To the Graduate Council:

I am submitting herewith a dissertation written by Barbara Hershey Handler entitled "Reduction of Mathematics Anxiety in College Remedial Algebra Students." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.

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REDUCTION OF MATHEMATICS ANXIETY IN COLLEGE REMEDIAL ALGEBRA STUDENTS

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

Barbara Hershey Handler

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This dissertation is dedicated to the memory of my father, William Hershey, who taught me a love of learning that has endured beyond his lifetime.

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ABSTRACT

Debilitating anxiety in mathematics has been recognized as a student problem for many years. Recently researchers have taken a closer look at the problem of mathematics anxiety in order to formulate treatments and, ultimately, prevention of the problem. It was the purpose of this study to investigate the following two general hypotheses:

1. There is an inverse relationship between anxiety and competency in mathematics.

2. A decrease in mathematics anxiety can be brought about by a combination of mathematical and nonmathematical treatments.

Students involved in this project included 37 Freshmen students at Maryville College, Maryville, Tennessee, Fall, 1981. These students successfully answered less than nine questions on the Mathematics Placement Examination (MPE). Eleven students not being required to enroll in mathematics formed the Control Group. The remaining 26 students were placed in either the Instruction (15 students) or Instruction with Anxiety Reduction Treatment (11 students) Group. Both of these groups met four times per week for mathematics instruction. Members of the Instruction and the Instruction Anxiety Groups received their mathematics instruction in one of two classes taught by the same instructor. The Instruction Anxiety Group also met weekly with a counselor who led the group in mathematics anxiety reduction techniques.

For all three sections, the Mathematics Anxiety Rating Scale (MARS) was given as both a pre- and posttest. All students also took the Mathematics Placement Examination (MPE) as a posttest.

Within the three treatment groups, students were placed in the high, medium or low anxiety range according to their pretest MARS score. This division resulted in small groups and, thus, the results of various inferential statistical methods could not be utilized.

The first general hypothesis of the project was not supported statistically. All students in the Instruction Anxiety Group, however, did experience a decrease in mathematics anxiety, as measured by the MARS, and an increase in mathematics competency, as measured by the MPE.

The average final mathematics course grade for the Instruction Anxiety Group was one letter grade above the average final mathematics course grade for the Instruction Group. The conclusions of the study supported the second general hypothesis.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	THE PROBLEM AND THE EXPERIMENTAL DESIGN	1
	Statement of the Problem	1
	Method	2
	Description of the subjects	2
	Formulation of groups	2
	Measurement of mathematical anxiety	4
	Measurement of mathematical competency	5
	Procedures	5
	Definition of Terms	7
	Limitations and Assumptions of the Study	9
	Explanation of Notation	9
	Statistical Treatment of Data	10
	Importance of the Study	10
	Organization of the Study	14
II.	SURVEY OF THE LITERATURE	15
	Definitions of Mathematical Anxiety	15
	Anxiety Specific to Mathematics	16
	Debilitating anxiety and mathematics avoidance	16
	Measures of mathematics anxiety	17
	The Relationship of Anxiety and Mathematical Competency	19
	Highly anxious populations	19
	The establishment of principles relating anxiety and achievement	21
	Vocational demands and mathematics competency	21
	The Treatment/Prevention of Mathematics Anxiety	22
	Historical background	22
	Previously conducted intervention programs	24
	Suggestions for future intervention programs	28
	Conclusions	29
III.	PROCEDURES	31
	Population Description	31
	The Measuring Instruments	33
	The mathematics anxiety rating scale	33
	The mathematics placement examination	35
	Testing Procedure for Research Project Students	35
	Pretesting	35
	Posttesting	36
	The Common Curriculum for Mathematics 99 Students	36

CHAPTER PAGE

The Additional Curriculum for Nonmathematics Treatment 36
Summary 41

IV. RESULTS AND DISCUSSION 42

Results of the Interview 42
Results of the Sentence Completion Exercise 43
Results of Math Myths Exercise 48
Results of Relaxation and Fantasy Exercises 50
Results of the Math Autobiography Exercise 52
Earliest memories 53
Best experiences 54
Worst experiences 54
Effect of past experiences 55
Family influence 55
Evaluation by the Participants 56
Summary 59

V. SUMMARY AND CONCLUSIONS 60

Summary of the Study 60
Method 60
Conclusions 61
Discussion of the general hypotheses of the Study . . . 62
Implications 63
Suggestions for treatment and prevention of mathematics anxiety 64
Suggestions for further research 65

LIST OF REFERENCES 66

APPENDIXES 75

A. MATERIALS USED IN STUDY 76

B. STATISTICAL TREATMENT OF DATA 93

C. MATERIALS USED FOR INSTRUCTION-ANXIETY GROUP 108

D. SELECTED TRANSCRIPTIONS FROM ANXIETY REDUCTION SESSIONS 115

VITA 139

LIST OF TABLES

TABLE		PAGE
1.	Frequency Table of Subjects by Category	11
2.	Means, Standard Deviations and Reliability Coefficients for the MARS in Two Samples	34
3.	Topics Studied by Students in Mathematics 99	37
4.	Frequency of Students Attending Each IA Session with Average Attendance Indicated	38
5.	Results of Sentence Completion Exercise	44
6.	Comparison of Feelings toward Mathematics	53
7.	Evaluation Ratings by IA Students	56
8.	Frequency Distribution of Course Grades in Mathematics 99	58
B-1.	Means, Standard Deviations and Significance Values for the Difference Scores on MPE by Treatment	95
B-2.	MARS Pretest Scores Percentile Equivalents	96
B-3.	Summary Table for Analysis of Variance of Final Scores for the MPE	96
B-4.	Summary Table for Analysis of Variance of Anxiety Difference Scores for the MARS	97
B-5.	Means and Standard Deviation of the MPE by Treatment	98
B-6.	Comparison of the Means of the MPE Scores with the Means which are not Significantly Different Underlined	99
B-7.	Means and Standard Deviation of the MARS by Treatment . . .	101
B-8.	Comparison of the Means of the MARS Scores with the Means which are not Significantly Different Underlined	103

LIST OF FIGURES

FIGURE PAGE

B-1. Plot of Differences in MPE Scores by Differences in MARS Scores—Group C 105

B-2. Plot of Differences in MPE Scores by Differences in MARS Scores—Group I 106

B-3. Plot of Differences in MPE Scores by Differences in MARS Scores—Group IA 107

CHAPTER I

THE PROBLEM AND THE EXPERIMENTAL DESIGN

The last few years have brought forth much discussion regarding mathematics anxiety in students and nonstudents, of all ages. Recognition of a problem tends to call for solutions. Sheila Tobias (1978, p. 17) stated that perhaps it was too early to write about mathematics anxiety since experts have just begun to examine the nature and causes of mathematics avoidance.

I. Statement of the Problem

This study was conducted in order to offer insight into further problems and solutions in the area of mathematics anxiety. Previous research has indicated that both mathematical and nonmathematical statements can be used, favorably, to reduce anxiety produced by the study of mathematics.

The specific purpose of this study was to test the following general hypotheses:

1. There is an inverse relationship between anxiety and competency in mathematics.

2. A decrease in mathematics anxiety can be brought about by a combination of mathematical and nonmathematical treatments.

II. Method

Description of the Subjects

Participants in the study were members of the Freshman class of Maryville College, Maryville, Tennessee, during the Fall of 1981. The population of the Freshman Class was 180. The specific students involved in the research were those who had correctly answered less than nine of the first 25 questions on the Mathematics Placement Examination (Appendix A). There were 68 such students. Of these, only 61 students were original participants in the research project. The entire Freshman class (n = 180) was also given the Mathematics Anxiety Rating Scale (Appendix A).

Formulation of Groups

Students correctly answering less than 9 of the first 25 questions on the Mathematics Placement Examination were required to enroll in Mathematics 99, a noncredit remedial Algebra class, if their proposed majors required any mathematics credits for the completion of a degree. Students may not pursue another mathematics class without successful completion of Mathematics 99. Mathematics 99 has been renumbered and is currently (1982) known as Mathematics 105.

Of the students described above, two groups were formed; those required to enroll in Mathematics 99 and those who were not required to do so. There were 48 students originally required to enroll and 13 students not originally required to do so.

The original control group (c) consisted of the 13 students not required to enroll in Mathematics 99. The final control group contained

11 members. One student withdrew from the college and one student could not be located for follow-up testing. The control group took a posttest Mathematics Anxiety Rating Scale (MARS) and the Mathematics Placement Examination (MPE) after the passage of seven weeks of nonmathematics academic work. These students received no other specific mathematics treatment.

Students who were required to enroll in Mathematics 99 (n = 48) were placed in one of two sections according to their individual academic time schedule. Within the framework of each section, a stratified grouping was made so that the Instruction (I) and the Instruction-Anxiety (IA) Groups were similar in the number of students representing three different levels of anxiety. Twenty-four students were to be in the I Group and 24 in the IA Group. Due to various problems; withdrawal from school, withdrawal from the mathematics class, change of major, and choosing not to participate, the final I Group consisted of 15 students while the final IA Group consisted of 11 students.

In addition to regular classroom instruction, the IA group worked with a counselor using nonmathematical anxiety reduction techniques such as those suggested by Tobias (1978), The Institute for the Study of Anxiety in Learning (1980), Kogelman and Warren (1978), Crawford (1980), The Wesleyan Study (1977) and Mallow (1981). A description of class meetings and activities follows in Chapter III. All students were given at least one consent form (Appendix A). The students involved in the IA Group were given an additional consent form (Appendix A).

Students in the I and IA Groups were to attend four 70 minute mathematics classes per week. The IA group members were to meet with a

counselor, for 70 minutes, on the fifth day. An attendance record was kept for the mathematics and nonmathematics classes. Some meetings were scheduled for individual interviews for IA students. Students were also encouraged to see the counselor any time they felt it was necessary.

Outside of classroom mathematics help was available to both I and IA students. The help was available from a student tutor and from the classroom instructor.

After the passage of seven weeks in the Fall 1981 quarter, both I and IA Groups were given the Mathematics Anxiety Ratings Scale (MARS) as a posttest measure of anxiety. The first 25 questions of the Mathematics Placement Examination (MPE) were given to both groups as a final exam for Mathematics 99 and as a posttest measure of competency in mathematics. Grades were determined for students based upon their work in their regular mathematics class.

Measurement of Mathematical Anxiety

Both pretest and posttest mathematics anxiety were measured by the scores on the Mathematics Anxiety Rating Scale (MARS). This instrument was developed by Richard M. Suinn in 1972. The MARS consists of 94 items thought to provide a reliable measure of mathematics anxiety, as well as a change in the level of mathematics anxiety in persons beyond the high school level. There is an additional instrument for use in grades 7-12 (MARS-A). The scale used will be discussed in more detail in the following chapters.

Measurement of Mathematical Competency

A 50-item examination based upon the content of the Freshmen level courses at Maryville College was developed by William Dent, Chairman of the Mathematics Department at Maryville College, and John Nichols, associate professor in Mathematics at Maryville College. The first 25 questions pertain to algebra while questions 26-50 test knowledge of material normally covered in the study of trigonometry. This instrument was used as an aid in student placement and as part of the final measure of mathematics competency for the students involved in this research project.

A reliability analysis of the first 25 items of the Mathematics Placement Examination (MPE) was performed. These first 25 items are algebraic in nature and were selected to test material taught in a beginning college mathematics course at Maryville College. Using 168 cases, Cronbach's Alpha was .86386. Cronbach's Alpha is a measure of the means of all possible split halves. It is a measure of internal consistency reliability (Nunnally, 1967). The formula is:

$$\alpha = \left(\frac{n}{n-1}\right)\left(1 - \frac{\Sigma V_i}{\Sigma V_t}\right)$$

where V_i = variance of part I of a test, size not specified

V_t = variance of total scores

n = number of parts (Guillford, 1954)

Procedures

During registration week, all members of the incoming Freshman class were assembled for various purposes. One of these meetings was a 45

minute session during which the students were given consent forms to sign and the MARS was administered. The next day, all students took the MPE. After these were scored, the MPE score was used by members of the Mathematics Department to determine student placement in the various mathematics courses offered at Maryville College. The suggested placements were then forwarded to academic advisors. When students met with their advisors, they were told of their placements. The MARS scores were not seen by anyone except the IA counselor and the researcher. Their use was purely statistical and is described in Chapter IV. After students were registered in various courses, the Control Group was formed from those who were eligible for Mathematics 99 but elected not to enroll in any mathematics course during Fall, 1981. These students were contacted through the campus mail at least three times, and then called by telephone. They scheduled a time, seven weeks after the beginning of the Fall program, during which they took the posttest MPE. It was not possible to have the Control Group assemble as one group; therefore, the posttest MPE was administered at several different times during the course of one academic week.

Students selected for the IA Group were notified during the first class meeting of Mathematics 99. They were given additional consent forms during the first meeting with their counselor.

The I and IA groups met in a traditional mathematics class four times per week and were taught in a "supportive" manner by the same person. Both groups used the same text, Elementary Algebra by Sellers (1981). There were two classes of Mathematics 99 and each contained both I and IA students.

During the passage of the academic quarter, the IA Group was scheduled to meet at least six times for 70 minutes with their counselor. Some students elected to meet a seventh time. Time was also available on an individual basis for counseling. All meetings were tape recorded with student knowledge and consent. The counselor for the IA Group was an advanced graduate student in Clinical Psychology at The University of Tennessee, Knoxville, Tennessee.

During IA Group meetings techniques such as the writing of a Mathematics Autobiography, the keeping of a Mathematics Journal, group desensitization, audio-visual aids and outside reading were discussed and/or employed. Actual sessions are outlined in Chapter III.

III. Definition of Terms

1. Mathematics Anxiety is defined as the experience of mental disorganization, panic, and fear that prevents one from learning mathematics. Although anxiety can be facilitating when it serves as a motivator, debilitating anxiety closes off options. This study is considering anxiety of the debilitating nature. Mathematics anxiety was measured by Suinn's (1972) Mathematics Anxiety Rating Scale.

2. Mathematics 99 is a noncredit mathematics course taught at Maryville College, Maryville, Tennessee. It is essentially a course in beginning and intermediate Algebra.

3. The Control Group was composed of students who scored less than 9 on the first 25 questions on the Mathematics Placement Examination administered at Maryville College during registration week.

These students were not required to take Mathematics 99 because their major area of study did not require any college mathematics credit.

4. The Instruction Group also scored less than 9 on the first 25 questions on the Mathematics Placement Examination. These students were required to take at least one mathematics credit course as dictated by their major area of study. They were required to enroll in, and successfully complete, Mathematics 99 before being able to enroll in a credit mathematics course. They met four times per week, seventy minutes per class period, for ten weeks.

5. The Instruction-Anxiety Group was similar in composition to the Instruction group. However, they agreed to meet a fifth day, for seventy minutes, for at least six weeks, with a counselor, in order to work on nonmathematical anxiety reducing techniques. Additional counseling time was also available.

6. Mathematical Competency for both the Instruction and the Instruction-Anxiety Groups is defined as a score of less than 9 of the first 25 questions on the MPE and a grade of satisfactory from the instructor of Mathematics 99, upon completion of the course. For the Control Group, mathematical competency was defined by their posttest score on the MPE only.

7. Nonmathematical Anxiety Reducing Techniques consisted of personal interviews, small group discussions, mathematics autobiographies, sentence completion, mathematics journals, systematic desensitization, self talks, values clarification, strategies and other methods as were dictated by the needs of the group.

IV. Limitations and Assumptions of the Study

Any conclusions drawn from this study are applicable to a population similar to the population described previously or to the specific population described, i.e., the incoming Freshman class (n = 180), Fall, 1981, Maryville, Tennessee.

It is a practical necessity to assume, for the purposes of the Maryville College curriculum and this study, that the mathematical competency of students successfully completing Mathematics 99 is increased in the areas of elementary and intermediate algebra.

V. Explanation of Notation

Symbols used in this study are as follows:

C: The Control Group

I: The Instruction Group

IA: The Instruction-Anxiety Group

P_r: Pretest

P_o: Posttest

M_a: Mathematics Anxiety Rating Scale (also MARS)

M_p: Mathematics Placement Examination (also MPE)

H: High anxiety pretest score

Q: Medium anxiety pretest score

L: Low anxiety pretest score

These symbols are also combined in usage, e.g., P_oM_aC symbolizes the posttest of the Mathematics Anxiety Rating Scale as given to the

Control Group. QP_rM_aI would indicate medium anxiety pretest MARS Instruction Group.

