REDUCTION OF MATH ANXIETY IN
JUNIOR HIGH SCHOOL STUDENTS
THROUGH SELF-INSTRUCTIONAL PROCEDURES

A Thesis

Presented in Partial Fulfillment of the
Requirements for the Degree Master of Arts

by

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This thesis is dedicated to my cat Purrrl; she spent more time "on" it than I did. It's amazing how enlivening a wet nose in the face can be.
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CHAPTER I
REVIEW OF LITERATURE

The conspicuous lack of women in mathematical careers is a phenomena which has continued despite attempts to raise awareness that women are an untapped force in many career areas. During 1972 to 1975, less than 10% of the Ph.D.'s were earned by women in the math oriented subjects such as business administration, computer science, geology, engineering, and applied mathematics (Ernest, 1976). In response to this phenomena, researchers such as Levine and Rowlings (1977) have spent much time trying to extract those factors relating to qualified females' non-pursuance of mathematically oriented careers. Most blatantly exists the factor of inadequate mathematical background for most women.

Fundamentally, lack of educational preparation in secondary schools would seem to be the immediate cause of women's scarcity in math-oriented careers. If females do not have adequate background in mathematics, it becomes difficult to pursue subjects requiring math training, unless the individual is interested in returning to school or in flooding their schedule with prerequisite math courses upon entering college. Ernest (1976) noted that at Berkeley in 1972, a systematic random sample of freshmen revealed that 57% of the males had taken four full years of math in high school while only 8% of the females had taken such a sequence. He also found that in the fall of 1973 at the University of California at Santa Barbara, 36% of the freshmen men had four years of
high school math in their background as compared to 16% of the women, still a statistically significant difference. It appears that once women have the option of taking math courses as opposed to taking them as requirements, they more often elect to drop math from their schedule.

Attitudes and Mathematics Achievement

An interesting point is that math is not necessarily one of the most popular subjects for either sex. For example, Dutton & Blume's study (1968) of 346 sixth through eighth graders revealed that 53% were merely neutral towards math and 17% avidly disliked it. For both females and males it becomes more unpopular in high school and is reported as generally being disliked about the same by both (Ernes, 1976; Callahan, 1971). It has been suggested then that perhaps men take math not because it is a favorite subject but because they realize it is necessary for future careers (Aiken, 1961). In support for this proposition are several studies which have shown that males' attitudes toward math do not significantly relate to their achievement scores. Unfortunately, females' feelings of anxiety towards math can affect their achievement (Aiken, 1961; Fennema, 1974b). These results suggest that men who opt to take math courses may succeed despite less than positive feelings. On the other hand, females often do not recognize the usefulness of math in their life plans and therefore may see no reason for high achievement in that subject area (Fennema and Sherman, 1977).

Antonnen (1969) investigated the relationship of math attitude and math achievement over a six year period, comparing fifth and sixth graders to eleventh and twelfth graders. He found that there are higher
correlations between secondary attitude scores and secondary math
achievement, than for elementary. Attitudes become a more important
factor with older students and also more highly significant for males
than for females. Examination of Antonen’s study suggests that perhaps
it is incorrect to conclude that males’ attitudes towards math do not
affect their achievement scores. Instead the studies’ results may be
dependent on which attitudes were tapped -- those which affect achieve-
ment and those which do not. Other factors may also be playing into
the results such as the conclusion found in Aiken’s study (1970) that
middle range attitude scores do not predict achievement. Only at the
extremes of highly positive or highly negative attitudes do scores
significantly affect achievement.

Neal (1969) suggests that what is needed to provide support for
attitude-achievement correlations are time span studies with pre and
post measures. Most studies have measured both attitude and achievement
at the same time and therefore do not differentiate if attitudes
affected learning and achievement or if learning provided positive
experiences and thus affected attitudes (Neal, 1969; Aiken, 1970; Elton
& Rose, 1967).

Fox (1977) reports that when sex differences in math achievement
did occur, they usually became evident at grade eight or nine and that
no significant differences are found in the elementary years (Fennema
& Sherman, 1977). However, she notes that in examining studies with
these results, females are compared to males who have continued to take
math courses while the high school girls have not. Fox feels this
factor points out that differences in achievement are due to differ-
ential course taking rather than any inability on the part of females to do mathematics.

**Biological Factors**

Possible biological causes for differential ability or achievement have been investigated. Although positive identification of a genetic or biological source have not been proven, spatial visualization is one area which has continued to emerge in the literature as the most significant intellectual difference between males and females (Fennema, 1974; Maccoy & Jacklin, 1974). Several explanations have been suggested for this factor.

**Spatiality**

Sherman (1977) found in reviewing the literature that evidence was weak or non-existent for hypotheses such as spatiality as an X-linked characteristic or the inheritance of spatial visualization and/or problem solving abilities. However, she found one hypothesis which received supporting evidence, that of earlier left cerebral dominance in females than males. The left cerebrum is linked to verbal, analytic learning modes as opposed to the right cerebrum which is associated with spatial-gestalt modes of learning. Sherman suggests that early reliance and development of left cerebral functions may overshadow the use of the right cerebrum and thus hamper development of math learning which has a strong spatial visualization component. In contrast to the cerebral development theory, spatial visualization may be dependent on the environment, with sex stereotypic roles dictating the amount of experience and therefore the growth in this area. For example, manipulative activities and athletics require more spatial judgement than homemaking
activities in children's play. Sherman notes that perhaps spatial visualization is an area which could be developed through training, but that further research is needed to fully understand its emergence in males and females.

Computational Ability Versus Reasoning

A second area of intellectual differentiation between males and females which has emerged with more solid results is that females excel in computational math and males in mathematical reasoning (Fennema, 1974a; Fennema, 1974b; Fennema & Sherman, 1977; Maccoby & Jacklin, 1966; Sherman, 1971). Again, no genetic source has been proven in relation to these abilities. However, Fennema's review of the literature revealed that when mathematical ability differences did occur between the sexes, the studies' results tended to support boys as being more capable in higher level cognitive skills such as comprehension and analysis, while girls excelled in lower level cognitive tasks such as computation. As discussed earlier in relation to achievement, the difference could be due to that fact that females do not take math courses as often as males once they become electives (Fennema, 1974a), and thus do not have the background for higher cognitive mathematical skills. In Callahan's study of 366 eighth graders, females showed a much stronger dislike for word problems that did the male students. Fennema and Sherman's study (1977) revealed that females had a lack of confidence in their ability to problem solve. These studies leave open to interpretation whether the attitudes are a result of inability or a cause preventing success. This remains, therefore, an unconcluded area of study with more information needed to determine any biological sources.
It appears that the search for proof of a genetic or biological source of differences in mathematical abilities between males and females has resulted in studies which are at best inconclusive. The differences themselves stemming from ability appear to be negligible. Fox (1977) suggests that social factors are of major significance in males' and females' math achievement. Studies on the myriad of social factors will therefore be reviewed next to determine any possible sources for differential mathematics abilities in the sexes.

