0010 1030); and (b) students who chose not to take 0010 and took as their first course 1010, 1020, or 1030 (0010 1010, 0010 1020, 0010 1030).

Beginning in 1977, MAT 0010 was mandatory; however, some student who placed into M0010 took 1010, 1020, or 1030 as their first course, either by slipping by, or as in most cases the department chairman made an individual judgement permitting the person to remain in the course. Again, these students were pre-warned of the predicted difficulty that they would have. The departmental chairman would only permit them to stay in 1010 or 1020 if there were extenuating circumstances, not considered by the placement devices.

Even though the data shows notable results primarily in the MAT 1020 course, it is a more valid evaluation to consider the percent of those taking the course who place into 1010 upon completion of M0010. Out of 295 who finished the course, in Fall 1976, Spring 1977, Fall 1977, or Spring 1978,

7.1% n = 21 placed into 0010

72.2% n = 213 placed into 1010-1020

15.6% n = 46 placed into 1030

5.1% n = 15 placed into 1110

It should also be noted that 170 who have taken 0010 (121 passed) have not taken another math course. These are not included in the preceding comparisons.

COMPARISON OF GROUPS BY PERCENTAGE

Placed into 0010								Placed into 1010		
Percentage of Those Who Passed 1010, 1020, 1030								Took 1010, 1020, 1030, 1110 as a First Course		
having taken 0010				not having taken 0010						
				1976 Only						
0010	1010	79%	n=38	0010	1010	75%	n=98	1010	91%	n=281
0010	1020	60%	n=16	0010	1020	66%	n=24	1020	85%	n=237
0010	1030	40%	n=5	0010	1030	47%	n=19	1030	85%	n=61
								1110	54%	n=11
				1977 and following						
0010	1010	76%	n=46	0010	1010	80%	n=41	1010	85%	n=379
0010	1020	89%	n=35	0010	1020	60%	n=10	1020	71%	n=435
0010	1030	50%	n=4	0010	1030	33%	n=6	1030	83%	n=67
								1110	50%	n=8

Note: *For those who placed into 0010 the biggest difference in groups was in those taking 1020.

**No analysis was done to compare the placement scores of those TAKING MAT 0010 vs. those choosing NOT to take it, however one could speculate that those choosing not to take MAT 0010 had either: borderline test score, or very positive self concept; or high motivation to pass. All were prewarned of their lacking in background.

One important consideration is that in this comparison study, the two groups--(a) those taking M0010 prior to their college course; and (b) those not taking M0010 prior to their college course-- are not equivalent. In the first group, there is a higher percentage of students with very poor background, poor self concepts, and with more anxiety toward math. Those who risk not taking M0010 and take the college course are generally unintimidated and strongly motivated. This has not been shown statistically but is a strong feeling of the instructor and advisors.

Conclusion

Appalachian State University has taken a step toward meeting the needs of a large number of students who do not have the skills necessary to complete a college mathematics course successfully. Math 0010 is not only providing the students with the skills, it is also providing many of them with an improved self-concept, especially in their feelings about their ability to do math. The placement program is also providing information about their skill levels and is recommending preparatory work where necessary to those students who are required to take calculus. The course has met a very positive response from students. It has solid administrative and faculty support. The framework for placement and instruction have been modified as necessary and seem to be working very well. The program will continue as long as there are students in need.

APPENDIX B

A SHORT-TERM CLINIC IN MATH ANXIETY REDUCTION

A SHORT-TERM CLINIC IN MATH ANXIETY REDUCTION

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A SHORT-TERM CLINIC IN MATH ANXIETY REDUCTION

In May, 1978, a Math Anxiety Clinic was held at Appalachian State University for a small group of adults. They were self-admittedly math anxious, having avoided math for years, but were faced with the problem of needing more math in pursuit of their careers. The central aims of the clinic were for the participants, through one week of anxiety-reducing group process to 1) become aware of and learn to control their bodily reactions to stress; 2) to discover their self imposed-mental premises, set concerning mathematics, which were now affecting their performance; 3) to possibly re-set these premises, thus allowing the participants to function normally in a math related situation; and 4) to reinforce successful steps in anxiety reduction in a math classroom.