VI. Statistical Treatment of Data

The reliability of the MPE was tested using Cronbach's Alpha, which is a variation of the Spearman-Brown formula for split halves. Cronbach's Alpha is a measure of the means of all possible split halves. Using an n of 168, $\alpha = .86386$.

The original design called for an analysis of data using analysis of variance techniques. However, one of the assumptions for the use of ANOVA is randomness (Edwards, 1954, p. 316). Since it was not possible to select members of the Control Group randomly, the research design lacked complete randomness. The Control Group consisted of 11 students who were not enrolled in a mathematics course after scoring less than 9 on the Mathematics Placement Examination.

The original design is described in Appendix B. It is doubtful that reliable conclusions could be drawn from the particular population in the reserach as the final cell sizes in the analysis of the data were very small (Table 1). Therefore, the statistical analyses of results can be found in Appendix B while the remaining discussion follows a descriptive approach.

VII. Importance of the Study

Mathematics has acted as a filter in determining educational and career choices for many years. Lucy Sells (1972) became aware of this

Table 1

Frequency Table of Subjects by Category

Treatment	Anxiety Levels			Total
	Hi	Med	Low	
Control				
Frequency:	1	7	3	11
Percent:	2.70	18.91	8.11	29.73
Instruction				
Frequency:	7	7	1	15
Percent:	18.91	18.91	2.70	40.54
Instruction-Anxiety				
Frequency:	3	6	2	11
Percent:	8.11	16.22	5.41	29.73
Total				
Frequency:	11	20	6	37
Percent:	29.73	54.05	16.22	100.00

filtering effect when she surveyed the entering class at the University of California at Berkeley. Her data tabulations showed that 57 percent of entering males vs. 8 percent of entering females had had four years of high school mathematics. This immediately restricted educational choices for 43 percent of males and 92 percent of females since roughly half of the major areas of study at Berkeley required a strong mathematical background.

Too often students, and the general public, are unaware of the importance of mathematics in every day living. People become avoiders of mathematics and/or mathematics anxious. Tobias (1978) feels one observation is undisputed: for the student who has developed a fear of the subject, conventional remediation will not be enough. Attention is being turned to attitudes, self-conditioning, psychological mind set and self-defeating behaviors of persons who have become mathematics avoiders, especially as a result of math anxiety.

Universally, courses and methods are designed by people who have successfully learned a subject. Perhaps the person who has not successfully learned a subject can be helpful in suggesting ways of presenting and explaining material, a combination of group discussion, asking questions free of penalty, working out explanations and even trying to teach concepts with traditional classroom techniques may help to reduce anxiety associated with mathematics and the classroom.

The Institute for the Study of Anxiety in Learning has published several handbooks (1980) including a listing of mathematics clinics throughout the United States and parts of Canada. Many of these institutions are collecting data at this point and results are just

beginning to be published. The general consensus of opinion is in agreement with data from the Wesleyan Mathematics Clinic (1978), i.e., following work in the clinic, students' anxiety significantly decreased, confidence significantly increased and there was a marginally significant increase in the value placed on success in mathematics. From these results, Auslander (1979) believed it wise to create a supportive atmosphere in the mathematics classroom even at the cost of less coverage. It appears to be more productive in the long run, if the focus of the mathematics class is on mastery and development of positive feelings rather than in the amount of material covered.

It is hoped that the development of mathematics and/or science clinics will be even more widespread when more current research results are published. It is expected that results will continue to point in the direction of usefulness and that more math-anxious people will become math-able people as a result of getting in touch with their own feelings and attitudes regarding the study of mathematics.

The importance of this study lies in the development of teacher education programs which consider student attitudes towards mathematics, in the development of clinics for the math-anxious and math-avoiders, the development of re-entry classes for all adults and changes in attitude towards females in "male disciplines" and/or jobs. The dispelling of mathematics myths (Kogelman and Warren, 1978) and thus the erasure of false impressions about mathematics are essential in our technological society.

VIII. Organization of the Study

This research study is organized according to the following outline by chapters.

Chapter I begins with a statement of the problem followed by a description of methods and procedures, including a description of the instruments used for data collection. There are sections describing definition of terms, explanation of notations, limitations, assumptions and the importance of the study. An outline of the statistical treatment of data is located in Appendix B.

Chapter II presents a survey of the present literature including research conducted in math and science anxiety clinics, projects pertaining to the reduction of mathematics anxiety, and to the development of an awareness of the subject of mathematics anxiety and avoidance.

Chapter III includes a discussion of procedures followed, participants involved, classes conducted, and evaluation methods used by the participants in the research project.

Chapter IV contains a relatively descriptive, noninferential, discussion of the various instruction methods, problems and results of the study.

The final chapter, Chapter V, contains a summary, conclusions, implications and suggestions for further research in the area of mathematics anxiety.

CHAPTER II

SURVEY OF THE LITERATURE

Anxiety has been the subject of research for over a quarter of a century. The following chapter will deal with anxiety as it relates to the study of mathematics. Included in this survey will be various definitions of mathematical anxiety, anxiety specific to mathematics, the relationship of anxiety to mathematical competency and the treatment/prevention of mathematics anxiety.

I. Definitions of Mathematical Anxiety

Kvarnes (1980) describes "math anxiety" as a basic situation in which the person experiences, or expects to experience, a loss of self-esteem if and when confronted with a situation involving mathematics. Furthermore, a distinction is made between anxiety and fear. Fear generally has to do with a perceived threat to one's physical intactness while anxiety threatens one's sense of personal security with the basis of the threat being little, if at all, perceived.

Donady and Auslander (1980) define mathematical anxiety as the experience of mental disorganization, panic, and fear that prevents a person from learning mathematics. A more concise definition is offered by Aiken (1976, p. 295); "Anxiety in the presence of mathematics." The term "Mathophobia" was coined by Lazarus (1974, p. 22) to mean an irrational and impeditive dread of mathematics. A "mathophobe" rapidly

develops a fatalistic attitude about problems with mathematics, and fully expects to do poorly.

Other researchers have defined mathematics anxiety to include feelings of tension that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations (Richardson and Suinn, 1973a, p. 551).

Authors of popular self-help books and articles have their own definitions of anxiety pertaining to mathematics: Tobias (1976, p. 57) calls mathematics anxiety the "I can't" syndrome, whenever it strikes it creates the same symptoms and response, "I can't do this." Kogelman and Warren (1978) tie their definition to past experiences, stating that math anxiety is an intense emotional reaction to mathematics based on such experiences. In another variation, Crawford (1980) contributes a definition which states that math anxiety can be described simply as a fear of figuring, a fear of doing anything mathematical. Although Brush (1981, p. 38) fails to offer a formal definition of mathematics anxiety, she classifies mathematics anxiety as not coming from the fear of the mathematics but from the fear of the performance or the threat to one's self-esteem or self-image. It is of interest to note the different meanings attached to the word "fear" in these definitions while there is general agreement as to the meaning of anxiety, as applied to mathematics.

II. Anxiety Specific to Mathematics

Debilitating Anxiety and Mathematics Avoidance

Learning theorists (Paul and Bernstein, 1976; Allen, 1972) generally divide debilitating responses to anxiety into two catagories:

avoidance and escape behaviors. These behaviors seem to be specifically demonstrated in the anxiety associated with mathematics. The anxiety leads to avoidance of mathematics which tends to weaken the knowledge and basic skills of the subject and to produce greater anxiety which, in turn, causes the student to stop studying mathematics (Tobias and Weissbrod, 1980). There is a tendency for this cycle to continue and for the anxiety to become stronger and even to generalize due to the cumulative nature of mathematics. Tobias (1978) states that people use events, such as "being absent the day we started fractions," to rationalize failures in mathematics although these same people have learned to spell. She contends that it is unlikely that one missing link can abort the whole process of learning elementary mathematics.

Measures of Mathematics Anxiety

Researchers (Richardson and Suinn, 1973b; Dreger and Aiken, 1957; Suinn, Edie, Nicoletti and Spinelli, 1973; and Betz, 1977) seem to feel that mathematics anxiety exists and is different from general anxiety. Their work has led to the conclusion that individuals can suffer from mathematics anxiety without suffering from other tensions. As a result of these studies, several instruments have been developed which are believed to measure mathematics anxiety. Among these instruments are the Mathematics Anxiety Rating Scale, known as the MARS, developed by Suinn in 1972. Suinn developed this scale to "provide a measure of anxiety associated with the single area of the manipulation of numbers and the use of mathematical concepts." A copy of the MARS is included

in Appendix A and a summary of normative data for the MARS appears in Chapter III. Recently Rounds and Hendel (1979) reported that their research indicates that the MARS measured test anxiety rather than mathematics anxiety. Morris, Kelleway and Smith (1978) report that the effect of mathematics anxiety, per se, on performance is probably indirect and unlikely to be found consistently in specific situations. The MARS does, however, represent an improvement over general test anxiety scales in predicting performance difficulties.

Dreger and Aiken (1957) measured number anxiety by using three mathematical items from the Taylor 47-item Manifest Anxiety Scale. Specifically, these items asked the examiner if arithmetic made him/her nervous, if a mathematics problem caused "freezing" and if he/she was as good in math as in other subjects.

The Syracuse Mathematics Anxiety Scale (SMAS) is an eighteen-item scale developed by Sudweeks (1980). The test-retest reliability was found to be .84 while internal consistency (Cronbach's Alpha) was .95. A 10-item Likert scale was administered to the normative group to measure general anxiety. The correlation between general school anxiety and mathematics anxiety was reported as .37. This relatively low correlation provided Sudweek with support for the construct validity of his mathematics anxiety scale. Research is presently underway for further investigation of construct validity of the Syracuse Scale to determine if the SMAS differentiates between mathematics anxiety and, more general, test anxiety.

Alpert and Haber's Achievement Anxiety Scales were modified by Wilson and Segle (1972) for use in the National Longitudinal Study of

Mathematical Abilities (NLSMA). The modifications resulted in two scales. One of these scales is a measure of the degree to which mathematics achievement is facilitated by conditions of stress. The second scale measures the degree to which achievement is debilitated by stress conditions.

Hendel (1980) claims that test anxiety and self-estimated mathematics ability are the most important variables in the prediction of mathematics anxiety. It is a conclusion of Butler and Austin-Martin (1981) and Rosenberg (1980) that further research is needed to identify the predictors of mathematics anxiety.

III. The Relationship of Anxiety and Mathematical Competency

Highly Anxious Populations

Academic performance has been affected by the debilitating effect of high anxiety levels, as reported by Paul and Bernstein, 1976; Bander, 1982; Betz, 1978; and Austin-Martin, Waddell and Kincaid, 1980. They have found that mathematics anxiety has an adverse impact on mathematics achievement.

In a 1981 study by Kincaid and Austin-Martin, high math-anxious students' achievement in mathematics was found to be unrelated to their math anxiety ($r = 0.0016$, $p > .05$) while, for low math-anxious subjects, mathematics achievement was significantly and positively related to math anxiety ($r = 0.7056$, $p < .001$). The population studied by Kincaid and Austin-Martin consisted of female college freshmen. It is the contention of these researchers that mathematics anxiety treatment programs cannot

simply focus on either mathematical content or mathematics anxiety reduction since a focus on one may not affect the other. Thus, a "good" program must combine both areas.

Butler and Austin-Martin (1981) did not find a clear relationship between mathematics anxiety and mathematics achievement for a group of high-anxious female college freshmen. Several possible explanations are offered for these findings. In the first place, math anxiety may be irrational and therefore unaltered by mathematics achievement. Secondly, math anxiety may be a phenomenon more influenced by sex role behavior than by mathematics achievement. Finally, math anxiety appears to be a construct that is not easily definable and that varies individually so that a set of common characteristics for high-anxious female college freshmen does not exist. Butler and Austin-Martin admit that it remains unknown, at this time, whether math anxiety for this group began early enough to result in poor achievement or whether their poor achievement resulted in high math anxiety.

Austin-Martin (1980) looked for correlates of math anxiety in the female college freshmen group. He found achievement in mathematics and math anxiety to be negatively correlated ($r = -0.2027$). High math-anxious subjects exhibited less competence in mathematics knowledge than less math anxious subjects. The data showed that as mathematics based anxiety increased, mathematics competency decreased.

In a 1970 study, Szetela (1973) hypothesized that high test anxious subjects would perform in an inferior manner when compared to subjects with low test anxiety. Furthermore, it was hypothesized that these

subjects under failure conditions would report higher mathematics test anxiety than those under success conditions. The study revealed a significant difference between the performance of the high-anxiety and low-anxiety students. At that time, Szetela was cautious about making any implications from this result.

The Establishment of Principles Relating Anxiety and Achievement

Rosenberg (1980) summarizes some of the general principles relating anxiety and achievement:

1. high levels of anxiety are debilitating
2. a curvilinear relationship exists between anxiety and learning
3. anxiety interferes with problem solving
4. there is an inverse relationship between anxiety and performance levels on complex tasks
5. highly anxious people do poorly on timed tasks.

She continues by listing the following relationships between anxiety and the learning of mathematics based on the above conclusions:

1. high levels of anxiety are debilitating
2. advanced mathematics may be viewed as a complex task which requires problem solving skills; therefore, one could expect anxiety toward mathematics to be extremely debilitating
3. frequently, math performance is evaluated on timed tasks which would enhance the negative effects of anxiety.

Vocational Demands and Mathematics Competency

Sells began studying the connection between vocations and mathematical ability in 1973 after becoming aware that mathematics was acting as a "critical filter" in the job market. In 1976, she reported that basic knowledge of algebra and geometry divides the unskilled

workers from the better paying, upwardly mobile, jobs. Sells estimated that successful completion of basic algebra could make a difference of $3,000 in the starting salary of a high school graduate. It is Sells (1976) opinion that anxiety, rather than ability, or lack of it, acts as a critical filter for women in careers involving science and/or mathematics.

A failure in mathematics is serious, according to Bartel (1975). It might even be more serious than a failure in reading due to the demands society places on quantitative processes. Bartel suggests that educators look for an answer to the question, "How much of what type of mathematics does an individual need for successful participation in the adult world?"

It seems evident that the relationship of anxiety and mathematics competency needs further investigation. Most of the research, at this time, indicates that an inverse relationship between the two does exist. If improving competency in mathematics is a basic concern of society, then it seems educators and/or psychologists need to discover ways of reducing, even ultimately preventing, debilitating mathematics anxiety as it exists today.

IV. The Treatment/Prevention of Mathematics Anxiety

Historical Background

The first reported clinic for the treatment of mathematics anxiety was at Wesleyan University in 1975 (Tobias and Donady, 1977). During the first semester of operation, the clinic offered students the opportunity for discussion, consultation and noncredit math learning.

Thirty-five students responded to the initial brochure given to all students at the university. To meet the needs of an increasing number of students who did not possess an adequate background in mathematics, a credit course, "Review of Mathematics" was offered during the Spring of 1976. The staff observed that students benefitted most from being taught in small, homogeneous sections. The demand for the services of the clinic and the review course grew rapidly from two sections in 1976 to seven sections in the Spring of 1977. During this period of time, the mathematics department remained skeptical as to the value of the counseling component. It is interesting to note that most of the math anxiety, math avoidance and re-entry mathematics courses are housed in mathematics departments of postsecondary institutions and are taught, or at least supervised, by mathematicians (The Institute for the Study of Anxiety in Learning, 1980a). A study by Liff (1978) indicated that maximum achievement can be better attained when the program is conducted outside the Mathematics Department since some students are so afraid of the subject that they will not enroll in any course associated with the department.

The Wesleyan Clinic developed a good reputation and a large following, but systematically assessing the effectiveness of the counseling in ameliorating fears and bad learning habits was yet to be established. The interest in mathematics anxiety on campus stimulated new offerings (1980) including a Department of Graduate Liberal Studies credit course entitled "Demystifying Statistics."

Many of the programs for the reduction of math anxiety available in 1980 indicated that their enrollments were small (Ibid). This could

be due to the newness of the enterprise or to the risks involved. The enrollment problem may have to do with the affliction (math avoidance) itself. It takes a special kind of encouragement, perhaps from former enrollees, a promise of long and short term benefits and other forms of reassurance to attract math avoiders to clinics or other "help" situations. This seems to be an argument for incorporating anxiety reduction techniques into the regular classroom, i. e., nonthreatening supportive teachers.

Previously Conducted Intervention Programs

Professional people (Smith, 1981; Mallow, 1981; Kogelman, 1980; Tobias, 1978; Wright and Miller, 1981; and Liff, 1978) involved in the study of the treatment and/or prevention of mathematics anxiety agree that attention must be paid to more than the remediation of students' mathematics skills. Smith repeatedly (1977, 1981) states that simply forcing additional or missing mathematical knowledge is not the answer for students with long histories of unfortunate mathematical experience. Self-confidence must be increased and anxiety reduced before a conventional rate of learning can take place.