**Social Factors**

**Male Domain and Peer Pressure**

Differences in attitudes towards the learning of mathematics (i.e. viewing math as a male's domain) have been cited as due to the effects of various social factors such as peer pressures, attitudes of significant others, and sex role expectancies (Levine & Rowing, 1977; Maccoby & Jacklin, 1966; Fox, 1977; Broverman et al., 1972, Aiken, 1972; Sherman, 1976; Horner, 1972; Fox, Fennema & Sherman, 1971; Fennema & Sherman, 1979). It has generally been documented that the differences in mathematics achievement and attitude emerge in the junior high school years and increase through high school. Females tend to avoid higher mathematics at that time, treating it as if it were a male domain. Male adolescents also tend to verbally stereotype higher level mathematics as a male domain at that time creating peer pressure to conform (Fox, 1977; Fennema & Sherman, 1977; Maccoby & Jacklin, 1966).

Lack of reinforcement for females who do achieve in math may also act as a deterrent. Fox (1977) noted that adolescent females often report receiving no positive reinforcement from teachers or parents when
they performed well in math classes. Fennema & Sherman (1977) proposed that females students do not choose to study mathematics to the same degree that they do neutral or female domains. The study of higher mathematics is not viewed as an appropriate activity or as useful for future plans.

Several studies have shown that women incur conflicts between a homemaking role and a career. Professionals, especially men, view negatively a woman who attempts to fulfill both roles (Fox, Fennema & Sherman, 1971). As a result, women have a lack of experience in their youth with the expectancies of a career and a lack of exposure to career role models. This is especially true in the field of mathematics with so few women graduating with higher degrees in math oriented fields. (Ernest, 1975).

Discrimination

Levine & Rowlwing's (1977) study found that although fourth grade students were not aware of discrimination towards the sexes in mathematics, high school girls and some college sophomores were very aware of peer pressure and prejudice by counselors, teachers, and parents. Those college sophomores who reported discrimination were interested in mathematical careers as opposed to students enrolled in traditionally female dominated fields such as nursing and speech pathology, who were relatively unaware of any discrimination towards them. A survey of female mathematicians revealed that they had incurred numerous instances of discrimination, increasing in frequency through graduate schools and academic careers. An interesting point is that these women related that as students opting to go on in mathematics, they also had sources of
encouragement in particular teachers, and in parents and husbands.

Parents

The literature reveals conflicting reports as to the effect parents have on students's feelings towards mathematics. Sherman (1971) conducted a study on 2000 midwestern public school students in grades six through twelve. When the students were rated on their perceived parental attitudes towards themselves as learners of mathematics, more positive attitudes towards boys, especially at the high school level, were found. Both male and female students perceived their fathers as being more encouraging towards the study of mathematics than their mothers.

Sherman (1971) also found socio-economic family levels to be a factor in females' attitudes towards mathematics. At the high school level, low socio-economic females' attitudes towards mathematics were more positive than males. However, at the high socio-economic levels, females were less positive towards mathematical success than males. Unfortunately, as Sherman comments, students from high socio-economic levels are more apt to go on for further training and more able to finance future education.

Broverman et al (1972) reports that sex role perceptions vary as a function of the mother's employment status. Male college students viewed the competency of women the same regardless of whether their mothers had never been employed or were currently employed. Females whose mothers were working, however, perceived women to be more competent than did daughters of homemakers. Broverman concludes by stating that attitudes can be changed, subject to variations in an indi-
vidual's experiences. This study also has obvious implications as far as the effect of parents exposing their daughters to varied and positive females role models. It suggests that females' attitudes can be affected and changed by the home environment, particularly by the role models provided by the mother.

Maccoby (1966) contradicted the theory that females' identifying and modeling of the same sex parent affects their academic achievement and attitudes. As proof, she quotes a study showing that underachieving female high school students usually begin to do so at puberty while underachieving high school males do so at an earlier age. The females are reacting to sex-typed interests, especially those relating to future career goals. Maccoby's conclusion would seem to be unfounded, however. Girls may learn female sex-typed interests by using their mothers as one source of information on the topic or as a role model. In support of this position, Ernest (1976) reveals that mothers help in mathematics in the lower grades. However beginning sixth or seventh grade, fathers consistently help their children more in math. Ernest notes that

"This fact alone must have a subtle influence on a young girl's (or boy's) attitude" (p.4)

Teacher Influence

Teacher influence on students' attitudes towards mathematics is one area of school which affects achievement and confidence. Aiken (1972) found that negative attitudes in both males and females were significantly related to negative demanding attitudes by teachers. Conversely, positive attitudes toward math were associated with positive attitudes
toward the teachers. However, this association did not always carry over for the girls and they were able to have positive attitudes towards their teachers without positive attitudes towards mathematics. Ernest (1976) found when sampling a number of teachers, that 14% felt boys do better in mathematics than girls. None of the teachers felt that girls performed better in math than boys. However, not all studies have concluded with similar results. Fennema and Sherman (1976) studied teachers' views on students and found that their attitudes were significantly related to the students' intentions to take more math courses and not to the students' sexes.

Several researchers have suggested that a little teacher encouragement may go a long way towards improving females' attitudes towards mathematics. In Levine & Rowling's survey (1977) female mathematicians claimed teacher and parent support for their mathematical endeavors. Ernest (1976) discusses the results of professor encouragement on campuses. He notes Professor Joan Birman's success at Bernard-Columbia, encouraging females to try a competitive exam for an honors calculus course. The previously all male course consisted of 5 males and 5 females the next year due to her efforts. Ernest also cites his own experience of encouraging women to enroll for an honors calculus course with positive results of 3 out of 9 students being female in the 1972 class. It would appear from these studies that female participation could be increased to some degree by simple encouragement and enthusiasm on the part of teachers with whom they come in contact.

Courses and clinics have been opened at the college level providing encouragement and aid in overcoming fears and blocks towards mathematics
(Ernest, 1976). For example, the University of California at Santa Barbara conducts a weekly tutoring session, Wesleyan has a math anxiety clinic, Wells College has remodeled work shops and precalculus courses in order to diagnose problems and encourage students, and the University of Missouri holds precalculus courses designed to help women succeed in math, augmented by counseling and tutoring. As noted in this sample of schools, methodological approaches differ as well as their theoretical matrices of what the underlying problems actually consist.