Basic Hypotheses

In dealing with anxiety the human body reacts both autonomically and cognitively. Autonomically, one's muscles tense involuntarily and blood flow slows, making the hands cold and sweaty. Cognitively, one references the situation in personal meaning system influenced by past experiences and one's self concept. A person acts on beliefs based in this meaning system. If severe, the autonomic arousal may also influence one's actions.

The basic hypotheses are these: 1) One can become aware of his bodily functions and learn to manage bodily reactions to stress. 2) The person has set basic life premises based on past experiences which he believes true of himself; and since the person has set them, he can re-set them or change them. Note also that relaxation plays an important role, for it is through relaxation that person begins to become aware of his bodily

reaction to stress. Also, life premises are usually set while the person is in a relaxed state; therefore the person must be relaxed in order to re-set the life premise.

Procedure

For experimental purposes, the twelve participants were divided into two groups: the experimental group and the control group. The experimental group entered the one week of preparation (directed by instructor A_1 and A_2 and counselor 1) to be followed by a week of classroom work (taught by T_1 and T_2), while the control group took the two weeks in reverse order. The preparation phase for the experimental group was central to the aim of the clinic. These participants were asked to be as open as possible about themselves during an initial period of self-introduction and getting acquainted. An atmosphere of helpfulness and mutual sharing was created. Within this atmosphere two interrelated changes were attempted. First, each participant was to bring into focus negative self-statements and underlying life premises causing conflict and stress (for example, one person's negative statement was: "I cannot do well in a math class," and the underlying irrational life premise was, "What I do must be perfect"). Once these began to surface through the interaction of the group, the instructors suggested the possibility of each participant consciously changing an irrational basic life premise. The second change was based in developing an awareness of the physical effects of stress and consisted of learning to control them. Personal, direct attention to one's body, finger thermometers (finger temperature will drop when one is under stress), and biofeedback equipment (very delicate mechanisms to detect body tenseness), were used to foster this awareness as well as help learn to control the physical states. Many

relaxation methods were presented, four of which were included in a series of cassette tapes on: a) progressive relaxation, b) self-directed relaxation, c) guided imagery, and d) breathing relaxation (Lowenstein, 1977). Applying the relaxation methods was practiced by presenting mathematical material which tended to cause anxiety. (In some of these individuals, finger temperature varied as much as 15 degrees within 10 minutes, at the mention of a math problem).

Diaries were kept by participants and collected daily. These were very important for assessing progress and planning each session with individual differences in mind.

Toward the end of the preparatory week the participants were given the opportunity to use a deeply relaxed state to consciously change an identified life premise. This interrelated the two methods of change and brought a sense of closure to the week.

The following week was spent by the experimental group in a math class in which statistics and beginning algebra were taught. Participants were encouraged to remember to use the relaxation techniques which they had acquired. The control group, after one week of math, was given the "preparation week" during the second week.

Evaluation

Statistical Analysis was done; however, since the groups were very small (n=5) the emphasis was placed on the evaluations by the participants, instructors, and counselor. It should be noted that the statistical analysis did not contradict the evaluations, but rather complemented them.

Teacher and Counselor Evaluations

Evaluation by the Teachers (T_1 and T_2) and by the Group Leaders (A_1 and A_2 and counselor) pointed out that:

1. Anxiety was reduced by the participants knowing the clinic instructors really cared about helping them reduce anxiety.

2. Group cohesiveness, that is, the experimental group, having been through a week of learning anxiety-reducing techniques and getting to know one another, was a very positive aspect of the experimental group.

3. Daily diaries were helpful to all, in that participants wrote their feelings on paper in instances where they would hesitate speaking out in a group.

4. Thermometers were surprisingly effective in aiding participants to become aware of their bodily reactions to stress.

5. The life premise notion was rather deep and not all participants were ready to re-set premises after only one week. It was still a very effective exercise, planting a seed at the very least. The counselor felt that the life premise notion had a unifying effect. The group pooled their personal experiences in an effort to help each other uncover their premises. In his estimation, much progress was made in a very short time span. Then in a classroom situation, peer competitive pressure was eliminated.

Evaluation by Participants

1. Almost all participants wrote in reference to the attitude of the instructors as if it were a unique experience that teachers would be 1) sensitive to their feelings and place these feelings above the mathematics; 2) clear and able to be understood when explaining math.