Smith is supported by Mallow's (1980) statement that math anxiety clinics must use a variety of learning techniques, not simply tutoring. The lack of mathematical skills is a result of math avoidance which is caused by anxiety. He also claims that therapeutic sessions must deal with training in doing and not simply with intellectual insight. Kogelman (1980), in dealing with participants in the "Mind over Math"

workshops, asserts that anxiety is relieved through the expression of thoughts, feelings and reactions even though anxiety is produced by looking at mathematics problems. In the "Mind over Math" sessions no mathematics are attempted until at least the fourth session as it is believed that not until subjects come to grips with their feelings about math, can they do anything in the way of mathematics. Kogelman claims that he has yet to encounter anyone who could not attain his or her goals in mathematics once their anxiety was overcome (1980, p. 27).

In 1977, Crumpton tested two general hypotheses concerning mathematics competency and mathematics anxiety:

1. An increase in the mathematics competency of students is accompanied by a decrease in mathematics anxiety.

2. Increasing the competency in mathematics is as effective a method of reducing mathematical anxiety as certain nonmathematical treatments.

The conclusions reached as a result of this study indicated that as mathematical competency increased, mathematical anxiety decreased. The nonmathematical treatments used, in examining the second hypothesis, included group discussions, individual interviews and the use of Math Anxiety Desensitization cassette tapes (Suinn, 1972) played in a regular classroom setting. Crumpton concluded that these particular methods of treatment may have had little effect on reducing mathematical anxiety. Furthermore, it appeared to her that improving mathematical competency through mathematical treatments was more effective in decreasing mathematical anxiety than was the use of nonmathematical treatments.

Blum and Givant (1980) prefer to deal with math anxiety in the classroom. They feel that students who have had negative experiences in mathematics need to have confidence in their ability restored through successful experiences in a regular classroom setting with material that the students see as challenging. Blum and Givant find it regretful that there is so much emphasis on the individual's psychological problems—as opposed to societal problems. They feel that a carefully designed substantial mathematics program is a more feasible solution to the problem of mathematics anxiety than are counseling or desensitization sessions. Their specific objection to such sessions is that they do not prepare students for more advanced work.

Smith (1981) set up a research project to compare records of her anxiety reduction mathematics class to a traditional mathematics class. She was concerned with the following comparisons:

1. attrition vs. retention in developmental classes
2. number who take another math course after completion of the developmental course
3. marks in these following courses.

A total of 1,105 students were involved in the study conducted from 1977 through 1980. Findings showed that:

1. There were fewer withdrawals and incompletes in the anxiety reduction classes ($p < .01$).
2. The percentage of students who took another math course was greater in the anxiety reduction classes ($p < .05$).
3. The pattern of grades for the two groups was the same ($p = .180$).

On the basis of these findings, Smith concludes that there is no significant difference in the ability of the two groups to cope with

higher-level mathematics courses. Thus, her findings seem to contradict the opinions expressed by Blum and Givant (1980).

Hendel and Davis (1977) conducted a study to describe the effectiveness of a combined curricular-counseling intervention strategy for reducing mathematics anxiety in adult women. Their results suggested that maximum effectiveness was achieved when participants enrolled in a mathematics course and attended a multifaceted counseling support group. Tobias (1978, p. 246) feels it is advisable to have a psychologist and a math instructor share responsibility in a math anxiety reduction situation so that errors in logical thinking and computational mistakes can be cleared up immediately. It is her opinion that the talking process is at the heart of all anxiety treatment.

Among other suggestions for the organization of clinics and/or classrooms for the reduction of mathematics anxiety are the union of Gestalt process and mathematics learning (Donady and Auslander, 1980), the training of faculty advisors (Gelwick and Stuth, 1980), the use of a confluent approach to mathematics anxiety (Culler, 1980), accelerated massed desensitization, anxiety management training and/or systematic desensitization (Richardson and Suinn, 1973) and cognitive restructuring (Mallow, 1981). Betz (1978) suggests that basic anxiety management techniques, treatment of test anxiety, and training in test-taking skills may be useful, although probably not sufficient, components of math anxiety treatment programs. She concludes that further study is needed concerning effective methods for the treatment of mathematics anxiety.

Curricular intervention (e.g., math labs, individualized instruction, math games) may assist math anxious participants in an intervention program in developing more positive perceptions of teacher attitude toward them as learners and in developing attitudes of involvement and enjoyment of mathematics (Rounds and Hendel, 1980). Rounds and Hendel further state that treatments need to be tailored to the individual. A basic assumption underlying all of these different methods is that if anxieties can be learned, they can be unlearned (Tobias, 1978, p. 247).

Suggestions for Future Intervention Programs

Wright and Miller (1981) and Mathison (1979) suggest the same four components for a postsecondary math anxiety program,

1. a math anxiety diagnostic clinic
2. math classes
3. math anxiety support groups
4. math tutorial sessions.

Techniques underlying these program suggestions include:

1. building an atmosphere in which participants are not afraid to ask "dumb" questions.
2. teaching math content using methods students can identify with; use concrete examples.
3. talking about personal math difficulties.
4. allowing students to work together.

Video and film programs are now available for use in classrooms, community meetings, and intervention programs. Among these are:

1. Multiplying Options and Subtracting Bias, a four part video series designed to encourage females to enroll in mathematics courses.

2. Math Anxiety Reduction: The Third Session, a forty minute video tape of how an intervention session proceeds.
3. Math Anxiety: We Beat It So Can You, a 16 mm film that describes a math class for adults and includes a retrospective discussion by participants.
4. Can I Have It All?, a half-hour video cassette describing women in science and mathematics careers.

The Institute for the Study of Anxiety in Learning (1980) has published a series of four manuals for use in planning and conducting intervention programs. They have also held Institutes for the purpose of assisting teachers, counselors and administrators in designing and conducting intervention programs. One manual, Paths to Programs for Intervention, is a catalogue of current (1980) programs in the United States and Canada. It contains actual materials used in over 100 institutions. Each listing includes the program title, contact persons, program description and list of materials available. Many listings include samples of materials used in actual intervention programs.

V. Conclusions

This review of the literature has included various definitions of mathematics anxiety. It has also included a discussion of anxiety as it relates specifically to mathematics, the relationship of anxiety to mathematical competency and a section on the treatment/prevention of mathematics anxiety.

The two general hypotheses of this study:

1. There is an inverse relationship between anxiety and competency in mathematics.
2. A decrease in mathematics anxiety can be brought about by a combination of mathematical and nonmathematical treatments.

were formulated on the basis of supportive literature in the area of mathematics anxiety.

The mathematics anxiety reduction techniques used in this project were extracted from reports of successful intervention programs.

CHAPTER III

PROCEDURES

This chapter contains a discussion of the procedures used for this project. A description of the population studied, the measuring instruments, the common curriculum, special activities for the IA Group, and testing procedures are also included.

I. Population Description

The population for this research was composed of members of the incoming Freshman class of Maryville College, Maryville, Tennessee, Fall, 1981. More specifically, the population consisted of 37 students who answered correctly less than 9 out of the first 25 questions on the Mathematics Placement Examination given by the Maryville College Mathematics Department. One student had a score of 10 correct answers and had elected to enroll in Mathematics 99. The entire Freshman Class (180) was given this examination known as the MPE.

The 37 students described were required to enroll in Mathematics 99 unless their major area of study did not require a college level mathematics course; there were 12 such students. The remaining 26 students enrolled in one of two sections of Mathematics 99 according to their academic time schedule.

The study was described as a research project involving alternate ways of teaching mathematics. All students were asked whether or not they wished to participate in the study. The entire class consented and

signed consent forms such as the one shown in Appendix A. All students (n = 180) took the MPE and the Mathematics Anxiety Rating Scale (MARS) during Freshman orientation.

The Control Group (C) did not meet again as a group although 11 of the original 12 did consent to take the MPE seven weeks after the beginning of the Fall term. All students took the post-MARS during a meeting of a course known as Freshman Inquiry. This was a convenient way of getting all students tested without calling a special meeting. It was felt that the retest rate would be higher if students were tested during a required meeting.

All students involved in the Instruction Only Group (I) and the Instruction Anxiety (IA) Group met with their instructor for a period of ten weeks. There were originally 48 students in the combined groups, 24 in each class section. If a student had an attendance record indicating 9 or more absences from the regular Mathematics 99 class, he/she was dropped from the study as it was felt that missing approximately 25 percent of the academic instruction would affect their academic standing regardless of participation in this study. There were 22 students with 9 or more absences who were dropped from the I and IA groups. This is not an uncommon attrition rate for this particular course at Maryville College. Perhaps this is an indication of some necessary changes needed in the mathematics curriculum and course design. One student withdrew from school during the first week. Thus there were 37 students involved in the entire project, 11 in Group C, 15 in Group I and 11 in Group IA.

Attendance in the anxiety reduction sessions was not as high as originally anticipated. Some of the students who did not attend more than once were also students who had at least nine absences from the Instruction class. Students who did not attend any IA sessions or attended the IA sessions once were dropped from the IA Group as it was felt they could not have been exposed to the additional treatment. There was no way to require students in the IA Group to attend the additional class. Since college could not require or include it as part of a course grade, this created a problem in attendance. There were three students who attended all seven classes, one who attended six classes, one who attended five, two who attended four times, two who attended three times and three who attended twice. This made a total of 12 students, one student, however, was dropped due to lack of a posttest MARS score, resulting in a final enrollment of 11 for the IA Group.

II. The Measuring Instruments

The Mathematics Anxiety Rating Scale

A pre and post measure of mathematics anxiety was recorded for each member of the Freshman class, Maryville College, 1981. Mathematics anxiety was measured by the Mathematics Anxiety Rating Scale (MARS) designed by Suinn (1972). This scale consists of 98 items representing mathematical situations. Students are asked to rate the degree of anxiety aroused by these items by indicating their response on a one (not at all) to five (very much) scale. The possible range of scores is from 94 to 470. A complete copy of the MARS can be found in Appendix A.

Normative data for the MARS was collected from a sample of 397 students enrolled at the University of Missouri and 119 students attending Colorado State University. These data are summarized in Table 2.

Table 2

Means, Standard Deviations and Reliability Coefficients for the MARS in Two Samples

Sample	1st Testing	2nd Testing	Reliability*
Colorado State University (n = 119)	187.3 (S.D. = 55.5)	179.9 (S.D. = 59.9)	0.78 (after two weeks)
University of Missouri (n = 397)	215.4 (S.D. = 65.3)		.97 (internal consistency)
University of Missouri (n = 35)	235.1 (S.D. = 51.3)	232.9 (S.D. = 56.5)	.85 (after 7 weeks)

*Test-retest internal consistency

From: MARS Information for Users, R. Suinn, 1972.

The .97 internal consistency reliability coefficient shows that the average intercorrelation of items in the test is quite high. It confirms that the test is highly reliable and indicates that test items are heavily dominated by a single, homogeneous factor, presumably mathematics anxiety (Richardson and Suinn, 1973b).

Correlations between the MARS and the Differential Aptitude Test (DAT), for the Colorado State study, were -.35 ($p < .05$) and -.32

($p < .05$) for a test-retest situation. The negative correlations were taken to indicate that high anxiety, as measured by the MARS, is associated with low performance on the DAT (Suinn, Edie, Nicoletti and Spinelli, 1973). For the smaller group study at the University of Missouri, the correlation between the measures was -.64 for a population of 30 junior and senior students. Richardson and Suinn (1973b, p. 553) concluded that "since high anxiety interferes with performance, and poor performance produces anxiety, this result provides evidence that the MARS does measure mathematics anxiety."

The Mathematics Placement Examination

The Mathematics Placement Examination (MPE) is a 50 item examination used by Maryville College for mathematics placement of new students. The instrument was designed by two members of the Maryville College Faculty. The first 25 questions of the MPE were also used as a final examination for the students enrolled in Math 99. An internal consistency reliability coefficient, alpha, (Numnally, 1967) was found to be .86 for an N of 180. A copy of the MPE is included in Appendix A.

III. Testing Procedure for Research Project Students

Pretesting

All students (n = 180) in the Freshman class were given a pretest MARS and a pretest MPE during the week of Freshman orientation. The MARS was administered one morning and the MPE was given the following morning. Students were also given other tests (i.e., English Placement, Reading Test) during the orientation week.

Posttesting

The control group was given the MPE during one of two periods convenient for them. The MPE was administered in a regular classroom during two different class times. This was sufficient scheduling for the 11 students involved. The I and IA Groups took the MPE, first 25 questions, as part of their final examination in Math 99.

All Groups (C, I and IA) were given the posttest MARS during a required class. Only one research student, dropped from the study, did not complete the posttest MARS.

IV. The Common Curriculum for Mathematics 99 Students

The Mathematics 99 classes, during Fall, 1981, were taught by the department chairman. All students used Elementary Algebra by Gene Sellers (1981). The course is designed as a refresher or remedial course for students needing to enroll in a higher level class (precalculus, calculus, or finite mathematics) in order to pursue their specific degree. It was a traditional class covering the topics indicated in Table 3. Students were given quizzes, exams and a final exam which consisted of the first 25 questions of the MPE. These scores, plus homework grades, determined their final grade in the course. This grade was assigned by the classroom instructor.

V. The Additional Curriculum for Nonmathematics Treatment

The students selected for the IA Group were notified during the first class meeting of Mathematics 99. Their names were called and

they were asked to step into the hall. At this time the researcher explained that they had been asked to take part in a project involving alternate teaching methods. They were then told when and where they were to meet for their extra classes. Since an extra class was being asked, students were told that this extra session would help them in their mathematical competency. Their first meeting was during the second week of the Fall term. At this time they met with an advanced clinical psychology student from The University of Tennessee, Knoxville, Tennessee.

Table 3

Topics Studied by Students in Mathematics 99

Chapter Number	Topics
1.	Real Numbers and Basic Operations
2.	Axioms of Equality, Addition, and Multiplication
3.	Algebraic Expressions
4.	Linear Equations in One Variable
5.	Polynomials
6.	Factoring Polynomials
7.	Rational Expressions
8.	Linear Equations
9.	Systems of Linear Equations
10.	Radical Expressions
11.	Quadraric Equations

The above procedure was used for both sections of the IA Group. One group met once a week at 11:15 A.M. and one met once a week at 1:10 P.M. These were their regularly scheduled class times. Table 4 shows the number of students attending each session. It should be noted that the 1:10 P.M. group asked to have an extra meeting as only six

meetings were originally scheduled. The program for the two IA Groups were as similar as possible, although there seemed to be a difference in the behavior of the groups. The counselor followed the group lead but made sure that both groups were exposed to the same activities. The 11:15 group was more verbal but it was the 1:10 group that asked for an extra class meeting. All materials used in the IA sessions are included in Appendix C.

Table 4

Frequency of Students Attending Each IA Session with Average Attendance Indicated

Session Number	11:15 A.M. Class	Session Number	1:10 P.M. Class
1	10	1	6
2	6	2	9
3	3	3	3
4	5	4	5
5	3	5	4
6	1	6	4
		7*	3
	Average = 4.67		Average = 4.86

*Group elected to have an extra meeting.

Session One: The first session began by organizing the program. the counselor asked for questions from the group. The questions asked concerned how they were chosen and what they were going to do. A discussion of attitudes and self-fulfilling prophecies followed. Each group formulated a definition of anxiety. They discussed what made

mathematics classes different from other classes. Both groups verbalized that mathematics classes were stressful situations due to time limits, boardwork, right or wrong problems, and memorization of useless or meaningless formulas.

Further discussion revolved around other Math Anxiety Clinics at the college level, signing up for personal interviews and the formulation of the Math Autobiography. The autobiography outline is located in Appendix C and a more detailed discussion follows in Chapter IV. The members of the group introduced themselves to each other, as did did the counselor. It was found that the majority of the students were Business majors.

Session Two: Students were reminded of their Math Autobiography and given the second part of their ongoing assignment. A sentence completion exercise was given (Appendix C). Students answered the open-ended questions then exchanged papers and read answers while the counselor catagorized the answers on the board. These results are discussed in Chapter IV. A general discussion of the "Real World" vs. the "Classroom World" followed.

Session Three: During this session, the group discussed their progress in Mathematics 99. They also talked about attitudes and study habits. The counselor began to direct the group toward dispelling some common math myths (Appendix C). They were given another section of the autobiography outline.