Math Anxiety

The condition of math anxiety has several definitions dependent on the source, and has been known by other labels such as "mathe- maphobia", and "number anxiety" (Rounds and Hindel, 1980). As a result, it has been difficult to cross-reference studies and to devise test instruments because several opinions exist as to what the construct actually entails (Rounds and Hindel, 1900). Richardson and Suinn (1972) have created a definition of the construct, however, which seems adequate for this study.

"Mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations."

(p. 501)

Math Anxiety and Academic Performance

What are the effects of math anxiety on academic performance? Researchers have suggested that it may block students from taking advanced courses in math and science or from even passing fundamental
mathematics courses due to poor performance. Avoidance of mathematics may be a result (Richardson and Suinn, 1972; Aiken, 1970; 1976; Fox, Fennema and Sherman, 1977). One study by Peterson (1977) on 130 ninth graders supported the hypothesis that anxious students with low ability do better in less demanding academic situations. High anxiety/high ability students, though, were able to meet the demands of a high structure/high participation environment. Thus low ability students found their anxiety to be much more of an academic deterrent than did high ability students.

Factors Associated with Math Anxiety

Some recent studies have tried to delineate many of the factors associated with math anxiety, rather than trying to prove sources of the anxiety.

One study conducted by Betz (1977) suggested that a major factor affecting mathematics achievement is anxiety towards the subject and notes that math anxiety occurs frequently among college students. The results of studying 655 college students at Ohio State University showed that higher levels of math anxiety were related to low math achievement scores and high test and trait anxiety. Math anxiety was more likely to occur among women than men and among students with inadequate high school math backgrounds. Students who had lower levels of anxiety reported more confidence in their mathematical learning ability. Fennema (1977) confirmed this result by reporting that anxiety and confidence are generally described as separate traits. However, in relation to mathematics, they highly correlate with high anxiety being accompanied by low confidence \( r = .89 \). Betz (1977)
also described high correlations of .73 to .83 from her research in this area. She then suggested test anxiety as another factor with moderate correlations of .42 to .65 with math anxiety. Betz concluded that since evaluation is a part of taking math courses, test anxiety would certainly be a related condition.

Although factors associated with math anxiety need more investigation, methods have emerged which successfully deal with academic anxiety. In working with college students, desensitization has been most popularly used to counteract test anxiety (Meichenbaum, 1972; Swinn, 1968; Wine, 1971; Hyman, 1973; Nash, 1970). Desensitization has also been used in a math anxiety reduction project (Crumpton, 1977). However, two of these studies report that the task oriented procedures were more fruitful than the desensitization itself (Crumpton, 1977; Wine, 1971) and one reported no significant results (Nash, 1973).

Self-instructional Strategies

A more recently utilized method of dealing with anxiety is cognitive modification, used to help test anxious college students attend to relative task behavior in lieu of attending to intrusive, emotional thoughts which interfere with performance (Meichenbaum, 1972). Meichenbaum developed this method of cognitive modification into a process called cognitive self-guidance or self-instructional training. He has used it successfully with schizophrenic patients and as a way of developing self-control in impulsive children (Meichenbaum and Cameron, 1973; Meichenbaum and Goodman, 1971). The subjects learned to modify their behavior by giving themselves step by step instructions
and reinforcement as they progressed with a task (Meichenbaum and Goodman, 1971; Meichenbaum and Cameron, 1973; Meichenbaum, 1975; Meichenbaum, 1979). A study by Genshaft (1979) with seventh grade females finished with positive results from utilizing self-instructional training with math anxiety. These junior high girls were underachievers in mathematics and were showing signs of math anxiety and lack of confidence in their ability to deal with math. The students showed significant progress in their math achievement and changed to more favorable attitudes towards mathematics by the end of the project.

Meichenbaum (1975) also used modification of self-statements to enhance creativity in college students. In this study, a self-instructional training group was compared to a group receiving Gindillen's focusing training and to an untreated control group. Results showed that the group with focusing training reported more feelings of creativity but did not score highly on creativity performance measures. The self-instruction group, on the other hand, had modified both self-perceptions as being more creative and creative performance scoring higher in that area.

Meichenbaum's methodology in the creativity study (1975) provided portions of the basic pattern used in the current project. Initial sessions in his study dealt with discussions of feelings and thoughts experienced during the preassessment situation. Next they attended to the effects that negative self-statements would have on creativity, helping the subjects to become aware of their own negative self-statements. These negative statements would henceforth act as cues or dis-
criminative stimuli for emitting incompatible positive self-statements. Subsequent sessions centered on development and rehearsal of each person’s individual set of self-statements. Training ended after discussions were held on extending self-statements to new situations.

One study investigated the effects of self directed behavior-modification on locus of control or feelings of internal versus external control (Pawlicki, 1976). The modification training for this group consisted of self-observation, self-reinforcement, and alternative response training. As compared to an untreated control group, the self-instructional group showed a substantially greater move toward internal feelings of control. Pawlicki noted that future studies should include a control group centered in the course of study, where change in attitude would be expected as a function of the course. Then possible placebo expectancy results could be examined for the group undergoing training, with both of these groups, compared to an untreated control.

Rationale

The present study was undertaken because, although mathematics anxiety is being dealt with to some degree at the university level with clinics and scholastic projects (Ernest, 1976), little has been done with females at the junior high level. Adolescence has been shown to be the time at which females begin to underachieve (Macoby, 1966). It is also the time when steps need to be taken to improve females' attitudes towards math, before the courses become optional and they elect not to take further mathematics classes. Few studies have been done on the modification of math anxiety in junior high
girls, yet this would seem to be the first step in preventing potential students from short cutting their future prospects. The target population was therefore chosen from girls attending ninth grade mathematics classes in a public junior high school.

**Hypotheses to be investigated**

This study was designed to train students in self-instructional procedures. The training would aid them to overcome negative attitudes and anxiety toward math and help them to learn a more positive approach. The step by step process learned for dealing with the subject of math included self-reinforcement which was to result in less anxiety and more profitable encounters with math problems. Tutoring in mathematics was also a major part of the design. Since anxiety and hesitancy to encounter math are often related to poor math background and less achievement, helping the girls become more competent in their math skills should then both affect their performance as seen in achievement scores and affect their anxiety levels. Math attitude scores should also rise in a positive direction in response. Some improvement in their Preference Pattern ranks would be probable. Also, the subjects' locus of control scores would indicate change in the direction of internal control as opposed to former feelings of external control.

The basic hypotheses studied with this student population are as follows:

1. There will be a significant improvement in the Mathematics Instructional Tests achievement scores for females who undergo self-instructional training.
2. There will be a significant improvement of math attitudes on the Revised version of Fennema-Sherman Mathematics Attitude Scales by females who have self-instructional training.

3. There will be a significant change from externally to internally perceived locus of control as seen by scores on the Locus of Control Scale for Children by students who are given self-instructional training.

4. There will be significant improvement of Fennema and Sherman's Math Anxiety Scale by those females who have self-instructional training.