2. All felt that the rationale in the experimental week was very interesting; about half, however, were not ready to re-set any premises.

3. The likes of the participants were not in agreement. Some liked the group process, some benefited from the tapes and relaxation exercises, and some were impatient to get into the math.

4. Many of the participants realized that much of the pressure was self-imposed by unrealistic grade demands. Also, many of their personal inadequacies which they felt were unique to themselves were shared by other group members. One participant mentioned that the sort of anxiety that was cleared up in the experimental group was peer anxiety. The feeling of being alone was replaced by a group feeling of cohesiveness. All participants felt that the absence of this competition freed them to learn.

Summary of the Statistical Results

Anxiety was measured with the Math Anxiety Rating Scale (Suinn, 1972). Briefly, the statistical results were as follows:

1. Upon comparing the two groups after the first week, the classroom alone reduced anxiety more than anxiety reduction sessions alone.

2. Over the two weeks, there was a linear trend downward in both groups; the biggest reduction in both groups occurred during classroom week.

3. The experimental group had more of a reduction over the two-week term than did the control group over the two-week term. This may imply that there is benefit from preceding the classroom situation by a math anxiety reduction preparation, and also from the first result in combination with this result, the anxiety in the experimental group reduced more when they had the opportunity to use the techniques learned in the sessions in the classroom. In this way the students proved to

themselves that they could do math and control their anxiety to some extent.

Follow-up

No attempt was made to make a follow-up survey. However, in personal conversations with four of the participants, all have a good feeling about taking more math, and one has already taken Calculus and Computer Science and done quite well.

Conclusions

1. With this adult group anxiety was reduced by both the supportive classroom situation and the stress reduction process involving work with personal life premises and relaxation techniques.

2. Important facets of stress reduction appearing during the project included the following:

a. Only after personal barriers within the group were removed were the subjects better motivated to learn. A non-competitive atmosphere based on awareness of fears, suspected weaknesses, and autobiographical data shared by each member of the group helped greatly to further progress.

b. Individual interest in and ability to use specific relaxation techniques varied, but in all cases in this experiment the subjects became very much aware of strong physical reactions in situations conceived as stressful. This helped each to begin making efforts to reduce the effects of stress and anxiety.

c. Perception of the teacher as sympathetic and caring greatly facilitated relaxation enabling more effective learning.

Achieving such a perception was accomplished through direct discussion and preliminary work with the concept of anxiety, its ill effects, and the possibility of overcoming these effects.

3. Personal responsibility for negative attitudes held concerning abilities or their lack is an important step in alleviating math anxiety and perhaps the most difficult step to attain. One reason for this is that it is not accepted until some specific method of changing old views is encountered. Changing these views in a state of deep relaxation is essential and was used with the participants to varying degrees of success. Some expressed that they had identified and changed a premise, others said that they understood the concept but were not ready to change.

Implications for the Classroom

Very significant is the fact that in the classroom situation there was a significant reduction in anxiety in both groups. This implies that a sympathetic teacher is an important component in significantly reducing anxiety. Since the experimental group had more total anxiety reduction, however, perhaps a caring instructor can be even more effective by preceeding the content presentation and incorporating into it some techniques for stress reduction; the implication is that stress reduction and concept presentation work effectively together. From the participants' remarks, it seems clear that students' past negative experiences in math make it important for an instructor to do more than present material clearly in an attempt to overcome the effects of these negative experiences. The teacher must implant a spirit of caring into the class as a whole so that the student have confidence first in the instructor and second in each other. Competition and the peer pressure of mistakenly feeling alone-in-ignorance should be replaced by cooperation and a sense of caring.

The teacher can be instrumental in spreading cooperation by 1) encouraging students to discuss their feelings in class, in the open, or by encouraging students to write diaries expressing their feelings; and 2) by showing an interest in student feeling rather than facts. An honest, caring, and helpful dialogue could be ongoing throughout the semester, among students and teachers.

As well as continuing to reduce stress in the classroom, teachers could also begin working with counselors and psychologists interested in this area in an effort to develop specific approaches to managing stress to be used in the classroom.