Session Four: Session four began with a discussion of tension and possible ways of reducing it. The counselor led the group in systematic muscle relaxation methods after the method of Wolpe (1958, 1973) and specifically outlined for math anxiety sessions by Higbee (1980a, p. 55). This outline is reproduced in Appendix C. After conducting the relaxation exercise, the counselor went on to the Wall Fantasy (Appendix C) substituting an obstacle of the students' choice for the wall. Another part of the math autobiography was given to the group.

Session Five: This session consisted of the discussion of Math Autobiographies (Appendix C). Each of the sections was discussed in detail by the group members. Other topics covered included memories, myths and the importance of the influence of the past upon the performance of the present. The counselor recommended outside reading such as Tobias (1978) and Kogelman and Warren (1979).

Session Six: The group discussed the family attitudes section of their autobiographies. The counselor related expectations of families to performance as students. The remainder of the session was used to explain more math myths (Appendix C). The 1:10 group decided that they wanted to meet for another session.

Session Seven (1:10 class only): The group conducted much of this session. They dealt with self-talk and attitudes, additional math courses and fears. They expressed a desire to meet again at some further data, even during another term.

VI. Summary

The purpose of this chapter was to describe the procedures used in this study as well as to provide a description of the population, the measuring instruments, the common and special curricula and the testing procedures. Both sections of Mathematics 99 studied the same material, from the same text, under the same instructor. The Control Group had no formal Mathematics instruction. The IA Group met six or seven times with a counselor and practiced anxiety reduction techniques.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter contains a descriptive summary of the data collected during this research project. A more statistical treatment of the data is included in Appendix B. Appendix D contains selected transcriptions from anxiety reduction sessions. Specifically, this chapter includes a detailed discussion of the Instruction-Anxiety Group sessions and data collected therein.

I. Results of the Interview

Each student in the IA Group (n = 11) was interviewed by the counselor as part of the anxiety-reduction treatment. The interview did not follow a standard form. The purpose of the interview was to allow for the interaction of counselor and student on a one-to-one basis. Discussions varied but basically covered individual feelings about mathematics, past experiences and personal goals. Most students indicated they were scared and uncomfortable in the mathematics class. Many were able to indicate a specific incident that "changed" their attitude toward mathematics. Students involved in early interviews expressed an uneasiness about the IA sessions as they did not know what was going to happen to them. Many said they felt "stupid" because they had to take Math 99.

The absence of "pressure" in the IA sessions was mentioned several times. Taking a mathematics class was usually seen as a pressured

situation. Several students felt their anxieties were not specific to mathematics classes and two students inquired about professional help in dealing with anxiety of a debilitative nature. Most students felt they needed some outside direction and enjoyed the chance to talk to someone, both in and out of the group sessions. A student interviewed after the fourth session stated, "I'm sure it's (the group) helpful."

The counselor felt that the individual interview was helpful in that it afforded him an opportunity to get to know group members individually. The interviews also allowed the counselor some input for planning IA sessions. Some students were more open in their interview than in the group sessions. The interview helped in identifying emotional blocks in regard to mathematics. All 11 students had individual interviews.

II. Results of the Sentence Completion Exercise

During the second IA session, the counselor presented a sentence completion exercise. The sentences are included in Appendix C. A summary of the five sentences used is included in Table 5. Fifteen students took part in this exercise, with each student giving up to 3 responses per item.

In responding to the open-ended statement "To me math is . . ." 77 percent of the responses were negative, 16 percent were positive and and 7 percent were considered neutral. During a discussion of the item, 5 students indicated that they were not "good" in mathematics because they did not like the subject whereas 4 students stated they did not like the subject because they were not good in it.

Table 5.

Results of Sentence Completion Exercise

Quotation	Sample Responses	Number
1. To me math is:	Negative:	
	Boring	10
	Rough	7
	Dull	4
	Not needed	4
	Scary, a pain, frustrating	1 each
	Positive:	
	Enjoyable	3
	Useful	2
	Challenging, no problem	1 each
	Neutral:	
	problems, exercises, numbers	1 each
2. The things I like best about math are:	Accomplishing something	10
	Structure and logic	7
	Manipulation of symbols	6
	Challenge	5
	Nothing	4
	Good teachers	3
	Usefulness	2

Table 5 continued

Quotation	Sample Responses	Number
3. The things I like least about mathematics are:	Homework	11
	Tests/quizzes	8
	Difficult, illogical, frustrating	6
	Manipulating problems	4
	Algebra	2
	Memorizing	2
	Being wrong, classes, rules	1 each
4. Math teachers:	Negative:	
	Expect too much	8
	have undesirable personalities	8
	are unfeeling	7
	are boring	4
	are hard to understand	4
	rush students	2
	Positive:	
	are intelligent	7
	are good teachers	3
5. This group:	Negative	
	Interferes with free time	3
	is dull	2
	dislikes math	1

Table 5 continued

Quotation	Sample Responses	Number
	Positive:	
	is helpful	10
	is interesting	5
	is fun, nice, exciting	6
	is understandable	2
	relieves tension	1
	Neutral:	
	talks about attitudes and problems	3
	is small	1
	is quiet	1

In listing responses to the second incomplete sentence "The things I like best about math are . . ." 11 percent of the responses were negative even though the item was worded in a positive manner. It was noted that while 19 percent responded with "structure and logic," 15 percent used the same response in answer to listing things liked least about mathematics. Eight percent indicated that teachers were one of the things they liked best about mathematics however, response to the open-ended "Math teachers . . ." found 80 percent of the responses to be negative.

Among the positive aspects of mathematics were "feeling of accomplishment" and "challenge" with 41 percent of responses indicating these two items. The same number of students (2) indicated they found the usefulness of mathematics to be favorable as indicated they found mathematics useless. Responses to least liked aspects of mathematics found 47 percent of the responses included written work, i.e., homework, quizzes and tests. All but one student listed a response of this nature.

The majority of replies to "Math teachers . . ." were negative (75 percent) and over half of the students expressed the feeling that the teachers expected too much from them while being "unfeeling" in their demands. When discussing this item in the IA session, students felt the teachers did not design requirements to meet students' needs but to meet "someone else's" needs. The "someone else's" was defined as the administration's, the departments, or anyone but the students themselves. Students also stated that they wanted to be taught as though they were in the "real" world. Further discussion of this found the students

stated that life doesn't require "exact" answers but the classroom does. This discussion stemmed from the idea of partial credit vs the traditional "all or none" approach. Most felt their teachers would be helpful if they went to them with problems. However, the students admitted that they did not seek help very often because it made them feel "stupid," "dumb" or otherwise inadequate.

Even though the sentence completion exercise was presented during the second IA session, the students seemed to have formed favorable opinions of the sessions, as 65 percent of the responses were positive. One student made only negative replies. After one meeting, two-thirds of the students felt the group was helpful. The most often negative reply was due to the sessions interferring with "free" time.

III. Results of Math Myths Exercise

Kogelman and Warren (1978) stated that participants in their workshops believed in one or more of the myths about math (Appendix C). The IA Group discussed four of these myths. The entire list of 12 myths was made available to them. The idea behind discussing, or recognizing, the myth list is that attitudes about math may be changed by challenging these myths and by encouraging new behaviors (The Institute of the Study of Anxiety in Learning, 1980a, p. 27).

There was no disagreement in the discussion of the first math myth. The group felt that men and women were equal in mathematical ability and that the question was an individual matter rather than a sex-related issue. The group was divided in their response to item number 5,

"It's always important to get the answer exactly right." One of the results of getting a "wrong" answer is that positive learning can take place from it. The group agreed that they could learn from their mistakes and that in many life situations an estimated answer is adequate. The rebuttal arguments centered around the need for precision in technical occupations and financial matters. One member pointed out that the government was not concerned with money values less than one dollar in income tax matters. The final consensus of the group was that approximate answers are often more important than exact answers and that even precision work and computer solutions have a margin of acceptable error. This observation was very similar to the discussion in Kogelman and Warren (1978, p. 37). The feeling of importance of exact answers stems from early learning of arithmetic as a skill and "good" feelings for right answers and "bad" feelings for getting incorrect answers.

The majority of the group felt that there was no "best way" to get a right answer. Only two members initially disagreed with this statement. One student pointed out that their classroom teacher for Mathematics 99 frequently presented problems in three or four different ways and told them to use the method that made the most sense to them, hence, the "easiest" way became an individual matter.

The only other myth that the group had time to discuss was "Mathematicians do problems quickly, in their heads." Several students said they felt they had almost been programmed into believing this, mainly due to speed tests and timed flash card drills in early grades. Since so much importance had been placed on "quickness" in answering,

they assumed that they should be able to do all problems quickly. The counselor lead a discussion concerning recall vs. problem solving. The majority of students disliked the "artificial" stress of a timed situation. It was difficult for them to believe that solutions to some problems could take years. Kogelman (1978, p. 40) summarizes that the time it takes to solve a problem depends upon the number of similar problems solved, confidence, how long it takes to get intuitive ideas—and a little luck. The group then discussed the need for homework and practice although they still argued that doing homework was one of the least desirable areas of mathematics for them. The group agreed that any problem was "easy" once you could do it.

The counselor expressed the opinion that it would have been beneficial to discuss all twelve of the myths in the group but time had placed a limitation on their discussion.

IV. Results of Relaxation and Fantasy Exercises

As a means of introducing the session dealing with relaxation techniques, the counselor asked the students how they felt before they took an examination in their mathematics class. Using a scale of 1 (low anxiety) to 10 (high anxiety), 7 was the most frequent response. A further discussion of physical feelings followed. The main point the counselor made was that stress is not only in the head. He proceeded to discuss body signs of stress and then led the group in breathing exercises. A complete list of the techniques appears in Appendix C. The group was very quiet and followed the directions given by the counselor.

Once the counselor felt the group had relaxed, he asked them to imagine a scene at the beach and then to shift the scene to their own special place. This special place was labeled their "comfort" zone. In another visualization exercise, the Wall Fantasy (Appendix C) was presented although "an obstacle" was substituted for "a wall" in the 11:15 group. The counselor did not include the condition that the "wall" or "obstacle" stretched as far as the eye could see. The obstacles created by the 11:15 group included a locked steel door, a large tree across the road (two students), a cliff on a mountain, and a wall. The solutions to the problem of overcoming the obstacles included going off the road and walking around the door, using a stick to pry up the tree to get it out of the way, climbing over the tree, going over the cliff safely even though the student got hurt on the way and "putting my head down and ramming through it," referring to the wall. The group expressed that they could not let the obstacle stop them. They examined the obstacle mentally and solved the problem although some saw it as harder than they originally thought. The student who "rammed through it," first stated that no one told him what to do so he waited for someone to come along and drive him off since he "wouldn't mess with it if I didn't have to."

The 1:10 group was read the Wall Fantasy as it appears in Appendix C. One student found a vine and swung over the wall to the other side while another examined the wall looking for a trap door or a loose brick. Although the wall was said to stretch to the left and the right directions as far as they could see, one student insisted he would go around it while another climbed over it. The fifth student "blew it up."

The discussion following this exercise, in both groups, dealt with looking for reasonable solutions, using other available tools for solving problems, waiting for "a miracle" or "someone else to do it for me," or examining the obstacle looking for a solution. The counselor led a discussion on feelings of being trapped and the relation of previous experiences to persent solutions. It was pointed out that the student who blew up the wall was feeling particularly angry that day because he was dissatisfied with the score on a test that had just been returned to him.

At the end of this session, and also in the evaluation, many students claimed that this session had been the most meaningful to them and that they felt they would use a shorter version of the relaxation techniques to help them relax before taking future tests or quizzes.

V. Results of the Math Autobiography Exercise

The Math Autobiography is one of the important components in the reduction of math anxiety (Tobias, 1978, Kogelman and Warren, 1979, The Institute for the Study of Anxiety in Learning, 1981a, and Mallow, 1981). It helps the individual examine his/her past relationship with mathematics. The autobiography used in this project was similar to the one designed by Donady and Auslander in the Resource Manual (1981a, p. 44). The students in the IA Group were given the outline shown in Appendix C. This specific outline was written by the IA Group counselor for this project.

Earliest Memories:

The earliest mathematical memories of three of the students dealt with manipulating symbols, i.e., adding and subtracting. Counting and writing "numbers" were also early memories. The most negative memory involved the stress of "races," "going to the board" and "being behind the other students." These memories were expressed by all but two of the students.

In discussing these memories during session five, it was found that there were seven negative memories as compared with two positive memories. The positive memories were "the thrill of learning" and "loving to do workbooks and finishing the pages." The negative expressions centered around not understanding a concept and having the teacher explain it over and over again and still not understanding it, having the class laugh at mistakes and criticism from the teacher. The group prepared a table comparing their earliest memories with their present feelings about mathematics (Table 6).

Table 6

Comparison of Feelings toward Mathematics

Past Feelings	Present Feelings
+	+
-	-
-	+
-	+
-	-
-	-
-	-

The group concluded that the past does influence the present and that people can change. Donady, in the Wellesley-Wesleyan Training Module (1977), states "That students need to exorcise old demons in order to deal with math in the present without getting hooked into old patterns of fear and avoidance."

Best Experiences

Good grades on tests was the experience most often listed as a best experience. This was followed very closely by "good teachers who explained well." One student related the experience of having designed a "handout sheet" to use in teaching a small group. Upon returning, a few years later, to visit the school she had attended, she found that the teacher she had had was using the "handout" she had designed.

Worst Experiences

The experience most often listed in this section of the autobiography was "poor" grades on tests. Two students recalled being "scared" of their teachers. All but one student mentioned the stress of timed tests and/or exercises. The group discussed what they felt was the unrealistic approach to timed situations. They agreed that a "range of limits" could be necessary in some situations but they saw no sense to the precise "down to the second" time limit except possibly during a standardized testing situation.

One student named "trying to learn long division" as his worst experience in mathematics; however, he added that he felt better since others were also having trouble. A female student failed a semester of

math after beginning with a "very good test." She decided that the class was "wrong for me."

Effect of Past Experiences

Previous unpleasant experiences in mathematics classes affected all but one of the students, according to their own analysis of the situation. When discussing ways in which to repair the damage of these "bad" experiences, all agreed they needed to change their attitudes but felt they had begun to work on that aspect through their participation in the IA Group. The counselor again discussed self-fulfilling prophecies, constructive self-talk (Tobias, 1978 p. 68), and ways of coping with the situation at hand. The fact that all students had met with success at some points in the mathematics careers was stressed by the counselor as he pointed out that the ability had to be present for success to have taken place.

Family Influence

One student felt "extreme" family pressure and coped with this by trying harder and getting help with academic studies, especially mathematics. The majority of the students said their families were average and one felt his family "was not very good" in their mathematics ability. One female felt she had received the message that she "should just get married and let her husband support her" and during times of academic frustration felt her family might be right.

The counselor mentioned that the group members had to realize that they were actually judging the expectations of their families and this,

itself, could cause some distortion of reality. More time for discussion was needed but was not available. The students summarized with these statements about their family expectations; "respect my ability," "expect me to do well," and "think I'm average," which indicated a wide range of perceived family attitudes.

VI. Evaluation by the Participants

Much of the evaluation of the IA project was verbal. The counselor reported that the students who attended the IA classes had favorable reactions. A few of them decided to try mathematics courses beyond those required of them. Since the sample was so small and much evaluation was oral, it would be difficult to include a statistical analysis of the evaluation. However, there were five of the 11 students who prepared a written evaluation. They were asked to rate the class meetings on a scale of 1 (unfavorable) to 5 (favorable). The results are listed in Table 7.

Table 7

Evaluation Ratings by IA Students

Rating	Number of Students
1.	0
2.	1
3.	0
4.	2
5.	2
	n = 5
	$\bar{x}$ = 4

The counselor felt that the students who remained in the classes were pleased with what had taken place.

The students stated that they felt they had "been able to overcome some of the factors that had been holding them back," changed to a more positive attitude" and "developed self-confidence." Their evaluations also included comments about the helpfulness of the class. Among those were the realization that "I didn't think I could do it, so I didn't try," "there were other people who had the same problem and I could talk to them" and "the relaxation exercises helped." The group generally agreed that they were apprehensive about taking their next mathematics course. Most of the anxiety was verbalized as being due to "an unknown situation." Most stated they still felt they would do poorly because the material was not going to be Algebra but something new they had not had before. The students were pre-enrolled in Mathematics 101, a precalculus course or Math 208, finite mathematics. The counselor reminded them that Algebra had sounded "hard" before they took their first Algebra course. He reminded them of the need for finding a new comfort zone. One student stated that "this quarter (Fall, 1981) was an exception." The counselor used this opportunity to review relaxation techniques they had learned.