5. There will be a significant improvement on the Math Anxiety Thermometer scores indicating less anxiety for females who are given self-instructional training.

6. There will be significant improvement on the Preference Pattern for Mathematics Scale for those females who have received self-instructional training.
CHAPTER II
METHODOLOGY

Subjects
Seventeen (17) female students enrolled in ninth grade general mathematics and pre-algebra classes participated in the study. All subjects attended the same Columbus City junior high school and included students of varied ethnic and socio-economic backgrounds. The mean age of the girls at the beginning of the study was 14 years, 5 months, and 14 days.

The girls were chosen on the basis of high scores on Fennema and Sherman’s Math Anxiety Scale (within the upper 2/5 of the scale with higher scores being related to greater anxiety) and high scores on a Math Anxiety Thermometer (within the upper half of the scale with higher scores related to greater anxiety). Intelligence was indirectly controlled for by selecting students with average standard achievement scores in mathematics and English (4th - 6th stanines) as shown from previously administered group testing with the California Achievement Tests (1970).

The subjects were randomly assigned to one of three groups, two groups containing 6 students each and one group of 5 students. Group I (5 students) received tutoring in mathematics using sequenced materials and self-instructional training. Group II (6 students) received
tutoring in mathematics using the sequenced materials. Group III (5 students) was an untreated control involved in pre and post measurements in addition to the first two groups.

Materials

Seven (7) pre and post measures were employed, all of which were paper and pencil instruments and six of which were self-report measures (See Appendix). One measure was used merely for subject selection (item 1).

1. California Achievement Tests: California Reading Test and California Arithmetic Test (1970). Level 4, indicated for use with grades 6 through 9, was utilized for subject selection. Those students whose achievement scores fell within the fourth to sixth stanines, indicating average ability in math and reading, were considered. The Reading test consists of vocabulary and comprehension, and the Arithmetic test consists of comprehension, conceptualization, and application. These group administered test were taken by the students in either April of 1978 or April of 1979.

2. Mathematical Instructional Tests from the Metropolitan Achievement Tests (1978). The Advanced One, form JI which is suggested for grades seven through nine was used. The Problem Solving subtest, consisting of 6 orally administered questions and 18 questions read by the students, (24 total) was the only subtest employed due to time constraints and also due to the research conclusions that females don't tend to do as well on problem solving or higher cognitive pro-
cesses. Therefore, this area of mathematics would be of more interest for research with measured growth in problem solving possibly being a deterrent to students' math anxiety.

3. **Locus of Control Scale for Children** by Nowicki and Strickland (1972). This scale was designed to measure students' feelings of self (internal) versus other (external) control over their own performance outcome. Higher scores are associated with perceived external control and lower scores with internal control. Forth items are included in the scale resulting in a single numeric score. All 40 items are answered either yes or no.

4. **The Preference Pattern for Mathematics** by Ernest (1973). This is a ranked scale rating students' preferences for mathematics, science, social studies, and English. All students assign a number from one to four to each subject area depending on how well that subject is liked, with no duplication of numbers. A 1 stands for most preferred and a 4 stands for least preferred.

5. **Fennema and Sherman's Mathematics Attitude Scales** (1976). Four of the nine scales created by Fennema and Sherman were utilized in the study. Unlike the original scales which were arranged on a Likert type scale, the four scales utilized were revised to answered with either a yes or no response. Forty-eight items were included and a single numeric score was computed. A high score indicates greater feelings of anxiety in regards to math and reservations to-
ward computing mathematical problems. A low score indicates less anxiety or reservation.

The four scales are titled "Male Domain", "Confidence", "Effectance Motivation", and "Usefulness". "Male Domain" consists of 12 items which would help to reveal if the girls consider mathematics to be male associated (high score) or an area in which both sexes could participate without any sex designation attached (low score). The "Confidence" scale, consisting of 12 items, aids in revealing which students feel confident in their ability to do mathematics (low score) and which students feel that they just have no ability and therefore would probably not do well in math (high score). The "Effectance Motivation" scale, consisting of 12 items, was constructed to show how motivated students felt toward studying mathematics and persevering when faced with difficult math problems. High motivation is reflected in a low score and low motivation in a high score. The "Usefulness" scale was constructed of 12 items designed to reveal how useful students felt mathematics was for them presently and in the future in adult life. High scores indicate little perceived usefulness in mathematics and low scores indicate that math is seen as very useful.

This scale was designed to measure students' feelings of anxiety when faced with mathematics and of uncomfortableness when faced with mathematical problems. Twelve statements
were arranged on a five point Likert scale with a one indicating that the student strongly agrees with the statement and a five indicating that the student strongly disagrees with it. Questions are rated so that a high score represented high anxiety and a low score represented low math anxiety.

7. Revised version of Sarason's Test Anxiety Scale for Children (1960). This test was designed to measure a student's feelings of anxiety towards general testing situations in the school setting. The 30 questions are answered yes or no and yield a single numerical score with high scores representing high test anxiety. Several of the items were revised to make them more appropriate for a junior high school population as the original questions were written for grade school children. Words referring to the students as "boys and girls", for example, were changed to "students" and those items referring to subjects such as "reading" and "Arithmetic" were changed to "English" and "mathematics" respectively.

8. Math Anxiety Thermometer. This instrument is a graphic representation of a thermometer. Anxiety towards mathematics is recorded by placing a mark at that point in the scale which best represents the individual's anxiety level. Marks high on the thermometer stand for high anxiety, marks low on the scale stand for low anxiety. Each mark on the scale stands for one numerical score. Numbers can run from 0 to 100. (See Appendix).
In conjunction with the above mentioned pre and post measures, sequential instructional materials in basic mathematics were used in the tutoring sessions. Those math skills which were recommended by the head of the junior high mathematics department were focused upon. (See Appendix). The basic texts used in each class were employed as sources of instruction.

The approval of both the Human Subjects Committee at Ohio State University and of the Columbus City School's Research Committee was obtained before conducting the study.

Procedure

The seventeen females who fulfilled the requirements of enrollment in ninth grade mathematics classes, of normal achievement range, and of high math anxiety scores on the Fennema and Sherman scale and Anxiety Thermometer were administered the 5 remaining previously described pre instructional test instruments. The subjects were then randomly assigned to one of three groups, each group containing three general math and three pre-algebra students excepting the modified group which finished the program with three prealgebra students and two general math students.