The results for the math anxious student who has successfully met the challenge of the mathematical concepts as well as stress management are important in that a possible new field of study involving mathematics is open which previously would have been closed by math avoidance.

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APPENDIX C

CLASS HANDOUTS

ATTITUDE QUESTIONNAIRE[a]

1. Name_____ Date_____
2. Local Phone_____ Class: Math 0010 sec.____ time____
3. Local Address_____
4. Classification_____
5. Major_____
6. Math Class (es) need (ed) after M0010_____
7. Prior to which semester did you take the placement test? Fall____; Spring____ 197__
8. Are you presently registered for chemistry, physics, biology, any other math, or any other course requiring a knowledge of math?____. If yes, what is it?_____

Please answer the following as accurately as possible. Your answers will be respected.

____1. I am taking this course primarily
(a) to learn math which I have not previously learned in school.
(b) because I have to.

____2. Choose the response which best describes your feelings with respect to this course.
(a) I am willing to work as hard as I need to in order to learn the math to the best of my ability.
(b) I would like to do well, but I have a hard time actually sitting down to work.
(c) I would like to place very little emphasis on this course and more emphasis on my other courses.
(d) I would like to do only as much work as is needed to get by.

____3. How many hours are you willing to spend OUT of class, for every hour in class in which new material is presented (MWF)
(a) no more than 2 hours
(b) no more than 1 hour
(c) no more than 1/2 hour
(d) 0 hours

____4. How do you view your past math background
(a) excellent
(b) above average
(c) average
(d) below average
(e) didn't really take any math to speak of

____5. With respect to this course, I am
(a) dreading it
(b) dreading it, but I'm willing to try
(c) not really dreading it or looking forward to it
(d) looking forward to it

____6. Do you feel that learning math is more a matter of
(a) memorization
(b) understanding

IF YOU WOULD LIKE TO COMMENT FURTHER ON ANY OF THESE QUESTIONS, PLEASE DO SO ON THE BACK . . . THANKS.

---

[a]This form was given to all classes on Day 2.

DAILY DIARY[a]

Date_____ Name (optional)_____

1. Record while you are studying math:

   (a) thoughts and feelings (and activities) other than math that you experience while you are studying.

   (b) your finger temperature

      1. at the start of math homework _____

      2. when stuck on a problem _____

      3. when successful with problems _____

      4. upon completion of the homework (or when you stop studying) _____

   (c) Record amount of time spent on homework._____

2. Give your reaction to class activities.

[a]This form was given to the experimental class daily for two weeks.

NAME_____ Total Score_____

MATHEMATICS ANXIETY RATING SCALE (MARS)

The items in the questionnaire refer to things and experiences that may cause fear or apprehension. For each item, place a check (√) in the box under the column that describes how much you are frightened by it nowadays. Work quickly but be sure to consider each item individually.

	Not at all	A little	A fair amount	Much	Very much
1. Determining the amount of change you should get back from a purchase involving several items.					
2. Having someone watch you as you total up a column of figures.					
3. Having someone watch you as you divide a five digit number by a two digit number.					
4. Being asked to add up 976 + 777 in your head.					
5. Dividing a five digit number by a two digit number in private with pencil and paper.					
6. Calculating a simple percentage, e.g., the sales tax on a purchase.					
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
7. Listening to a salesman show you how you would save money by buying his higher priced produce because it reduces long term expenses.					
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.					
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).					
10. Totaling up a dinner bill that you think overcharged you.					
11. Telling the cashier that you think the dinner bill was incorrect and watching the cashier total up the bill.					
12. Being treasurer for a club.					
13. Totaling up the dues received and the expenses of a club you belong to.					
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
14. Adding up 976 + 777 on paper.					
15. Doing a word problem in algebra.					
16. Solving a problem such as: If x=11, and y=3, then the result of x/y is equal to ____?					
17. Solving the problem such as: If x=12, and y=4, then the ratio of x to y is equal to_____?					
18. Determining the grade point average for your last term.					
19. Reading an article on the basketball team, showing what percentage of free throws each player made, the percentage of field goals made, the total number attempted, etc.					
20. Reading an historical novel with many dates in it.					
21. Counting the number of pages left in a novel you are engrossed in.					
22. Guessing at the number of people attending a dance you're at.					