The classroom instructor stated that he felt he noticed marked improvement, in the students involved in the IA project, especially those who were consistent in their attendance of the extra group. Although the math instructor did not know, specifically, who was

involved in the IA Group, he felt reasonably sure he could pick out the students involved by a change in their attitude and performance noticed during the instruction period (Table 8).

Table 8

Frequency Distribution of Course Grades in Mathematics 99

Letter Grade with Numerical Value	I	IA
A - 12		
A- - 11	2	
B+ - 10		
B - 9	1	4
B- - 8	1	1
C+ - 7	2	1
C - 6	2	3
C- - 5	2	
D+ - 4		
D - 3	3	
D- - 2		
F - 1	2	
Average grade:	n = 15 5.73 (C to C-)	n = 11 8.45 (B to B-)

During the remainder of the school year (1981-82), several students approached the researcher to comment on the help they had received from The IA classes. Several asked if Maryville College planned to hold similar sessions again. At least 5 students who were not involved in the project asked if the service could be provided for them as they felt they needed help in dealing with their anxieties in learning.

VII. Summary

The results of the interview and the results of each nonmathematical anxiety reduction exercise; sentence completion, math myths, Relaxation-Fantasy, Math Autobiography, as well as the evaluation by the participants have been presented in this chapter. Selected transcriptions from anxiety reduction sessions are included in Appendix D. Some discussions of results have been included in this chapter. Appendix B contains a statistical treatment of the data.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. Summary of the Study

Although some anxiety may be necessary for success, academic performance, specifically in mathematics, can be hindered by a high level of anxiety. This study was based on the premise that there are methods which can be used to successfully reduce mathematics anxiety. More specifically, was the purpose of this study to investigate two general hypotheses:

1. There is an inverse relationship between anxiety and competency in mathematics.

2. A decrease in mathematics anxiety can be brought about by a combination of mathematical and nonmathematical treatments.

Method

The project involved 37 students in the Freshman class of Maryville College, Maryville, Tennessee, during the Fall of 1981. Of the 37 students, 11 received no classroom instruction in mathematics while the remaining 26 students were enrolled in Mathematics 99. Fifteen of these students received classroom mathematics instruction only and the remaining 11 received classroom instruction in mathematics and nonmathematical treatment for anxiety reduction. Mathematics instruction took place four days per week in a "traditional" classroom. The once per week anxiety sessions used group discussion, individual interviews and other

mathematical anxiety desensitization techniques in addition to regular classroom instruction.

In all three groups (C, I, IA) the Mathematics Anxiety Rating Scale (MARS) was used as a pretest and posttest measure. The Mathematics Placement Examination (MPE) was also administered to all students as a pretest and a posttest.

II. Conclusions

Based upon the results of the study, the following conclusions were reached:

1. Mathematical competency, as measured by the MPE, increased significantly for the I and IA groups over the period of ten weeks.

2. Mathematical competency, as measured by the MPE, did not increase significantly for the Nonmathematical Treatment group (C) over the period of nine weeks.

3. The students involved in the IA process averaged one letter grade above students receiving instruction only for their mathematics course work.

4. The techniques used for the purpose of instruction and for the reduction of mathematics anxiety effectively increased mathematical competency and reduced mathematics anxiety for the IA Group.

5. Mathematical anxiety, as measured by the MARS, decreased in each of the three groups involved in the research project.

The following conclusions were inferred on the basis of these results:

1. Since the attrition and failure rate for Mathematics 99 is usually 50 percent, a change in the course structure of Mathematics 99 seems evident. More specifically, the classes should be small (n = 15), should include group and individual counseling time, and should continue to be taught in a supportive manner.

2. Classroom teachers need to be aware of the problems related to mathematics anxiety and of services available for mathematics anxiety reduction, i.e., clinics and/or counseling, should be available to students.

3. Student attitudes, as expressed orally, were positive in regard to the anxiety reduction techniques used in the IA Group. The students felt as though they had been helped with what they had considered to be a problem.

4. Students are often able to trace their mathematics anxiety back to an early age and can often identify specific incidents they feel contributed to their present level of such anxiety.

Discussion of the General Hypotheses of the Study

The main purposes of this study concerned two general hypotheses. The first of these was: There is an inverse relationship between anxiety and competency in mathematics. The statistical analyses of data collected for this study did not support this hypothesis. The raw data, however, supports increases in mathematical competency accompanied

by decreases in mathematics anxiety in 78 percent of the cases represented. Of the 22 percent of the exception cases, 16 percent were students representing the Control Group. Thus, for 37 students, 6 in the Control Group did not support the inverse relationship between MPE and MARS scores, while only 2 students in the I Group fell into this category. All students in the IA Group decreased their MARS score an average of 92.82 points and increased their MPE score an average of 8.18 points.

Some of the statistical procedures used in this study may be of questionable inferential value as described in Appendix B, therefore, it is necessary to pay attention to the raw data, student comments, and the results of previous and ongoing research.

The second general hypothesis of this study states that a decrease in mathematics anxiety can be brought about by a combination of mathematical and nonmathematical treatments. Some of the conclusions of the study (c.f. conclusions 4 and 5) support this hypothesis.

Implications

Course work in mathematics seems to be an effective method of reducing anxiety in mathematics. Course work, supplemented with anxiety reduction techniques, may be an even more effective treatment for the problems related to mathematics anxiety.

Further research in the area of mathematics anxiety is needed. The following section includes suggestions for treatment, prevention and research in this area.

Suggestions for Treatment and Prevention of Mathematics Anxiety

1. Treatment programs, such as anxiety clinics, should continue to function and to report the success and failures of their various programs.

2. Teachers should be made aware of the role debilitating anxiety may play in preventing their students from "success" in mathematics. This could be achieved through inservice training programs.

3. Counselors and classroom instructors should work together in seeking ways to manage anxiety in learning.

4. Treatment programs should consider models which incorporate attitudinal changes.

5. The prevention of mathematics anxiety begins in "early" years and teachers need to be aware of preventative measures as well as treatment methods. Parents also need some direction in these areas. The subject of mathematics anxiety would be an excellent program for teacher and/or parent meetings sponsored by the school.

6. Persons responsible for designing methods and preservice courses for future teachers should incorporate the subject of mathematics anxiety into their course outline.

7. Group meetings for the treatment of mathematics anxiety should continue for a time span of eight to ten weeks.

Suggestions for Further Research

Suggestions for further research include the following:

1. A longitudinal study involving mathematics anxiety treatment for remedial students at the Freshman level.

2. A study including students who receive a treatment of mathematics anxiety reduction methods and no mathematics treatment.

3. A replication study utilizing a more random method of selecting a control group.

4. A study comparing the results of anxiety reduction treatment for remedial, average, and advanced mathematics students.

5. A study relating the students' phenomenological description of their mathematics anxiety and various personality profiles.

6. Studies investigating physiological aspects of anxiety.

7. A study comparing group effectiveness, of a counselor and mathematics teacher working separately with the effectiveness of the team working together.

8. A study which uses volunteer subjects.

9. Studies leading to the development of guidelines for recognizing "anxiety" error patterns in mathematical computations and conceptualizations.

The above list is by no means exhaustive, but rather, includes some areas of needed study. In our technological society, it is imperative that we work to treat, and especially to prevent, mathematics anxiety.

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Multiplying Options and Subtracting Bias. Video cassette (3/4") available from Dr. E. Fennema, Department of Curricular Instruction, University of Wisconsin, Madison, Wisconsin, 53706, or from Educational Development Center, 55 Chapel Street, Newton, Massachusetts.

Suinn, R. Math Anxiety Desensitization. Cassette tape available from Fort Collins: Rocky Mt. Behavioral Science Institute, 1972.

APPENDIXES

APPENDIX A

MATERIALS USED IN STUDY

Information about the Use of the MARS and the MPE

in the Freshmen Class at Maryville College

(All Students)

During the Fall of 1981, part of the Freshmen Class will be involved in a Mathematics Anxiety Reduction Project. Additional data are needed concerning all students who are taking Mathematics 99 and from selected others who are not involved in any mathematics this Fall.

Maryville College requires that you take the Mathematics Anxiety Rating Scale and the Maryville Mathematics Placement Examination. You may be asked, as part of a research project to take these exams again towards the end of the grading period. Your participation, if asked to retake the exams, is voluntary if you are not a student enrolled in Mathematics 99. If you are enrolled in Mathematics 99, you will be required by Maryville College to retake both exams later in the fall.

No student will be identified in any way in the publication of the research. If you have any questions regarding the project, please ask them now or check with Barbara Handler, 210 Sutton, Ext. 275.

If you are under 18 years of age, please check with Mrs. Handler.

I have read the above explanation and give my consent to participate in the research project.

Name_____

Box #_____

Date_____

Please check the appropriate blank:

I am over 18 _____

I am under 18 _____

Information about the Mathematics Anxiety Reduction

Project in Mathematics 99, Fall, 1981

(Nonmathematical Treatment)

During the Fall of 1981, I will be conducting a research project devoted to the study and treatment of Mathematics anxiety in Mathematics 99 students at Maryville College.

You have been randomly selected to participate in one class meeting per week which will deal with nonmathematical treatments of mathematics anxiety. During this time there will be group sessions concerning your feelings towards mathematics, one-to-one interviews where you may express how you feel about mathematics and the use of other techniques especially prepared for the treatment of mathematics anxiety.

Although the results of your participation in this project are not guaranteed, it is anticipated that you will probably experience a decrease in mathematics anxiety and an increase in your mathematics competency.

Participation in this project is voluntary. If you wish to withdraw from the project at any time, you may do so without penalty. However, you will have the opportunity to attend a tutoring session one evening per week.

No student will be identified in any way in the publication of the research. If you have any questions regarding the project, please them now or check with Barbara Handler, 210 Sutton, Ext. 275.

If you are under 18 years of age, please check with Mrs. Handler.

I have read the above explanation and give consent for my participation in the research project.

Name_____

Box #_____

Date_____

Please check the appropriate blank:

I am over 18_____

I am under 18_____

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.	☐	☐	☐	☐	☐
7. Listening to a salesman show you how you would save money by buying his higher priced product 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.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

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	Not at all	A little	A fair amount	Much	Very much
12. Being treasurer for a club.	☐	☐	☐	☐	☐
13. Totaling up the dues received and the expenses of a club you belong to.	☐	☐	☐	☐	☐
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 results 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.	☐	☐	☐	☐	☐
23. Buying a math textbook.	☐	☐	☐	☐	☐
24. Watching someone work with a slide rule.	☐	☐	☐	☐	☐
25. Watching a teacher work an algebraic equation on the blackboard.	☐	☐	☐	☐	☐
26. Signing up for a math course.	☐	☐	☐	☐	☐
27. Listening to another student explain a math formula.	☐	☐	☐	☐	☐
28. Walking into a math class.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
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).	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐
45. Raising your hand in a math class to ask a question.	☐	☐	☐	☐	☐
46. Reading and interpreting graphs or charts.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
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.	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐
60. Playing cards where numbers are involved, e. g., bridge or poker.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
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 application 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."	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
75. Thinking about an upcoming math test one hour before.	☐	☐	☐	☐	☐
76. Thinking about an upcoming math test five minutes before.	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
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.	☐	☐	☐	☐	☐
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 _____

MATHEMATICS PLACEMENT EXAMINATION

Maryville College

Prepared by W. H. Dent and J. W. Nichols

1. $3\frac{2}{3} + 2\frac{1}{2} =$

   (A) 6

   (B) $5\frac{3}{5}$

   (C) $6\frac{1}{6}$

   (D) $5\frac{5}{6}$

   (E) none of these

2. $-8 - (4 \cdot -3) =$

   (A) 4

   (B) -4

   (C) 20

   (D) -20

   (E) -9

3. Evaluate: $3 - [-2 \cdot (3 - 4) + 2 \cdot 3 + 4] =$

   (A) -13

   (B) -9

   (C) -5

   (D) 15

   (E) 19

4. $(5x - 2)(3x + 1) =$

   (A) $15x^2 - 2$

   (B) $15x^2 + 11x - 2$

   (C) $15x^2 - 11x + 2$

   (D) $15x^2 + x - 2$

   (E) $15x^2 - x - 2$

5. $(2 + \sqrt{3})^2 =$

   (A) $4 + \sqrt{3}$

   (B) $7 + 2\sqrt{3}$

   (C) 7

   (D) $4\sqrt{3}$

   (E) $7 + 4\sqrt{3}$

6. $(2y^2 - 4y + 1) - (y^2 - 3y - 2) =$

   (A) $y^2 - y + 3$

   (B) $y^2 - 7y - 1$

   (C) $y^2 - y - 1$

   (D) $3y^2 - 7y - 1$

   (E) $3y^2 - y - 1$

7. $4x^2 - 11x + 6$ factors as

   (A) $(4x - 3)(x - 2)$

   (B) $(2x - 3)(2x - 2)$

   (C) $(4x - 1)(x - 6)$

   (D) $(2x + 3)(2x + 2)$

   (E) $(x - 3)(4x - 2)$

8. $x^2 - 9y^2$ factors as

(A) $(x - 3y)^2$

(B) $(x + 3y)^2$

(C) $(x - 3y)(x + 3y)$

(D) $(x - y)(x + 9y)$

(E) cannot be factored

9. $(x + 2)(x + 1) - (x + 2)$ factors as

(A) $(x + 2)(x + 1)$

(B) $(x + 2)^2$

(C) $x(x + 2)$

(D) $4(x + 1)$

(E) does not factor

10. When the polynomial $x^2 + 3x - 10$ is divided by the polynomial $x - 3$, the quotient and remainder, respectively, are

(A) x and -10

(B) x + 6 and 8

(C) x + 6 and -28

(D) x - 6 and -8

(E) none of these

11. $\frac{40x^2y^2}{16x} \div \frac{8x^2}{9y} =$

(A) $\frac{20x^4y}{9}$

(B) $9y^3$

(C) $\frac{20x^3y}{9}$

(D) $\frac{45y^3}{16x}$

(E) none of these

12. $\frac{2}{x^2y} - \frac{1}{xy^2} =$

(A) $\frac{1}{x^2y}$

(B) $\frac{1}{xy^2}$

(C) $\frac{2y - x}{x^2y^2}$

(D) $\frac{2x - y}{x^2y^2}$

(E) $\frac{1}{x^3y^3}$

13. The solution set of the following equation is

$$3(x - 1) + 2 = 2(x + 1)$$

(A) $\{-3\}$

(B) $\{3\}$

(C) $\{1\}$

(D) $\{-1\}$

(E) none of these

14. The solution set of the equation $|3x - 7| = 8$ is given by

(A) $\{-1/3, 5\}$

(B) $\{5\}$

(C) $\{-1/3\}$

(D) ϕ

(E) $\{1/3\}$

15. The solution of $|5 - 3x| < 4$ is given by

(A) $-3 < x < -1/3$

(B) $x > 3$ or $x < 1/3$

(C) $x < 3$

(D) $x > 1/3$

(E) $1/3 < x < 3$

16. The solution of the equation $\frac{2x}{15} + \frac{x}{5} = \frac{1}{3} - \frac{x}{10}$ is

(A) x = 10/13

(B) x = 10/7

(C) x = 1

(D) x = -13/10

(E) no solution

17. $(4)^{-3/2}$ =

(A) -8

(B) 6

(C) 1/8

(D) -1/8

(E) -6

18. $\frac{x^{-2}y^{2}}{x^{-3}y^{-2}}$ =

(A) 1/x

(B) x

(C) x^5y^4

(D) xy^4

(E) x/y^4

19. $\sqrt{12} \cdot \sqrt{6}$ written in <u>simplest radical form</u> would be

(A) $\sqrt{18}$

(B) $\sqrt{2}$

(C) $6\sqrt{2}$

(D) $\sqrt{72}$

(E) $3\sqrt{8}$

20. $\left(\frac{x^{1/2}y^2}{x^{-3/2}}\right)^2 =$

(A) x^4y^4

(B) $1/x^4y^4$

(C) x^2y^4

(D) x^4y^2

(E) none of these

21. The solutions of the quadratic equation $x^2 + 2x - 1 = 0$ are

(A) $1 \pm \sqrt{2}$

(B) $-1 \pm \sqrt{2}$

(C) $1, -1$

(D) $1 \pm i\sqrt{2}$

(E) $-1 \pm i\sqrt{2}$

22. If $x + 4 = 2\sqrt{x + 7}$ then $x =$

(A) $2, -6$

(B) $-2, 6$

(C) -6

(D) 2

(E) $\frac{-6 \pm \sqrt{32}}{2}$

23. $\frac{2}{x + 4} + \frac{2}{(x + 4)(x - 1)} - \frac{1}{x - 1} =$

(A) $\frac{-5(3x + 2)}{(x + 4)^2(x + 1)^2}$

(B) $\frac{x - 4}{(x + 4)(x - 1)}$

(C) $\frac{1}{x - 1}$

(D) $\frac{x + 11}{(x + 4)(x - 1}$

(E) none of these

24. The solution of the following system of equations is

$$2x - y = 5$$
$$x + 3y = -1$$

(A) $x = -1, y = 2$

(B) $x = -2, y = 1$

(C) $x = 2, y = -1$

(D) $x = 1, y = -2$

(E) none of these

25. $2/\sqrt{3}$ equals

(A) $\sqrt{2}/3$

(B) $\sqrt{6}/3$

(C) $2\sqrt{3}/3$

(D) $\sqrt{3}/2$

(E) none of these

APPENDIX B

STATISTICAL TREATMENT OF DATA

STATISTICAL TREATMENT OF DATA

The following null hypotheses were formulated before the actual collection of data. However, due to the resulting small sample size, and lack of complete randomness, it was doubtful whether the statistical measures could be used in their usual inferential way. The null hypotheses and their resulting analyses are listed here for completeness in reporting the research project.