Group three was an untreated control group which underwent pretesting during the first week and post-testing during the tenth week. Group two received pretesting the first week, post-testing the tenth week, and was sequentially tutored in math skills from week two to week nine. The first five minutes of each period was spent in general discussion, centering on events taking place at the junior high in the past week. Group one received pretesting in the first week, post-
testing in the tenth week, and was sequentially tutored in math skills from week two through week nine. The first five minutes of each session for these students was spent in self-instructional procedures. The girls essentially learned to verbalize instructions to themselves, helping to guide themselves through difficult problems with consequent self-reinforcement at the end of each sequence. They concurrently learned to cope with frustration and anxiety associated with mathematics. An example of self-verbalization might be: Take a problem bit by bit -

"one step at a time; you can handle the situation.
Relax, you're in control. It worked; you did it.
It wasn't as bad as you expected" (Meichenbaum, 1975, p. 371)

Tutorial sessions for mathematics and self-instructional training took place over a ten week period in winter and spring of 1980. All sessions were conducted during study hall periods. The girls were instructed twice a week in groups of one to four. Two persons were involved with administering pretest and posttest instruments; however, one person conducted all tutoring and instructional sessions.

A Schedule of Self-Instructional Procedures

Week one (see Appendix for introductory lectures). Session 1:
The overall purpose of the modification program was first explained to the students in an introductory lecture. A discussion was held on the topic of negative statements which the girls had heard other people make. The subjects then talked about negative statements which they felt had been using themselves. Session 2: A lecture on self-in-
strucional training was presented. Examples of possible negative self-statements were discussed and the faulty reasoning behind such statements. Positive self-statements which could be used in place of the negative were considered. (See Appendix)

Week two. Session 1: Examples of anxiety producing situations in the subjects' present math classes were discussed and the girls created positive self-statements which they would wish to tell themselves in those instances. A set of 10 positive self-statements was shown as an example of what the girls could produce for themselves. It was stressed that each set should be appropriate for the students' individual situations and that a statement of positive reinforcement for 'doing a good job' should close each set. Session 2: Each subject drew up a set of 10 positive self-instructional statements which they felt would be helpful to their particular needs in regards to mathematics. Each subject then read their statement set aloud to the group.

Week three. Each subject practiced their own list of self-instructional statements aloud several times each session. Discussions were held on the topic of possible anxiety producing situations (math exams, a list of difficult problems to do for homework, etc.) with self-instructional (S-I) statement sets as a way to talk themselves through the situations. Particular situations within mathematics which made each person the most uncomfortable (taking tests, solving word problems, etc.) were then compared.

Week four. Subjects were told to imagine a situation with mathematics which made them uncomfortable and then to repeat the S-I state-
ments aloud. Subjects were also instructed to use the S-I process whenever negative self-statements were emitted during the tutoring sessions or during class when they found themselves making negative statements about their ability to do math.

Week five. Subjects were told to memorize the sequence and only to glance at the cards if they needed to refresh their memory. They were again told to think of situations with mathematics that made them feel anxious and to then silently review the S-I statement sequences. Statements were recited aloud at the beginning of each session.

Week six. The subjects continued imagining anxiety producing incidents with mathematics while saying the S-I statements to themselves. A discussion was held on future course taking in mathematics and whether each subject intended to do so or not. The use of self-instructional statements was examined as a possible way to help the girls through their future courses.

Week seven. The subjects still practiced their S-I statements covertly. Different situations which made the girls anxious such as an approaching health test were discussed. The girls then wrote new self-instructional statements or modified their old ones to make the lists applicable to the different situations.

Week eight. Subjects continued silently rehearsing their S-I statements. A review of the self-instructional method and the steps each subject went through was given. Each subject described the S-I method in their own words to another subject in the group and gave examples of how it could be used, to demonstrate their understanding of the process.
Following the tutoring and self-instructional sessions, which extended for eight weeks, all seven post test measures (as previously described) were given to the two experimental groups and the one control group.
CHAPTER III
RESULTS

A Multivariate Analysis of Variance program was utilized to compute the statistics on all seven variables. They included mathematical problem solving (achievement), attitudes toward mathematics, test anxiety, math anxiety taken form a questionnaire measure and a graphic representation measure, locus of control, and preference ranking of subjects (including math). The Mann-Whitney U test was also used to provide statistics for the seventh variable, preference ranking. Effects of modification and tutoring (the independent variable) from pre to post testing were analyzed on all 7 measures.

Hypothesis 1

There will be a significant improvement in the Mathematics Instructional Tests achievement scores for females who undergo self-instructional training.

Means for pre and post testing by group and for the instructional measure itself are presented in Table 1. The changes from pre to post testing indicate that scores stayed approximately the same or decreased slightly.

The results of analysis of variance as seen in Table 2, indicate that there were no significant effects due to treatment from pre to post testing. There was little differentiation among the two
Table 1
Pretest and Posttest Means for
the MAT Problem Solving Subtest

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>15.60</td>
<td>13.60</td>
<td>14.60</td>
</tr>
<tr>
<td>Group II</td>
<td>17.00</td>
<td>17.66</td>
<td>17.33</td>
</tr>
<tr>
<td>Group III</td>
<td>20.33</td>
<td>19.16</td>
<td>19.76</td>
</tr>
<tr>
<td>Total</td>
<td>17.64</td>
<td>16.81</td>
<td></td>
</tr>
</tbody>
</table>

Note: Maximum score = 24
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
Table 2
Analysis of Variance for Improvement in the MAT Problem Solving Scores after Treatment

<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>74.648</td>
<td>2.243</td>
<td>.142</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>5.859</td>
<td>.589</td>
<td>.455</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>5.234</td>
<td>.526</td>
<td>.601</td>
</tr>
</tbody>
</table>
experimental and one control groups in over all achievement or in problem solving from the beginning to the end of the project. The results, therefore, did not support hypothesis one.

**Hypothesis 2**

There will be a significant improvement of math attitudes on the Fennema-Sherman Mathematics Attitude Scales by females who have self-instructional training.

Means for pre and post testing of attitudes are presented in Table 3. It can be seen from this table that attitudes remained approximately the same, except for group III, (the control) which decreased slightly in their attitudes towards mathematics.

No significant differences for treatment effect were found as presented in Table 4. Over all, changes from pre to post testing were also significant. Therefore, hypothesis two was not supported.

**Hypothesis 3**

There will be a significant change from externally to internally perceived locus of control by students who are given self-instructional training as seen by scores on the Locus of Control Scale for Children.