	Not at all	A little	A fair amount	Much	Very much
23. Buying a math text-book.					
24. Watching someone work with a slide rule.					
25. Watching a teacher work an algebraic equation on the black-board.					
26. Signing up for a math course.					
27. Listening to another student explain a math formula.					
28. Walking into a math class.					
29. Having to compute the miles/gallon on your car.					
30. Watching someone work with a calculator.					
31. Looking through the pages of a math text.					
32. Working on an income tax form.					
33. Reading your W-2 form (or other statement showing your annual earning and taxes).					

	Not at all	A little	A fair amount	Much	Very much
34. Studying for a math test.					
35. Starting a new chapter in a math book.					
36. Walking on campus and thinking about a math course.					
37. Meeting your math teacher while walking on campus.					
38. Reading the word "Statistics".					
39. Sitting in a math class and waiting for the instructor to arrive.					
40. Solving a square root problem.					
41. Signing up for a course in Statistics.					
42. Checking over your monthly bank statement.					
43. Taking the math section of a college entrance exam.					
44. Having someone explain bank interest rates as you decide on a savings account.					

	Not at all	A little	A fair amount	Much	Very much
45. Raising your hand in a math class to ask a question.					
46. Reading and interpreting graphs or charts.					
47. Reading a cash register receipt after your purchase.					
48. Figuring the sales tax on a purchase that costs more than $1.00.					
49. Having a person illustrate to you the best way to divide your money into a savings and a checking account.					
50. Figuring out which of two summer job offers is the most lucrative: where one involves a lower salary, room and board, and travel, while the other one involves a higher salary but no other benefits.					
51. Reading a formula in chemistry.					
52. Hearing a lecture in a social science class where the instructor is commenting on some figures, e.g., the percentage of each socio-economic group who voted Republican.					

	Not at all	A little	A fair amount	Much	Very much
53. Taking an examination (quiz) in a math course.					
54. Taking an examination (final) in a math course.					
55. Hearing two of your friends exchanging opinions on the best way to calculate the cost of a product.					
56. Having someone ask you to recheck his figures in a simple calculation, such as division, or addition.					
57. Being asked by a friend to answer the question: how long will it take to get to Denver if I drive at 30 miles per hour?					
58. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at differing speeds.					
59. Hearing friends make bets on a game as they quote the odds.					
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
60. Playing cards where numbers are involved, e.g., bridge or poker.					
61. Hearing a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.					
62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.					
63. Juggling class times around at registration to determine the best schedule.					
64. Deciding which courses to take in order to come out with the proper number of credit hours for full time enrollment.					
65. Working a concrete, everyday aplication of mathematics that has meaning to me, e.g., figuring out how much I can spend on recreational purposes after paying other bills.					
66. Working on an abstract mathematical problem, such as: "If x=outstanding bills, and y=total income, calculate how much you have left for recreational expenditures.					

	Not at all	A little	A fair amount	Much	Very much
67. Being given a set of numerical problems involving addition to solve on paper.					
68. Being given a set of subtraction problems to solve.					
69. Being given a set of multiplication problems to solve.					
70. Being given a set of division problems to solve.					
71. Picking up the math text book to begin working on a homework assignment.					
72. Being given a homework assignment of many difficult problems which is due the next class meeting.					
73. Thinking about an upcoming math test one week before.					
74. Thinking about an upcoming math test one day before.					
75. Thinking about an upcoming math test one hour before.					
76. Thinking about an upcoming math test five minutes before.					
TOTAL					

	Not at all	A little	A fair amount	Much	Very much
77. Talking to someone in your class who does well about a problem and not being able to understand what he is explaining.					
78. Waiting to get a math test returned in which you expected to do well.					
79. Waiting to get a math test returned in which you expected to do poorly.					
80. Walking to math class.					
81. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.					
82. Picking up a math textbook to begin a difficult reading assignment.					
83. Being called upon to recite in a math class when you are prepared.					
84. Not Knowing the formula needed to solve a particular problem.					
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
85. Receiving your final math grade in the mail.					
86. Opening a math or stat book and seeing a page full of problems.					
87. Being responsible for collecting dues for an organization and keeping track of the amount.					
88. Getting ready to study for a math test.					
89. Listening to a lecture in a math class.					
90. Figuring out your monthly budget.					
91. Being given a "pop" quiz in a math class.					
92. Seeing a computer printout.					
93. Having to use the tables in the back of a math book.					
94. Being told how to interpret probability statements.					
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
95. Asking your math instructor to help you with a problem that you don't understand.					
96. Being asked to explain how you arrived at a particular solution for a problem.					
97. Tallying up the results of a survey or poll.					
98. Acting as secretary, keeping track of the number of people signing up for an event.					
TOTAL	____	____	____	____	____
TOTAL SCORE					