H_o1: There is no significant difference between the means on the MPE for the C, I and IA groups over the period of at least six weeks, i.e., $\mu P_o M_p C = \mu P_r M_p C$, $\mu P_o M_p I = \mu P_r M_p I$, $\mu P_o M_p IA = \mu P_r M_p IA$.

H_o2: There is no significant difference between the means on the MPE, across groups C, I and IA at each level of anxiety, H, Q and L, as catagorized by the initial MARS score, i.e.,

$\mu LP_o M_p C = \mu LP_o M_p I = \mu LP_o M_p IA$; $\mu QP_o M_p C = \mu QP_o M_p I = \mu QP_o M_p IA$;

$\mu HP_o M_p C = \mu HP_o M_p I = \mu HP_o M_p IA$.

H_o3: There is no significant difference in the level of anxiety as a result of a specific treatment, i.e., $\mu L(P_o - P_r)M_a C =$

$\mu L(P_o - P_r)M_a I = \mu L(P_o - P_r)M_a IA$; $\mu Q(P_o - P_r)M_a C = \mu Q(P_o - P_r)M_a I =$

$\mu Q(P_o - P_r)M_a IA$; $\mu H(P_o - P_r)M_a C = \mu H(P_o - P_r)M_a I = \mu H(P_o - P_r)M_a IA$.

H_o4: There is zero correlation (r) between the change in the level of mathematics anxiety and the change in mathematics competency within each treatment group, i.e.; $r_{xy} = 0$ where x represents $(P_o - P_r)M_a$ and y represents $(P_o - P_r)M_p$ for each of the three groups C, I, and IA.

It was not necessary to do an analysis of variance of the pretest scores on the MPE since the subjects for the research were selected because they all had a score of less than 9 correct answers for the first 25 questions on the MPE. This was taken to indicate that no variance was allowed.

The first null hypothesis (H_o1) was tested using a correlated t test. The mean, standard deviation and p value for each of the three groups is presented in Table B-1.

Table B-1

Means, Standard Deviations and Significance Values for the Difference Scores on MPE by Treatment

Group	Mean	Standard Deviation	p
C	-0.2727	2.195	.6889
I	6.6667	3.6968	.0001**
IA	8.1818	2.892	.0001**

**Significant at .0001.

In order to use a technique known as stratified selection or blocking on an intervening variable, the pretest scores for the MARS were used to form three groups, high (H), medium (M) and low (L) anxiety within each treatment group. Percentile equivalents were used for this division (Table B-2).

Table B-2

MARS Pretest Scores Percentile Equivalents*

Percentile	Score Range
L: 25	124-182
Q: 26-75	183-269
H: 76+	270-412

*Based on Maryville College Mathematics 99 students
$n = 61$, $\bar{x} = 223.85$, s.d. = 68.83

The second null hypothesis ($H_o 2$) was tested using a 3(L, Q, H anxiety) × 3(C, I, IA) analysis of variance to indicate the presence of any interaction between the two variables, mathematics anxiety and mathematics competency (Table B-3). It was not possible to look at each level of anxiety as the cells were too small.

Table B-3

Summary Table for Analysis of Variance of Final Scores for the MPE

Source of Variation	Sum of Squares	df	Mean Square	F	PR > F
Anxiety Level (A)	5.63	2	2.82	0.45	0.6424
Treatment (T)	302.74	2	151.37	24.16*	0.0001**
A × T	21.41	4	5.35	0.85	0.5031
Error		28	6.26		

*Significant at .0001 level.

As seen in Table B-3, the effect of treatment yields an F value significant at the .0001 level. However, the F values of less than one usually indicate a lack of randomness (Edwards, 1963). This is understandable due to the selection method of the control group.

H_o3 was tested with a 3 × 3 analysis of variance design, using the variable named anxdif, the difference of the posttest MARS score minus the pretest MARS score (Table B-4).

Table B-4

Summary Table for Analysis of Variance of Anxiety Difference Scores for the MARS

Source of Variation	Type III Sum of Squares	df	Mean Square	F	PR > F
Anxiety Level (A)	14962.53	2	7481.27	2.54*	.0972
Treatment (T)	13060.44	2	6530.22	2.21	.1280
A × T	10257.03	4	2564.26	0.87	.4948
Error		28	2949.50		

*Significant at .09.

The mean and standard deviation for each of nine combinations is presented in Table B-5. The means were compared using Duncan's Multiple Range Test for unequal observations (Kramer, 1956). The results are presented in Table B-6. The means which are not significantly different are underscored. There was no significant difference between the pretest MPE scores for the three groups, as

Table B-5

Means and Standard Deviation* of the MPE by Treatment

	Treatment		
	C	I	IA
Pretest	4.27 (1.91)	4.40 (2.35)	5.18 (1.78)
Posttest	4.00 (2.17)	11.07 (2.91)	13.36 (1.80)
Difference	-.2727 (2.195)	6.6667 (3.6968)	8.1818 (2.892)

*Standard deviation in parentheses.

Table B-6

Comparison of the Means of the MPE Scores with the Means which are not Significantly Different* Underlined

	Combination					
	Posttest C	Pretest C	Pretest I	Pretest IA	Posttest I	Posttest IA
Mean	4.00	4.27	4.40	5.18	11.07	13.36

*A minimum difference of 2.07 needed for significance.

would be expected since the groups were formed because of their similar scores on the original placement test. The difference between the pretest and posttest score for the control group was not significant, while the difference between such scores were significant for the I and IA groups. It should also be noted that the differences in the posttest scores for the I and IA are significantly different.

The following conclusions are based on the results of the analysis of variance of the final MPE score and the Duncan's Multiple Range Test for the comparison of group means:

1. Mathematical competency, as measured by the MPE, increased significantly for both the I and IA group over the period of ten weeks.

2. Mathematical competency for the control group did not increase when measured by the same instrument over the same time period as in 1 above.

3. The techniques devised for the treatment of mathematics anxiety and applied in the IA group with the traditional classroom effectively increased the mathematical competency of that group as measured by the MPE.

4. The method common to the I and IA group, i.e., classroom instruction, contributed to a significant increase in mathematical competency for these two groups as measured by the MPE.

Results obtained did not show a significant effect for anxiety level, treatment or interaction. The mean and standard deviation for each of the nine combinations is presented in Table B-7. The means were compared using Duncan's Multiple Range Test for unequal observations

Table B-7

Means and Standard Deviation* of the MARS by Treatment

	Treatment		
	C	I	IA
Pretest	209.27 (47.28)	258.00 (56.64)	246.64 (81.98)
Posttest	177.18 (44.97)	200.47 (74.05)	153.82 (40.63)
Difference	32.09 (32.68)	57.53 (68.86)	92.82 (46.01)

*Standard Deviation in parentheses.

(Kramer, 1976), even though the analysis of variance did not indicate significance (Table B-8). The .09 appeared close enough to the .05 level to warrant further investigation.

There was no significant difference between pretest anxiety scores, on the MARS, for the I and IA group. Ideally, these three groups should not be significantly different from each other. However, the lack of randomness in selecting the control group was recognized as a problem earlier. The control group mean score on the pretest MARS was significantly lower than the mean score for the other two groups. The control group's lower mean score could have been the result of the students knowing they did not have to enroll in a mathematics class. They could be classified as "successful" math avoiders. The knowledge that they did not need to "worry" about mathematics could, in effect, cause a lower mean score for them. The overall mean score for the pretest MARS for the students involved in the research project was 223.85.

The mean scores on the posttest MARS were significantly different for the I and IA groups. No other mean scores were found to be significant for the posttest measure of the MARS.

The following conclusions are based on the results of the Duncan's Multiple Range Test for the comparison of group means:

1. Mathematical anxiety, as measured by the MARS was decreased for each of the three groups in the study.

2. There was a significant difference in the posttest mean scores minus the pretest mean scores on the MARS for the C and IA groups.

Table B-8

Comparison of the Means of the MARS Scores with the Means which are not Significantly Different* Underlined

	Combination					
	Posttest IA	Posttest C	Posttest I	Pretest C	Pretest IA	Pretest I
Mean	153.82	177.18	200.47	209.27	246.64	258.00

*A minimum difference of 45.01 needed for significance.

3. The posttest MARS mean score for the I and IA groups were significantly different, thus indicating the difference in treatment for the two groups was an effective method of reducing mathematics anxiety. This difference in treatment refers to anxiety reduction techniques as described in previous sections, i.e., relaxation, desensitization, and discussion.

In order to investigate H_o4, or to answer the question how does the change in the level of mathematics anxiety correlate with the final level of mathematics competency, the described procedure was followed: The change in the level of anxiety was used on one axis and the change in the level of competency was used on a second axis. The pairs were plotted to see if the relation between the two was linear, curvilinear or nonexistent. This was done separately for each group. The plotting presented a visual representation for determining any existing relationship between the changes in anxiety and competency scores. An analysis of the data indicated that H_o4 had to be accepted for this sample (Figures 1, 2 and 3).

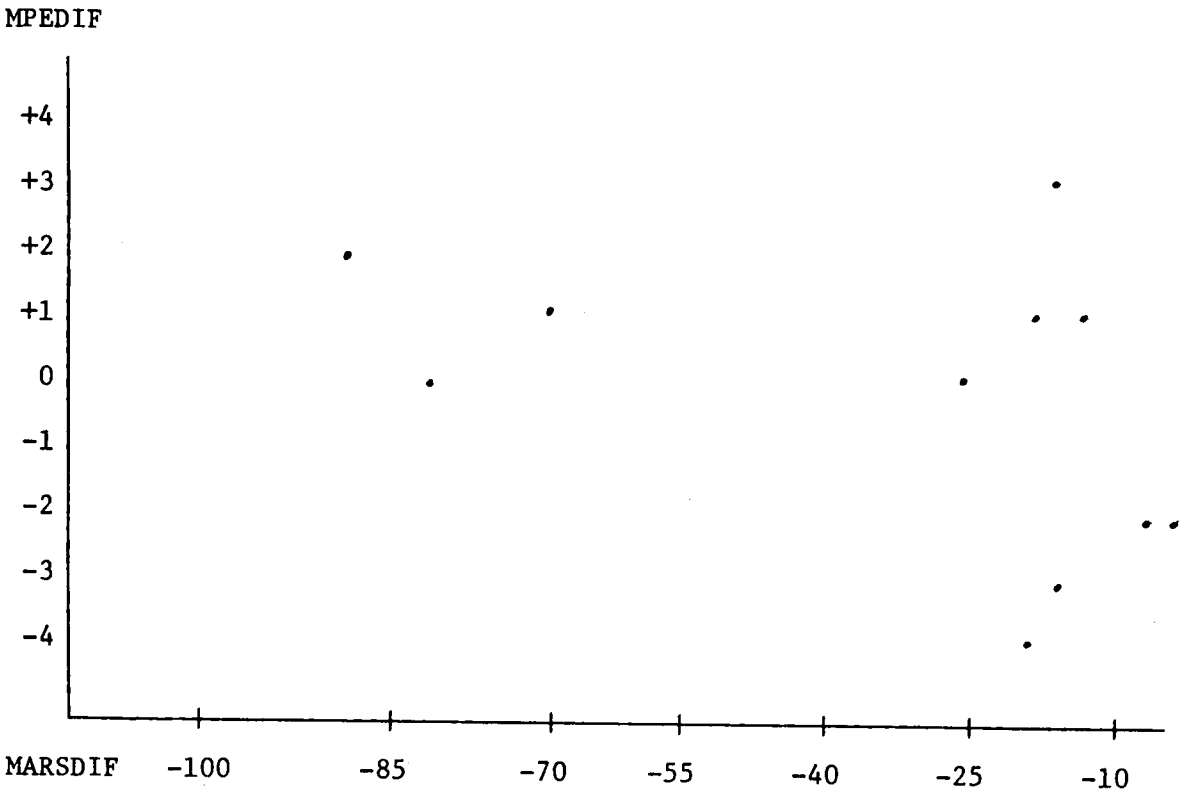

Figure B-1. Plot of differences in MPE scores by differences in MARS scores—Group C.

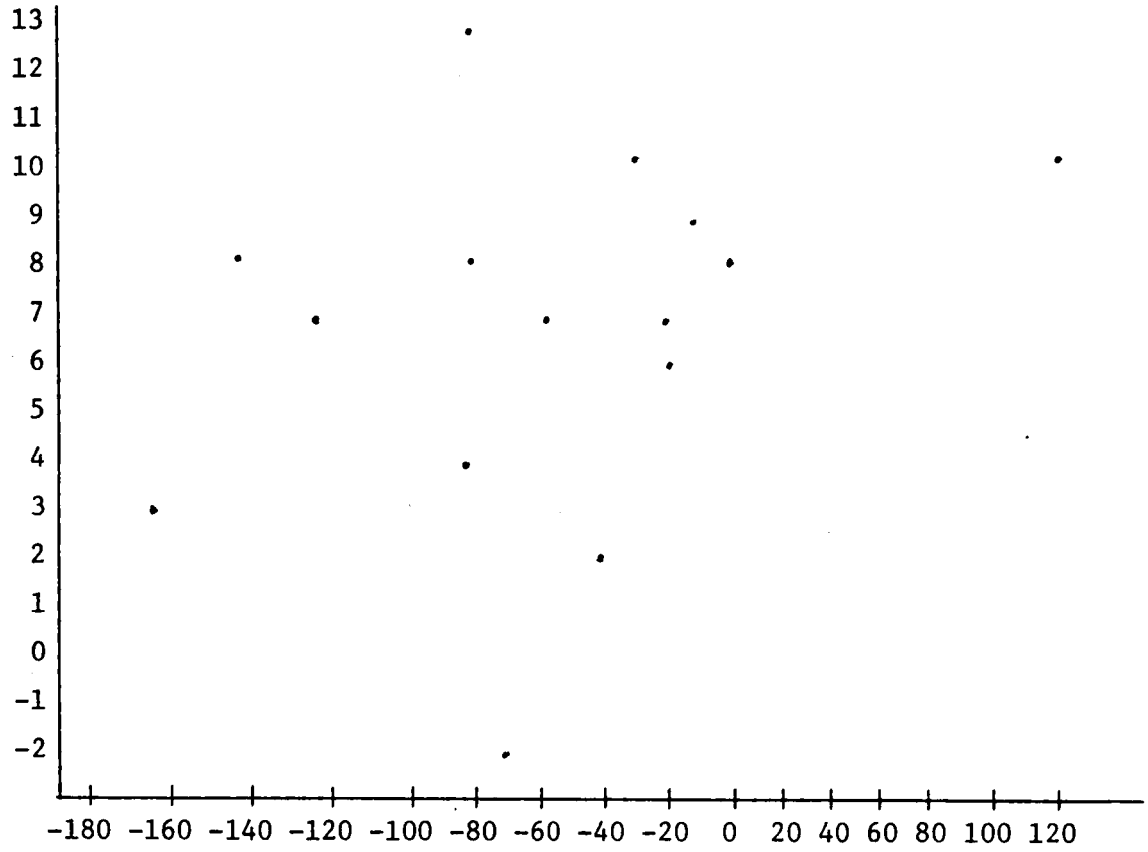

Figure B-2. Plot of differences in MPE scores by differences in MARS scores—Group I.