Table 5 presents the means for pre and post tests on perceived control locus. All three groups were nearly identical in their means. The tests revealed fairly low scores indicating more internally perceived control over their performance outcome. The group means remained approximately the same throughout the treatment. No significant effects from treatment were demonstrated in the overall testing from pre to post sessions or between the three groups (Table 6). In view of these findings, hypothesis three was not supported.
Table 3
Pretest and Posttest Means for
the Math Attitude Questionnaire

<table>
<thead>
<tr>
<th>*Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>35.60</td>
<td>35.60</td>
<td>35.60</td>
</tr>
<tr>
<td>Group II</td>
<td>30.16</td>
<td>29.33</td>
<td>29.75</td>
</tr>
<tr>
<td>Group III</td>
<td>35.33</td>
<td>29.50</td>
<td>32.41</td>
</tr>
<tr>
<td>Total</td>
<td>33.70</td>
<td>31.47</td>
<td></td>
</tr>
</tbody>
</table>

Note: Maximum score for negative attitude - 48.
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
Table 4
Analysis of Variance for Improvement in Attitude toward Mathematics after Treatment

<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>96.501</td>
<td>.961</td>
<td>.406</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>41.666</td>
<td>1.120</td>
<td>.307</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>27.994</td>
<td>.752</td>
<td>.489</td>
</tr>
</tbody>
</table>
Table 5
Pretest and Posttest Means for
the Locus of Control Scale

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>15.400</td>
<td>16.000</td>
<td>15.700</td>
</tr>
<tr>
<td>Group II</td>
<td>13.333</td>
<td>14.166</td>
<td>13.750</td>
</tr>
<tr>
<td>Group III</td>
<td>14.000</td>
<td>12.500</td>
<td>13.250</td>
</tr>
<tr>
<td>Total</td>
<td>14.244</td>
<td>14.222</td>
<td></td>
</tr>
</tbody>
</table>

Note: Maximum score for externality = 40.
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
<table>
<thead>
<tr>
<th>Title</th>
<th>Barcode</th>
<th>Duedate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of math anxiety in junior hi</td>
<td>32435012740856</td>
<td>Feb 20 2004</td>
</tr>
<tr>
<td>Variance Source</td>
<td>Mean Square</td>
<td>F Ratio</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>Treatment (TT)</td>
<td>18.853</td>
<td>.365</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>41.666</td>
<td>.000</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>4.644</td>
<td>.317</td>
</tr>
</tbody>
</table>
Hypothesis 4

There will be a significant improvement on Fennema and Sherman’s Math Anxiety Scale by those females who have self-instructional training.

The means for pre and post testing are cited in Table 7. Anxiety towards mathematics is represented as being slightly higher for the tutored students (group II) and for the control population (group III). However the groups concluded the project with similar means. It can be noted on Table 8 that no significant effects for treatment emerged for the overall anxiety scale pre to post testing or between the three groups. Evidence was not found to support hypothesis four.

Hypothesis 5

There will be significant improvement on the Math Anxiety Thermometer scores indicating less anxiety for females who are given self-instructional training.

From the examination of Table 9, it can be seen that the means on the anxiety scale decreased to some degree over the treatment period for all three groups. This indicates less anxiety by the program’s end. The overall change in test scores from pre to post-testing approached significance at the .08 level (Table 10). However, as all three groups changed similarly and there was no significant difference between them, treatment effectiveness could not be determined. The data do not indicate that self-instructional training produced superior results as compared to the other two conditions. Therefore, although a trend was noted for lessened anxiety at the end of the program, hypothesis five is not confirmed.
Table 7
Pretest and Posttest Means for
the Math Anxiety Scale

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>32.000</td>
<td>36.000</td>
<td>34.000</td>
</tr>
<tr>
<td>Group II</td>
<td>38.166</td>
<td>38.000</td>
<td>38.023</td>
</tr>
<tr>
<td>Group III</td>
<td>38.666</td>
<td>36.666</td>
<td>37.666</td>
</tr>
<tr>
<td>Total</td>
<td>37.277</td>
<td>36.888</td>
<td></td>
</tr>
</tbody>
</table>

Note: The maximum score for high anxiety - 60.
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>56.796</td>
<td>.288</td>
<td>.753</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>3.151</td>
<td>.131</td>
<td>.722</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>26.588</td>
<td>1.109</td>
<td>.356</td>
</tr>
</tbody>
</table>
Table 9
Pretest and Posttest Means for
the Math Anxiety Thermometer

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>15.400</td>
<td>16.000</td>
<td>15.700</td>
</tr>
<tr>
<td>Group II</td>
<td>13.333</td>
<td>14.166</td>
<td>13.750</td>
</tr>
<tr>
<td>Group III</td>
<td>14.000</td>
<td>12.500</td>
<td>13.250</td>
</tr>
</tbody>
</table>

Total    14.244    14.222

Note: Maximum score for high anxiety = 100.
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>128.307</td>
<td>.122</td>
<td>.885</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>2454.401</td>
<td>3.361</td>
<td>.088</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>182.526</td>
<td>.250</td>
<td>.782</td>
</tr>
</tbody>
</table>
Hypothesis 6

There will be significant improvement on the Preference Pattern for Mathematics Scale for those females who have received self-instructional training.

Mean ranks for pre and post testing of all three groups are given in Table 11. Although groups two and three had the identical mean rank during pretesting, group one had a higher mean ranking of mathematics indicating a greater preference for the subject. As seen on Table 12, the differences in ranking between group one and group two and between group one and group three approaches significance at the .089 level in pretesting. However, group two and three are not significantly different and in fact are approximately the same.

In post-testing, the means change as seen in Table 11. Group one is now approaching significant differences (.089 level) only with group three. There is no significant difference between group one and group two and between group two and group three.

No significance due to treatment can be substantiated. Group one began the program with a higher mean rank but no significant change occurred; the mean ranking remained the same after treatment. This lack of effect for both overall pre to post testing and for treatment can be seen in Table 13.

Test Anxiety

Test anxiety was not an area about which a hypothesis was made. The test was included to provide possible information about the three different groups' performances and to explore and area which may effect math anxious students.
### Table II
Pretest and Posttest Means for the Preference Pattern Scale

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>1.80</td>
<td>1.80</td>
<td>1.80</td>
</tr>
<tr>
<td>Group II</td>
<td>2.83</td>
<td>2.66</td>
<td>2.75</td>
</tr>
<tr>
<td>Group III</td>
<td>2.83</td>
<td>3.00</td>
<td>2.91</td>
</tr>
<tr>
<td>Total</td>
<td>2.48</td>
<td>2.48</td>
<td></td>
</tr>
</tbody>
</table>

Note: Greatest preference for math = 1.

* n = 5 for Group I, 6 for Group II, and 6 for Group III.
Table 12
Analysis of Pretest and Posttest Ranks
with the Mann-Whitney U Test on
Preference Pattern Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U</td>
<td>Probability</td>
</tr>
<tr>
<td>Groups I vs II</td>
<td>7</td>
<td>.089</td>
</tr>
<tr>
<td>Groups I vs III</td>
<td>7</td>
<td>.089</td>
</tr>
<tr>
<td>Groups II vs III</td>
<td>17.5</td>
<td>.500</td>
</tr>
</tbody>
</table>

* n = 5 for Group I, 6 for Group II, and 6 for Group III.
<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>4.082</td>
<td>1.401</td>
<td>.278</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>.078</td>
<td>.285</td>
<td>.756</td>
</tr>
</tbody>
</table>
Means for all three groups on pre and post testings of test anxiety are cited in Table 14. All groups started with a medium amount of test anxiety. Groups one and three slightly decreased their anxiety by the end of the program while group two showed a negligible increase. No significant difference was found in overall test scores from the pre to post sessions or between the three groups over time (Table 15). These results do not support self-instructional training or tutoring as effective means of reducing test anxiety.