Note. The Mathematics Anxiety Rating Scale by R. M. Suinn, 1972. Copyright 1972 by Rocky Mountain Behavioral Science Institute, Inc. Reprinted by permission.

HANDOUT 1[a]

1. Estimate your grade on the 2nd test _____.

2. Thinking back to the material covered on the test name, the five (5) types of instructions that you were given (you may want to give an example).

3. Verbally, tell what your solution strategy is in each case of two above.

---

1. Look at your test. Give the actual grade _____.

2. Did you anticipate each type of question?

3. Did you use a strategy in approaching problems?

4. Count up the number of points missed due to:
   (a) carelessness _____.
   (b) misunderstanding _____.

5. To what do you attribute the carelessness?

---

[a]Handout 1 was given to the experimental class on Day 23.

HANDOUT 2[a]

1. While waiting for the test to be handed to you, what were you thinking or telling yourself?

2. If you had any non-relevant thoughts during the test (thoughts not related to the test) what were they?

3. In preparing for this test, did you get tense?____ If yes, can you pinpoint the exact cause of the tenseness?____ If yes, what is it?
_____.

4. When was the first time your body showed any indications of tenseness in preparation for this test?_____. How did your body indicate this stress?_____.

5. Did the stress become more intense as the test came closer?____.
To what extent?_____.

6. Do you have any particular strategy you use to handle stress of this type?_____. If yes, what is it?_____
_____.

7. Do you feel that stress helped you or hindered you on this math test?
_____.

8. Would you like to develop a personal strategy designed for you to handle stress?_____.

If you have any other comments related to the above questions please share them with me on the back.

---

[a]Handout 2 was given to the experimental class on Day 33.

HANDOUT 3[a]

STRATEGY FOR PREPARING FOR AND TAKING A TEST

First, all homework problems must be done and concepts understood, prior to studying for the test.

1. Have a strategy for each type of problem. On this test, in particular, have a strategy for:

   (a) $\frac{1}{3} + \frac{X}{2} + \frac{1}{X+1}$ (b) $\frac{1}{3} - \frac{X}{2} - \frac{1}{X-1}$ (c) $\frac{1}{3} \div \frac{X}{2} \div \frac{1}{X-1}$

   (d) $\dfrac{\frac{1}{3} + \frac{X}{2}}{\frac{1}{X-1}}$ (e) $\frac{1}{3} + \frac{X}{2} = \frac{1}{X-1}$ (f) two types of word problems

2. When temporarily confused, revert to numerical fractions.

3. Eliminate all negative statements prior to the test and replace them with positive ones. Begin with the first thought of the test.

4. At the first sign of a tight stomach (or any other muscle being tight) relax by taking a deep breath consciously trying to relax the muscle. Also relax neck and arm muscles.

5. Do not waste energy and valuable study time with unnecessary worrying. Avoid irrelevant thoughts while studying and while taking the test.

6. Realize that one approach toward handling test anxiety is in four parts:

   (a) preparing for the test
   (b) confronting the test
   (c) coping with the feeling of being overwhelmed
   (d) reinforcing one's self for having handled stress

(see next page)

---

7. NOTE: Some tenseness and anxiety can be a good thing, so don't necessarily try and eliminate it. On the contrary, make it work in a positive sense--work FOR you, not against you.

   If you feel that the tenseness in your body is hampering your ability to think, begin next week on developing a personal body relaxation procedure. There are tapes in the language lab with strategies for relaxing that you may listen to (5th floor).

---

[a]Handout 3 is a two page handout given to the experimental class on Day 50.