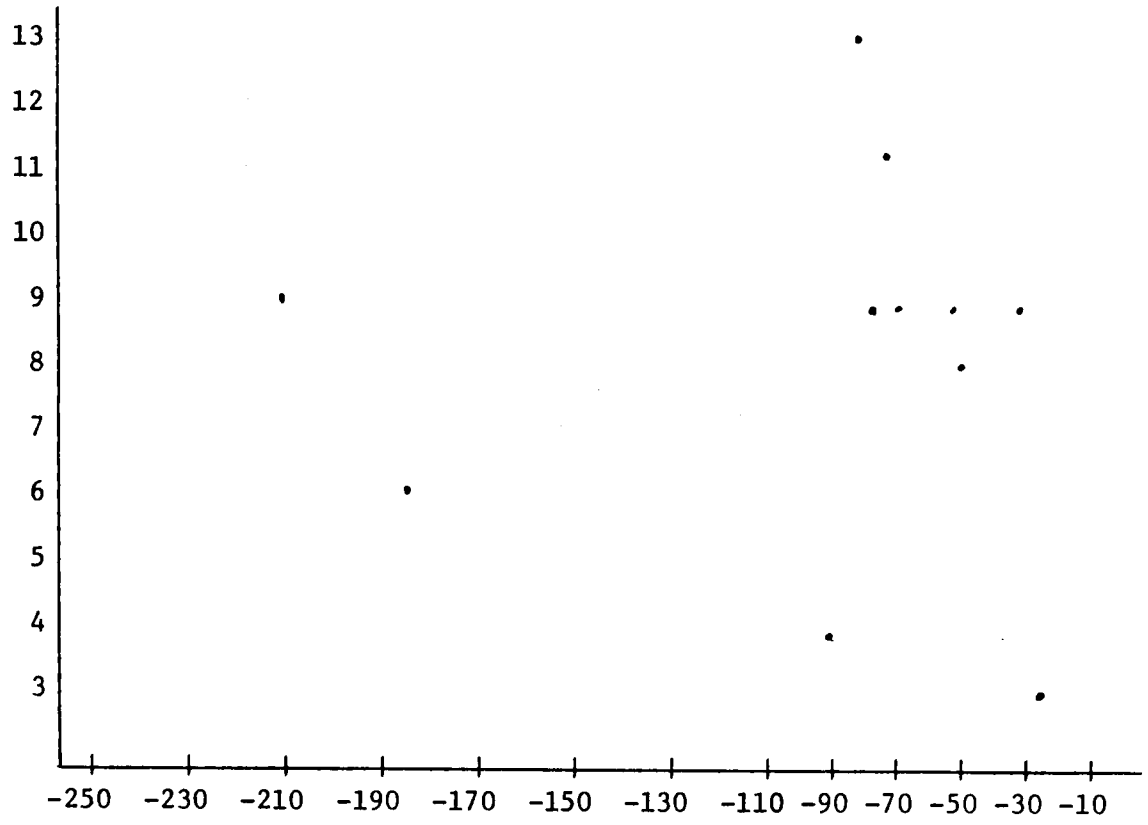

Figure B-3. Plot of differences in MPE scores by differences in MARS scores—Group IA.

APPENDIX C

MATERIALS USED FOR INSTRUCTION-ANXIETY GROUP

MATH AUTOBIOGRAPHY OUTLINE FOR IA STUDENTS*

I. Describe some of your earliest mathematics memories, in school and out.
   What is happening in these scenes?
   What are people saying?
   What thoughts and feelings are you having?

II. Describe the best math experience of your life.
   What happened?
   What made it good?
   How did you feel about it?

III. Describe the worst math experience of your life.
   What happened?
   What made it bad?
   How did you feel at the time?

IV. How have these experiences affected you as a mathematician?
   If some of your more negative math experiences have had a bad effect on you, what would it take to correct the damage?

V. How do (did) the other members of your family do in math?

   What do (did) they think about your math ability?

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*Adapted from Donady and Auslander, The Resource Manual, The Institute for the Study of Anxiety in Learning, Washington, D.C. 1980, p. 44.

SENTENCE COMPLETION EXERCISE*

1. To me math is

2. The things I like best about math are

3. The things I like least about math are

4. Math teachers

5. This group

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*Adapted from Michael and Kfoury, and Donady in The Resource Manual, The Institute for the Study of Anxiety in Learning, Washington, D.C. 1980, pp. 46-47.

MATH MYTHS

*1. Men are better in math than women.

2. Math requires logic, not intuition.

3. You must always know how you got the answer.

4. Math is not creative.

*5. There is a best way to do a math problem.

*6. It's always important to get the answer exactly right.

7. It's bad to count on your fingers.

*8. Mathematicians do problems quickly, in their heads.

9. Math requires a good memory.

10. Math is done by working intensely until the problem is solved.

11. Some people have a "math mind" and some don't.

12. There is a magic key to doing math.

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*Discussed in IA group sessions.

Kogelman and Warren, Mind Over Math, Dial press 1978 and McGraw-Hill Paperbacks, 1978.

OUTLINE OF RELAXATION INDUCTION*

I. Arms

- A. Clench right fist
- B. Clench left fist
- C. Clench both fists
- D. Bend elbows and tense biceps

II. Facial Area, with Neck, Shoulders and Upper Back

- A. Wrinkle up forehead
- B. Frown and crease brows
- C. Close eyes tighter and tighter
- D. Clench jaws; bite teeth together
- E. Neck-press head back as far as it can go
- F. Shrug shoulders

III. Chest, Stomach and Lower Back

- A. Breathe easily and freely in and out: notice how relaxation increases as you exhale.
- B. Hold breath, then exhale
- C. Tighten stomach muscles
- D. Notice rhythmic relaxation in lungs and stomach while exhaling

IV. Hips, Thighs and Calves

- A. Flex buttocks
- B. Flex thighs by pressing down heels
- C. Tense calves by pressing feet and toes downward, away from face

V. Let relaxation spread throughout body; feel body becoming progressively heavier; give muscles individual attention.

VI. From here you can go to a peaceful scene, if desired.

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*Jeanne Higbee, Resource Manual for Counselors/Math Instructors, The Institute for the Study of Anxiety in Learning, Washington, D.C. 1980, p. 55.

THE WALL FANTASY*

Directions: Have participants relax and get as comfortable as possible. If you are using a room with a rug, many people may enjoy lying down. Ask members to take some deep breaths before they begin this imaginary trip.

See yourself walking along a road. The dirt feels warm and soft beneath your feet. The sun is shining and feels warm on your back. The air is soft and the fields on both sides of the road are green and grassy. There are wild flowers, trees in the distance. The road leads up and down hills. Feel yourself walking. Feel your arms swinging. Feel the warm breeze.

The road takes a gradual curve and suddenly your path is blocked by a wall. Walk up to the wall and feel its texture. Look up and see the wall stretching up—it seems to go into the blue sky. To your left the wall stretches as far as the eye can see. To your right the wall stretches—it seems forever. How do you feel? What do you do?

Note to leaders: The wall fantasy is intended to make the participants aware of his(her) reaction to obstacles. Don't mention this to the participants.

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*Suzanne Culler, Resource Manual for Counselors/Math Instructors, The Institute for the Study of Anxiety in Learning, Washington, D.C., 1980, p. 49.

EVALUATION QUESTIONS

1. On a scale of 1 (low) to 5 (high), how favorable has this experience been to you, in mathematics.
2. Indicate the reason(s) behind your rating.
3. Has this group been helpful to you in nonmathematical ways?

APPENDIX D

SELECTED TRANSCRIPTIONS FROM ANXIETY REDUCTION SESSIONS

SELECTED TRANSCRIPTIONS FROM ANXIETY REDUCTION SESSIONS

Quotes are from students unless preceded by (C) indicating the counselor.

Session One (11:15 class):

"What are we doing here?" . . .

"Will there be any outside work?" . . .

"How were we chosen?" . . .

"Is this a graded experience?" . . .

"Do we need to take notes in here?" . . .

(C) "The point of our six meetings here, is to look at some of your attitudes about math, some of your feelings about math, some of your beliefs about yourself and mathematicians." . . .

(C) "Give me a definition of anxiety" . . .

"Depression"

"fear" "craziness" "nervous"

(C) "Why would math make so many people so worried and be so painful?"

"fear of making a mistake"

"fear of failing at it"

(C) "Why math more than English?" . . .

"English, though, you use it all the time"

"A lot of people don't like to work with numbers"

"They make you get up and write on the board—I hate that . . . teachers say it's your turn to go up to the front of the class and show us how you do it and then you go make a mistake"

"It's like you're naked up there and everyone can see what a dummy you are" . . .

"More quizzes—can't cheat and never prepared"

"Unexpected—although in some they do tell you"

"You have to remember formulas you know, like how to add, how to divide . . ."

(C) "What does a formula mean to you when you memorize it?"

"Nothing" . . .

"How many people do you know later on in life actually use Algebra on their jobs—unless they're like math majors or computer people?"

(C) "They don't use the formulas but they use the concepts . . . that would be my answer to that."

". . . if you're going into English or Business or something—why should you take it (math) . . . Why all these graphs and stuff?"

(C) "It doesn't seem to a lot of you that this math you're having to take makes a lot of sense or is very useful and I'm sitting here telling you . . . The concepts you are learning are important, at least I believe that, the formulas aren't all that important. Even if you're going to be a farmer, or a carpenter, these things will be important to you. . . . A lot of people because they hate math or don't think they're any good in it, say 'Math is no good,' rather than saying 'I don't think I'm any good at it.' It's a tradeoff. . . . Other ideas

about why math class makes you nervous? From the ladies . . . (no response) . . . What about time? . . . Is there anything different about math teachers as a group? . . . Ladies . . ."

"All the ones I had seemed to be vague about things . . . not really explaining it"

"Some teachers just throw the book at you and they say—here—learn it. . . . Demanding . . . They are less patient than other teachers when they should be more patient than less"

"Hey, we know it, so why don't you?"

"They forget sometimes that they are teachers—they are teaching" . . .

(C) "It takes place in a more competitive environment, a less supportive and more competitive environment . . . in math you're under more pressure to perform both against the clock and against other people with less support from your teacher and probably with less support from your friends who are just as nervous as you are"

"History seems the same . . . lots of dates to memorize . . . dates are numbers . . . and numbers are math. . . . I hadn't thought of that."

"Also in math, there's one specific right answer. In English, for instance, when you're writing a paper there's not exactly one."

(C) "We'll talk about that later in another exercise" . . .

Session Two (1:10 class):

(C) "I thought what we might do today, is complete some sentences, these sentences have to do with your feelings about math.

I hope this will give us some idea of how the group feels in general about math—what they like about it and don't like about it . . . Everyone take one of these pieces of paper—do not put your name on it . . . I'm going to read off a sentence and then each of you fill in the blank, anyway you like, in a way that seems accurate for you . . . hand them all in and I'll shuffle them all up and hand them back out . . . we'll discuss them to see what people think about these . . . The first sentence is (reads list on p. 110) . . .

(C) "Okay, someone start, To me math is . . ."

"hard" "Boring" "Is difficult the same as hard?"

"frustrating" "tedious" . . . "scary" "hard" "unuseful"

"monotonous" "dull" "helpful" "discouraging" "nonessential"

"stupid" "Most people aren't very good at math and that's why you get all the negative connotations"

"You just want to push it away and do something else"

"There's only so many times in a row you can take not being able to do something"

"As long as you can do a problem, it's okay" . . .

"What does math do to help a person?"

"Figure taxes, add checks"

"As far as your personality is concerned, what does it (math) do to help you?"

"Reasoning" . . .

(C) "What can you do when you can't do a homework problem?"

"Go get help from someone else"

"You just can't call a teacher up and say would you help me"

"If it's a problem I think I should get, I get in a stew about it"

(C) "Can you connect the impatience you see the teacher's having with yourself getting into a stew?"

"People don't work as hard with the one's that's not got it"

(C) "Do you all think this is true: Math is done by working intensely until the problem is solved, True or False"

"True"

(C) "How many trues—hands up (five)—how many falses— . . . In reality you don't have to do this. Put it down and come back to it."

Session Three (11:15 class):

(C) "You have a quiz tomorrow?"

"Yes, we've had four quizzes and one test"

"It'll be easy 'cept for the word problems"

"Hey, the word problems is what's easy—number problems is hard!"

"If I'm in a room by myself, I can do it, but if I have other distractions—it takes me awhile. I have to discipline myself."

(C) "The course seems real easy to you"

"So far, yes. My quizzes are good. I haven't had an Algebra like course for two years . . . I failed the three six weeks and got a C on the exam so he gave me a D for the semester . . . It's easy once you understand it. Sometimes it takes awhile to understand it."

"We have some people in our class who don't have a clue as to what's going on"

"What'd you do on that test?"

"I made 95 on that test and 15 out of 15 on all my quizzes."

"I got 11 on the first quiz, I missed one problem. We had to tell is it's greater than or less than, okay, for some reason, I forgot to bring down my negative sign and when I did it made it less than but it turned out it's supposed to be greater than. I got that wrong and ever since then I've been getting 15. . . . I got 85 on my test—a B."

"I've had Business Math and it's different. It's just a class for a football player to get by in, that's all there is to it."

"My counselor messed me up 'cause they said I had 2 years of math. My two years of math averaged out to a C average, right, even though I did bomb one semester, I got a C average and they said I had enough math. When I got to the college here, they said I needed another year of it. That's why I have to take math now. Otherwise . . . I <u>had</u> to take Math 99 . . . okay, here's what you're taking, no choice."

"I made a 77 on the test, two 13's and a 15."

(C) "Do you feel satisfied with that?"

"Oh, I could of made an 85 but I didn't study. I mean, I knew we had a test, but I didn't study. I got to be prepared, I can't remember all that stuff."

(C) "As you talk about this, it sounds like you want to get a B, a C would be okay. . . . You seem to see this as work that you can do. . . ."

"Yea, I could make high 80's, low 90's. But later on in the year, I'll have trouble."

(C) "How does what's going to come later in the year affect what you're doing now?"

"Well, see, I need to get my grade up now. Everything ties together. What we're doing now is going to help in what you do four chapters from now."

(C) "You're saying things that don't exactly go together for me. It's important to you to get the best grade you can now but you don't want to study for the test—you don't think you can do better"

"It's not that, I need to get the best grade I can at the first of the term because at the last we'll get harder stuff then I can't make as good grades and it'll lower my average."

(C) "Then why didn't you study for the last test?"

"Well, I had a paper due . . . We had an away game . . . Then I just figured I'd do alright so I won't worry about that now."

"I don't think that many people studied."

(C) "I'm not asking you so you have to defend yourself. I'm trying to figure out what goes on in your mind . . . People don't expect that they'll do well anyway."

"I was satisfied"

"I was satisfied for all the time I spend studying for the test."

"A B for me, in math, is outrageous. Mom and Dad, when they came up and I told them I got a B on that test—they were so happy, they could have gone out and bought me a new car or something. I just don't get B's in math. I never have. I felt pretty confident about what we were doing at the time."

(C) "Can you all understand what I'm saying here? This is a weird thing to me. I hear people say I don't have to study and still get B's and C's on the test. I'm doing okay but I don't want to study because, and I'm not sure what the rest of that is."

"Cause I don't want to waste the time because I feel pretty good now . . . I made a few little stupid mistakes but I still felt pretty good about the whole thing. . . . I've never done good. The way I've been doing is freaking me out—It's great."

"It's like you've done something for the first time that no one else has ever done—no kidding. The thing is, you can't let it all go to your head, you know, start walking around and saying, hey, man, I got an A." . . .

(C) "What do you see in the future?"

"It'll get harder. I don't think it'll be any more trouble. Maybe. I understand it . . . just sit down 15 minutes and then again 15 minutes later . . ."

(C) "You think you'll continue to do just as well later as now?"

"I don't know. . . . I don't think I'll fail any tests."

(C) "There's a lot of difference between a B and a F."

"Not really—not when it's my math, there isn't."

(C) "That's what I wanted you to see."

"When it's my math, there isn't much difference between a B and a F . . . just a lot of studying. When I take a book home, I sit there—the only time I work on my Algebra is on a Tuesday or Thursday, when I can get help. That's the only time I open my book except when

I'm in class. Usually I try to do what's due so I won't have to worry about it."

(C) "Let me tell you what I see as the danger, why I'm chasing this thing. I think to myself, these guys have done well so far and they like it. They feel good about what they've done."

"I didn't say I liked it"

(C) "He's doing well in math but he really doesn't enjoy it . . ."

"It's something that I have to do."