Summary

No significant treatment effects from the self-instructional method or from tutoring were found with any of the seven instruments used. Changes in math anxiety as measured by the Math Anxiety Thermometer did approach significance for overall pre to post testing. Math anxiety was appreciable reduced by the end of the program. However, this change occurred in all three experimental groups and therefore can not be attributed to treatment administered during the study.

Differences approaching significance were also found between the three groups on their preference for math. The first group rated math more highly than the second or third groups. However, these differences occurred before the treatment took place. No significant changes were found in the subjects' preference patterns from self-instructional training.
Table 14
Pretest and Posttest Means for the Test Anxiety Scale

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>16.400</td>
<td>15.400</td>
<td>15.900</td>
</tr>
<tr>
<td>Group II</td>
<td>12.833</td>
<td>14.666</td>
<td>14.250</td>
</tr>
<tr>
<td>Group III</td>
<td>15.333</td>
<td>13.000</td>
<td>14.166</td>
</tr>
<tr>
<td>Total</td>
<td>15.188</td>
<td>14.355</td>
<td></td>
</tr>
</tbody>
</table>

Note: Maximum score high test anxiety = 30.
* n = 5 for Group I, 6 for Group II, and 6 for Group III.
Table 15
Analysis of Variance for Improvement in
the Test Anxiety Scores

<table>
<thead>
<tr>
<th>Variance Source</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TT)</td>
<td>10.751</td>
<td>.110</td>
<td>.890</td>
</tr>
<tr>
<td>Testing (T)</td>
<td>5.859</td>
<td>.543</td>
<td>.473</td>
</tr>
<tr>
<td>(TT) x (T)</td>
<td>7.109</td>
<td>.658</td>
<td>.532</td>
</tr>
</tbody>
</table>
CHAPTER IV
DISCUSSION

Rationale
Math anxiety in females begins to manifest itself during the junior high school years, becoming more blatant in high school and college. During this time, a differentiation becomes apparent between males' and females' course taking and achievement scores in mathematics, especially in higher cognitive areas such as problem solving (Fox, Fennema and Sherman, 1977; Maccoby, 1966). Most clinics or projects attempting to lessen math anxiety have dealt with high school and college populations (Ernest, 1976). In contrast, this study was developed for use with math anxiety in junior high school students. Preventative measures and treatment projects seem to be most important for this population to deter them from curtailing their future career choices.

A Columbus city junior high school was selected to provide a heterogeneous population for the study. An earlier study by Genshaft (1978) was conducted with a homogeneous seventh grade population and it was suggested that a varied sample might incur more effects from a treatment project. Results might also be more generalizable to other populations with a heterogeneous group of subjects.
Project Conclusions

Results from multivariate analysis of variance do not support the efficacy of self-instructional training for treating math anxiety in this sample of junior high school girls. A trend for decreasing math anxiety was found with the Math Anxiety Thermometer, approaching significance at the .088 level. However, no significant differentiation can be made between the two experimental and one control groups, therefore providing no confirmation of the self-instructional training's efficacy.

The Mann Whitney U test revealed a difference approaching significance (.089) between the instructionally modified group and the other two groups on their Preference Pattern rankings. Pretesting revealed that the self-instructional group rated math highly with a mean ranking of 1.8 while the tutored and control groups ranked it less favorably with means of 2.7 and 2.9 respectively. Analysis of variance revealed no significant changes over the course of the project however, and thus no confirmation of treatment efficacy. In all other areas of attitudes toward mathematics, math anxiety, locus of control, and test anxiety, no significant changes were found and no trends emerged. Why, then, did such a program produce few results?

Issues

Self-Instructional Modification

Most of the previous studies have found self-instructional modification to be an effective treatment approach for improving performance deficits when the deficit is due to task anxiety. The females in this study were selected on the basis of their stated math anxiety
on at least one measure (e.g. Math Anxiety scale, or Fear Thermometer). These perceptions were the sole basis on inclusion in the experimental groups. Several reasons could be offered as to why the females did not improve their performance. One is that the females were not truly anxious but instead were reporting dislike for math. Another is that they may be anxious about their math performance but not to a sufficient degree so as to affect their behavior on academic tasks. Both of these will be explored in more depth later in the chapter. A third may be the ways in which self-instructional procedures are incorporated in the research. In this study it was intended that self-instructional procedures would be used to directly combat math anxiety. However, many of the females did not appear to be as highly anxious as they initially stated and had no difficulty in performing mathematics tasks. The self-instructional procedures became a preventive measure at that point rather than a treatment technique. Used in this way females may have had difficulty internalizing their self-instructional statements and utilizing them beneficially. It is therefore questionable as to whether self-instructional modification can be used effectively as a preventive approach to math anxiety. A fourth reason for the lack of results from self-instructional modification is that the highly capable students may not have been motivated to use the instructional technique and never internalized the approach. The students may not have been motivated to use the instructional technique and never internalized the approach. The students' ability is a main consideration in this issue. Several of the modified students (three) were on the honor roll during the period of time that the project occurred. The mean prefer-
ence ranking of mathematics by the modified group was 1.6; three students rated math as their first subject preference. The data suggest that anxiety was not detrimental to these students' performances. Consequently, there would be no blatant discrepancies which might motivate them to deal with their anxiety and to change their behavior.

These results may provide evidence for Peterson's study (1977) on which performance and ability versus anxiety. His research showed that highly anxious students who are able to meet the information processing demands of a situation will not be impaired by their anxiety. Many students in the current study were performing well academically as previously discussed, and may have found no reason to incorporate the self-instructional statements.

**Measures of Anxiety**

It has been assumed from the instruments used in measuring math anxiety that the student sample was "math anxious". Rounds and Hendel (1980), however, raised the point that there is a lack of researcher agreement as to what comprises the construction of math anxiety. They consequently question the use of many math anxiety measures. They note specifically the lack of much reliability and validity data for Fennema and Sherman's Mathematics Anxiety Scale and for Dreger and Aiken's Numerical Anxiety Scale. Rounds and Hendel conclude that it is difficult to assess the effects of math anxiety if studies are measuring different factors.

This study attempted to use the best instruments of math anxiety which are available as documented by Betz (1977), Genshaft (1979) and Fennema and Sherman (1976). However, given the criticism of Rounds
and Hendel, it is possible that the students' levels of math anxiety were not measured accurately.