TEST-SPECIFIC STRESS INOCULATION STATEMENTS

1. Preparing for Test Anxiety

- I know I'm well prepared for this test, so just relax.
- Before I look at the first questions, take a deep breath.
- I am very confident about getting a B, so take a little extra time and try for an A.
- I don't care what others are doing around me. I know this material as well as they do, maybe better.
- Remember to take one question at a time. Give myself a chance.
- Don't panic if I don't recognize the first question. I can always come back to it once I get started.
- It might be a little difficult, but I believe in myself.

2. Confronting and Handling Test Anxiety

- Don't think about being overwhelmed; just think about what I have to do, keep my mind on the test, nothing else.
- A little test anxiety is natural and it's a reminder to use my coping skills.
- If I'm not sure of several questions in a row, don't panic, but sit back for a moment and take a few deep breaths and relax.
- Get right in there, don't look around the room. Tests can be enjoyable when I feel confident about the material.
- The test is a challenge, nothing to get worked up over.
- I knew the material well last night so it'll come, just give it a chance.
- Drawing a blank is perfectly natural; just move along and come back later.

3. Coping with the Feeling of Being Overwhelmed

- When I feel anxiety coming on, just pause and try to concentrate on my paper.
- Don't let my mind wander to dispel the anxiety, I should channel the arousal more constructively in my work.
- Label my test anxiety from 0 to 10 and objectively watch it change.
- Since the test covers so much material, I'm bound not to know everything for sure. Just answer each item the best I can.
- Don't try to eliminate the anxiety totally; it's good to be somewhat aroused if it's kept at a manageable level.
- My muscles are starting to tense up. Time to tense up. Time to relax and slow things down. I have plenty of time.
- Now that I'm in control of my anxiety, I can't panic.
- The professor is not out to get me, I'll show him (her) just how well I can do.

4. Reinforcing Self-Statements

- Well I'm finished; I didn't even panic and I did well.
- I channeled my arousal in the proper direction, congratulations.
- I knew the material and it will show up in my grade.
- That wasn't so bad; I've got control from now on.
- I can be real pleased with the progress I'm making.
- Terrific! My test performance reflects my knowledge now.
- My confidence wasn't even shaken when others turned in their papers before I was finished.
- I handled that test pretty well. Now I can almost look forward to the next one.
- Now I see that there isn't anything to get so upset about.

HANDOUT 4[a]

For the remainder of the semester I, the teacher, would like to continue pursuing the topic of stress as related to math and to test taking, as we continue to study the math. To do this I need to know your responses to the following questions:

1. Please give your opinion of the handout I distributed before the last test "Strategy for preparing for and taking a test."

2. Concerning the above paper, did you read it (a) thoroughly; (b) skim over it; or (c) not read it at all? (choose one)

3. Did you employ any of the techniques on the handout?_____. In what way?

4. Did you attempt the four part outline of:
   (a) preparing for the test
   (b) confronting the test
   (c) coping with the feeling of being overwhelmed
   (d) reinforcing one's self for handling stress_____?

5. Give your honest opinion of it (read it again if necessary).

6. Choose the one which best describes you:
   ____(a) The tenseness I feel with regard to taking a math test helps me perform on the test because it makes me alert and ready.
   ____(b) The tenseness I feel has always hurt my performance and I have not improved this situation this semester.
   ____(c) The tenseness I feel used to hurt me, but I have learned this semester to use the tenseness in a positive sense.
   ____(d) The tenseness does not bother me as much as it used to, but I would like to continue working on it.

Would you like to investigate relaxation techniques which can be used quite effectively in conjunction with the technique we've already discussed?_____. (Note these techniques can be used in all types of situations. . .whenever one experiences stress).

7. Name three concepts or topics which we have studied this semester, with respect to math, which you feel you have learned thoroughly. Name them in the order to which you understand them. . . i.e. the one you understand best, put it first and so on. Name the concept which gives you the most trouble.

(1)_____(4) Trouble Concept_____
(2)_____
(3)_____

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[a]Handout 4 was given to the experimental class on Day 53 and 55

STUDENT EVALUATION[a]

1. In what ways has this course been beneficial to you?

2. What are the strong points of the program? What aspects of it have helped you the most?

3. Are there ways in which this course or program could be improved? How?

4. After having taken this course, do you feel any differently about your capacity to do math?

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[a]This evaluation was given to all classes.