(C) "I mean you like the fact that you've done well so far."

"That I do like."

(C) "You have a sense of accomplishment—you don't have to tell me, I can see it . . . You look down the road and think that for some reason you're not going to be able to do it—why is that? . . . What do you expect of yourself down the road . . . you don't sound like you have confidence to keep that B . . . Why?"

"Before, the teachers I had—you may think this is a cop out . . . I said look I'm doing what I should be doing—the teachers just don't like me, I don't know what the deal is . . . it wasn't me . . . I might be able to keep it . . . this teacher puts it across . . . he cracks a joke . . . I'm not a teacher's pet . . . I just listen."

(C) "Sounds to me like your relationship with the teacher is important in how well you do in math. Am I right about that?"

"Pretty much so I guess"

(C) "Do you think that's different than for anyone else?"

"I don't know" . . .

Session Four (1:10 class):

(C) "Today we're going to deal with relaxation and how you feel about tests. How did you feel when you took the test? Did you feel anxious or nervous?"

"We were worried about it 'cause the kids who had the class before us said that the test was going to be hard . . . it wasn't." . . .

(C) "What did you do when you felt worried about it?"

"Well, if I pass it alright—if not—ok."

(C) "That's what you told yourself? . . . How did you spend the last hour before the test? Did you read the book?" . . .

"I didn't want to listen to the others talking about it (the test)."

(C) "How did you prepare for the test? . . ."

"I wasn't nervous, I was familiar with the material—I felt confident . . . I paid attention in class" . . .

"I didn't even know were had a test" . . .

(C) "How did you feel before the test . . . 10 would be that you are so nervous you can't think and a one would be cream—where would you all rate yourselves?"

"3" "1" "5" "5" "7"

"I thought I knew most of it" . . .

"Two girls are really smart and I heard them say it was hard so I said, oh no, here I go"

(C) "How would you psych out your competition?"

"Oh, this was so hard, there's no way anyone could pass this" . . .

(C) "Did you think your nervousness had something to do with your rating of 7?"

"I think that had something to do with it—just the word test—ugh—. . ."

(C) "Can you think of any ways you could get your anxiety down? . . . Do you know what cognitive means? . . . If you think of yourself as a computer, those are cognitive human processes. What you do when you're thinking, using your memory and things like that. The affective parts of your mind, for the most part, it's the same as your feelings, it's emotions . . . Cognitive strategy for dealing with test anxiety would be when you're telling yourself things, cognitive activities, not emotions . . . it's thinking . . . what you tell yourself. You said you tell yourself the test isn't all that important and you can only do what you can do, is that right?"

"I just say, do your best. That's all you can ask of yourself." . . .

(C) "That helps you not to feel so anxious . . . what would be some other things you could tell yourself?" . . .

"I can't tell myself nothing—I can't forget about the test no matter what I say to myself . . ."

"It's just a test"

(C) "This is not a test of my right to be a human being . . ."

"I can't think of anything"

"I tell myself that it is important—I tell myself how important it is instead of how important it isn't." . . .

(C) "Does that keep you psyched up?"

"Yeh, it keeps me reviewing the material. Instead of worrying, I go over the stuff . . . I couldn't tell myself it wasn't important—I'd probably tell myself everything wasn't important." . . .

"You need to keep things in prospective—to know what's important and not to get anxious about it—that's what's important . . ."

(C) "I'll tell you what I see as the danger. The test may be important, but when you lose your perspective you feel it's a test of your integrity or your intelligence. I think that's when people start putting too much importance on it. They think not doing well says an awful lot of bad things about them. All it says, is that you didn't do well on this test . . . but you think you're worth less . . . A first rule for keeping anxiety down is to be prepared . . . I'm just going to relax. I don't know about the other people in class, but I'm prepared for this . . . If you come to one you can't do, hum, I'll come back to that, I forgot it right now . . . I'll go on 'cause I'm prepared . . . Today, we'll work on Behavioral activities, relaxation . . ."

(After the relaxation exercises, Appendix C)

(C) "I'd like to hear about your trips."

"I was walking toward a lake . . . I pushed the wall over. I just touched it and it fell."

(C) "Did you just use your abilities? What was your first reaction?"

"I just didn't want to be blocked . . . the wall was just like a nuisance."

(C) "Obviously, it wasn't going to hold you back."

"I wondered what the wall was doing there."

(C) "Did you think about how you would get to the other side?"

"Yes . . . should I go around it, or go over it" . . .

"I pictured the wall as going as far as I could see. I found a tree, I think of the weirdest things, I swung over on a vine . . . I first thought, Oh no! But I looked around and found my vine. At first I thought I would go around, but that sounded too easy. Then you said it went on." . . .

"Who put that there? I didn't know any reason for it to be there. The road was sort of dry out between these two banks. Actually, it was right down from my house. I just climbed up the bank. First I looked for a trap door. I thought there should be a trap door. If I pushed the right brick, the door would swing open. But I ended up going around it."

(C) "That's not unusual to be looking for a door . . . Remember how you felt, did you feel trapped or stuck when you first saw the obstacle?"

"I was just irritated. I wanted to get where I was going and that was just a nuisance and it shouldn't be there. I was kind of mad 'cause I felt someone had just put that there in front of me" . . .

"Mine was weird—I didn't want to talk about it."

(C) "You don't have to if you don't want to—I think everyone thinks theirs is weird because it's his own."

"I was on my way and it was in my way, so I blew it up!"

(C) "Where did you get the stuff?"

"I had it with me."

(C) "Had you been carrying it with you all the way on the first part of the trip?"

"No, I just had it."

(C) "After you got to the wall, you just realized you had it?"

"Yeh, I blew it up . . . I was fascinated by it when I first saw it." . . .

(C) "You all used different ways to deal with this obstacle . . . They were all imaginative strategies . . . When you aren't completely overwhelmed with the obstacle to begin with, there are lots of ways to get around them . . . It's too bad we don't teach the amazing ways the human mind has of dealing with obstacles . . . The mind is a great resource for dealing with obstacles." . . .

Session Five (11:15 class):

(C) "Let's talk about the math autobiography. Have you been doing them? What've you been learning from them?"

"What is there to learn? —You just write down facts."

(C) "Right, the idea is . . . no person comes out a certain way without the experiences you've had in the past . . . Your experience as a football player affects how you perform now . . . how you play and whether you enjoy it or not. Your history will be different than mine . . . The idea here is to look at some of the high points and some of the low points of significant things, your own personal history of mathematics and to see how they affected you. Sometimes understanding that helps to free you to do things differently if you want to . . . You're saying you've noticed changes, what do you mean?"

"Well, when I first started out I didn't realize it was important and as you get older you realize it is. Some people, when they see how important it is, they get nervous and other people just take it all in stride and it doesn't phase them."

(C) "What you're saying is true of most things . . . When you're little, you don't do so much thinking for yourself. Everything's given to you and you're told what to do and you kind of just do it. It's more automatic. When you're older, you develop a capacity to think about what you're doing. As you begin thinking about it, it becomes important to you . . . As you get older, you do things 'cause that's what you want. The same is true of mathematics. You've been saying in here, you don't know if this is relevant to my life. Five years ago you probably started thinking about this for yourself. . . . In your specific autobiography, what changes have you become aware of?"

"As time went on, . . . now it doesn't bother me so much anymore . . ."

(C) "Remember as best you can . . . describe some of your earliest math memories in school or out . . . (Appendix C)."

"I was in elementary school . . . You felt you were learning something real important . . . felt grown up."

(C) "That's changed?"

"Yes, . . . you really didn't see the importance of it in everyday life, everywhere you go, you have to add and subtract . . ."

(C) "What about when you look at things you don't know now . . ."

"It doesn't bother me now, you just have to learn it. There's nothing to get anxious about . . . There's a challenge to learning something and understanding it. It's really a challenge to go on to something like that."

(C) "When you finish this course you're taking right now, are you going to feel any sense of accomplishment, or is it something else done and out of the way?"

"For me it was just something done and out of the way. I had it in high school. For someone first enrolled in it, they might feel it's a big step . . . This I had before and I did okay, this was review. It's still nice to say you've finished it and got a good grade in it. It isn't like I'm doing something really hard."

(C) "Are you going to go on and take more math?"

"Yes. I'm taking precalc and calc . . . I'm up to a challenge . . . something new . . . an accomplishment."

"I couldn't understand my teacher's accent . . . fourth grade . . . advanced 2 + 2 . . . he always picked on me, sent me to the board—I hated that . . . I got picked on 'cause I was largest . . . I don't remember too much, just having to go" . . .

"In second grade we had to count in front of the class. I felt nervous. You worried you might leave out a number here or there . . . Everyone had to do it, volunteers went first." . . .

(C) "When you ask people to remember things, they remember the important things, the things that stand out. You can't remember all of everything . . . There's usually something about the things you do

remember . . . in short, you remember things that are significant to you . . . What was positive?"

"The thrill of learning something new" . . .

"Learning how to swim—especially if they throw you in the pool and say swim or drown." . . .

"My experience was negative. I didn't like what I was doing . . . the teacher . . . I didn't say it wasn't the math itself . . . I hate math. It was the teacher . . . My second grade teacher had a room on the second floor. There was a flagpole outside the window. She always threatened people she was going to go outside and hang them by their toenails from that flagpole. By your ears or toenails. I didn't like her too much."

(C) "When you start talking about math the things that come to your mind are teachers and teachers you didn't like. They made the math classroom an unpleasant place to be in. Now you're going to generalize those feelings to math. Do you understand what I'm saying?"

"Umhum"

(C) "When you're learning from someone you don't like and someone who's giving you a hard time, you're not going to like what you're learning. It's not the material itself, that's bad. It's the teacher that you're not getting along with." . . .

"My memory is unpleasant 'cause it was so boring and repetitious . . . I was nervous" . . .

(C) "Peoples earliest experiences influence their later experiences. Do you guys buy that?" . . .

"That affects your feelings not the thing itself . . . I didn't listen so I didn't learn . . . you'd be more cautious when you're older" . . .

(C) "Childhood experiences have incredible influences on us . . . There's a normal fear, respect, you should have that. When you go way beyond what's normal, that's a phobia . . . Do you understand what all this has to do with math and your math autobiographies?"

"Since _____ had good experiences, he has good feelings. Me, I hate math, always have and probably always will . . . I don't know, I don't mind it so much. Maybe it's my past experiences."

"I just don't see math in my future. I'm not going to take it if I don't have to for my major . . . Sometimes I'm positive and sometimes I'm negative . . . I'll balance my checkbook." . . .

(C) "Overall, now, when you think about math, is it negative or positive?"

"It's positive, it's helped me a lot."

"I'm only here in math 'cause I have to be—I'd be in accounting now." . . .

"Everybody's different . . . bad experiences when younger may not affect someone."

(C) "Bad experiences in early life doesn't doom one to have bad experiences in the rest of their life. It leans people—depends on what happens in between. . . . If you've had success, the ability must be there, maybe you need to work harder" . . .

Session Six (1:10 class):

"They got 90 and 95 on the test"

(C) "90 and 95?"

"I think I got at least a B."

(C) "You sound confident about it" . . .

"I got my midterm grades"

"I got brave, I signed up for 2 more classes in math"

(C) "Takes courage. That reminds me of how appropriate it would have been to discuss the Wizard of Oz . . . people went looking for things they already had—remember—they already had all the things—they just didn't know it . . . This is all good news."

"I got 89.8, I figured it out!" . . .

(C) "I'm impressed with how similar some members of your families sound to you . . . Abilities don't get passed on that way, you have to work . . . How about in a family where they saw themselves as not very good mathematicians—what affect would this have on someone?"

"However I do is fine."

(C) "What could be a disadvantage of having a family that didn't do very well and expected you to do well?"

"You might avoid math and not take it . . . maybe there's some field you wanted to go into and math was required for it and you might just avoid it because you said 'I can't do math'." . . .

(C) "What about in a family that was pretty good and the person was pretty good and the family communicated a lot of high expectations about that person—can any of you think of anything beneficial that might come out of that?"

"The person might want to try to do as good as his family—he'd try harder and he could depend on his family to help him along." . . .

"What attitude do you think prevails most often? Do people feel pressured more or motivated more?"

(C) "It's all different in different families. All the different combinations are possible . . . If you could have a family situation anyway you wanted it so that you could develop yourself anyway you wanted, what would it be like?"

"I'd like mine a little more average, their expectations are a little too high—some of them forgot to consider how they (the student) feel."

"I agree with that. I would like something to be expected of me, but not too much—they expect quite a bit."

"If my family expected any less of me, I don't think I'd try at all" . . .

(C) "Is there any value in doing a problem and not getting it exactly right?"

"You can learn from your mistakes"

(C) "Yeh, you learn what you can't do and then you go and learn from it. Just 'cause your answer isn't exactly right, doesn't mean you wasted your time. . . . You may have done lots of things in the process that were right." . . .

(C) "Rate how helpful this group has been to you, in math, only in math. Give the reason for your rating . . . How has this group been helpful in nonmath ways? . . . If any of you are interested in having another group, let me know . . . that's it . . ."

"Could we meet again?" . . .

"Will this go on Winter term?"

"I've enjoyed this."

"Wave your psychology book in my face" . . .

Session Seven (1:10 class):

(C) "How was math class?"

"It stinks"

(C) "Anything else?"

"It stinks"

(C) "What's the matter?"

"It always stinks."

(C) "You got your test back?" . . .

"78 . . . it's not that bad . . . I got 20 out of 20 on my quiz" . . .

"14 out of 20"

(C) "Did you have something you wanted to do?"

"Let's leave the math out" . . .

(C) "You've mentioned that you have some apprehension about the next math you are going to take . . . What are you worried about?"

"I get the feeling I'm not going to do good" . . .

"We've had Algebra before" . . .

"I'm scared to death, I've just gotten used to this and I've had my little extra surge of confidence. I'm going to be losing it now" . . .

(C) "I get the impression everyone thinks there's something entirely different after this course is over. Why is that?"

"Same teacher"

"Different teacher"

(C) "What is going to be so different? . . . You talk about it as though you were going to be walking into another world."

"It is"

"It is"

(C) "Why?"

"A different kind of math"

"We've heard of a lot of the things we're having now . . . some of the names of the new things sound so hard, it's intimidating" . . .

(C) "What are some of the words? . . . It sounds hard . . . Every profession has it's own jargon . . . Excludes people not in that profession" . . .

(C) "What's making you afraid? . . . List . . . teachers, new room, new friends (+ and -) . . . What's the same? Teacher, principles, concepts, and language . . . What it is, is what you make it into . . . You're going to project onto the new things, what's already in you . . . What do you expect?"

"Teacher will be incompetent, inhuman, and will write with chalk in his feet."

"The new teacher won't understand"

"I arranged to have the same teacher 'cause of all these things" . . .

(C) "You're making this much more difficult than it really is. . . . Does this remind you of an exercise we did?

"Yes"

(C) "Do you see how unrealistic this . . . You'll self-fulfill your prophecy. Has your teacher been that way?"

"No, he's an exception."

(C) "And where there's one, there'll be others . . . See what's really there . . . What could be done about this?"

"We could make an effort."

(C) "Good idea! Tell me about this class . . . Your friends . . . do you feel connected to your class? When you first came in you may never have seen each other—what were your first thoughts?" . . .

(C) "It's normal to be apprehensive, but I'm trying to show you that it's in your own power to change. The apprehension may not be reality. It may not be comfortable to change . . . You're making your own mess . . . Everyone in here is smart enough to pass . . . You need to let it be something different. Are you feeling bad, angry . . ."

"I don't think you're wrong"

"Truth sometimes makes people mad"

(C) "I was telling another teacher about what we were doing here and he said it's amazing how hostile the students are and that they don't want to learn . . . It takes two . . . if you expect a certain behavior, you'll usually get it." . . .

(C) "That's the end of our time—thanks for coming" . . .

"Someday we'll track you down"

(C) "Good luck"

"Bye"

"Bye"

VITA

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From 1961 to 1964 she taught mathematics at Williamston High School, Williamston, Michigan. In 1964, she moved to Knoxville, Tennessee, and taught at Farragut High School, Webb School of Knoxville and The University of Tennessee Evening School. In 1976 she accepted a graduate teaching assistantship in the Mathematics Department at The University of Tennessee and completed course work for the ED.D. degree in Curriculum and Instruction with an emphasis in Mathematics Education. From the Fall of 1980 to the present, she has been a part-time instructor of Mathematics at Maryville College, Maryville, Tennessee.

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Barbara is married to Leonard Handler of Brooklyn, New York, and they have two children, Charles Andrew and Amy Elisabeth.