**Anxiety and Performance**

Anxiety is a factor which may enhance or impede performance depending on the level exhibited. Certain levels of ability also seem to cancel out the positive or negative effects usually derived from anxiety or stress. This study was intended to focus on those students incurring the detrimental effects. However, in light of the fact that their performance did not benefit from modification techniques, several possible alternative effects from stress should be examined.

From Spielberger's study (1966) of college freshmen, he concluded that in the middle range of ability, low anxious students obtained higher grades than high anxious students. However, the students at the very highest level of ability performed well despite high anxiety. This study would suggest that the very bright student may achieve whether he/she is anxious or not. However the majority of students will not do well academically with higher anxiety levels.

The Yerkes-Dodson Law deals with this phenomena (Levitt, 1967). The relationship between fear or anxiety and learning is held as curvilinear. Low drive is seen as affecting learning very little since the motivation produced by it is little or nothing. High drive or stress interferes with learning, with the optimal amount of drive existing somewhere in the middle for most students. Simple tasks are improved by a higher level of drive than are complex tasks which may be disrupted by the stress.

These studies point out that a student requires a certain level
of anxiety before their performance is impaired. If the student sample chosen was not anxious enough to feel its effects academically, they may not have been motivated enough to do anything about it. In fact, anxiety may have been aiding them in their performance at that level.

Problem Solving

Tutoring for the two experimental groups consisted of teaching a variety of topics with an emphasis on word problems (see Appendix). Math problem solving was the chosen subject for this study for the obvious reason of assessing gains in that area. It was also chosen for the reason that it taps a higher level cognitive area in which females do not typically excel (Fennema and Sherman, 1971). Research has not proven whether this is due to ability, math anxiety, or other factors. The results of the current study may well confirm that it is very difficult for the girls to pick up the skills of problem solving as documented in their lack of achievement gains on the problem solving subtest. However, two factors are operating in this study which should be kept in mind. One student reached the top limit on the scale (24 out of 24 correct) and several had very high scores. Inability would not seem to be a problem here but the need for a more appropriate test which could differentiate between the students and their achievement gains. It is also questionable if a complicated process such as problem solving can be adequately taught or improved in only eight weeks working for less than an hour and a half a week. For example, a similar study by Ginshaft (1979) resulted in computational gains but no problem solving gains for the eight week program.
An additional consideration is that achievement tests in general may not measure all aspects of problem solving. Studies by Branca (1974) and Geeslin and Shavelson (1975) found that learning how to structure a problem, an important aspect of the problem solving process, may be a skill which is not measured by achievement tests. Basically, these tests do not require structuring to solve the problems and a student may score highly without it. Achievement test may, therefore, not be an adequate representation of a student’s total problem solving abilities.

Adolescence

A final area of consideration is whether attitudes at the junior high school level affect achievement. Antonnen’s study (1969) comparing fifth and sixth graders to eleventh and twelfth grade students showed that higher correlations exist between scores on attitude measures and achievement scores at the secondary level than at the elementary level. No mention is made of the junior high school level in Antonnen’s study. Other studies have not been specifically conducted on junior high populations concerning achievement and attitudes either, necessitating interpolation to determine effects at that age level. It has been only estimated, therefore, that achievement and attitudes are more highly correlated for junior high students.

Erikson describes the confusion of that age with his fifth stage of development entitled identity vs. identity diffusion (Horrocks, 1976). Puberty and adolescence are ushered in by this stage of experimentation and social experience which is used in formulating one’s identity. Maturation is viewed as a necessary step in solidifying a
person's self-concepts and attitudes. Selecting concepts, testing, and integrating are all part of the process. It is possible, therefore, attitude scores gained from self-report measures such as those used in this study, may not correlate highly with performance and behavior in adolescence or junior high. However with maturation, these attitudes may become more reliable predictors as Antonnen states (1969).

Limitations

The main limitation with which the study began was a small sample size. It is difficult to make generalizations to the junior high population based on so few subjects. Differences in treatment effects might also be more apparent with a larger sample, incurring less statistical influence from chance individual fluctuations which were not due to treatment.

A second limitation was the use of high scores on either the Fennema and Sherman Math Anxiety Scale or the Math Anxiety Thermometer (or both) to select students as math anxious. In light of the literature review, it is possible that even those students who scored highly on both measures might not be detrimentally affected by math anxiety. That is not to say that these students are not math anxious but that their levels of anxiety are either not high enough to affect their performance and motivate them to change their behavior or that their abilities are so high that they override their levels of anxiety. Additional measures such as the Preference Pattern may have to be used in conjunction with the anxiety scales to screen for subjects who would best benefit from a modification program.
Suggestions for Future Research

Several implications can be made for further research in math anxiety. Sample size should be increased to provide more generalizable results and to reduce the effect of chance fluctuations. The number of subtests should also be increased to provide a broader base in measuring achievement in mathematics. The main purpose for this increase would be to provide enough problems to differentiate between the students' achievement levels and to provide a measurement more sensitive to achievement gain. Another means of dealing with this problem would be to utilize a more difficult achievement test, selecting a problem solving subtest from a higher level exam. If the subtest(s) is administered during the last half of the school year, it is especially important to select a level which is difficult enough to differentiate between achievement gains up to that point. A most important consideration for future research is the selection of appropriate students for the study. A variety of screening measures, rather than relying on one or two, would be more helpful in revealing students who would most benefit from a modification program. Using both the Math Anxiety Thermometer and the Fennema and Sherman Math Anxiety Scale to screen students, requiring higher scores than for the present study on both, could provide a student sample which is more highly math anxious. Instead of the upper half of the Thermometer and upper two-fifths of the Anxiety Scale, requiring scores in the upper quarter and upper fifth respectively would set more stringent cut off levels.

In addition to anxiety measures, proof that the anxiety has been
detrimental to the student should be sought from other measures. One means of accomplishing this would be to screen students with the Preference Pattern, requiring a rank of less than one for mathematics. Another method would be to scan files for those students whose mathematics achievement scores were a year below the average scores for other subject areas. A third possibility would be to solicit volunteers such as from a study hall. Those students who volunteered and were found to be in the upper ranges of the anxiety scales would seem to be more motivated for change than a student who was "volunteered" by parents or teachers. This method would also control for those students who sensed a discrepancy versus those who had not identified with that difference yet, a serious consideration when working with junior high students as previously discussed.

It is recommended that studies continue to control for intelligence, hopefully by a more direct means than the achievement stanines available to this study. Research has shown that at the very upper and lower ends of the ability range anxiety is not a major factor affecting performance. It is most influential in the middle range of abilities (Spielberger, 1966). Therefore this group of students should benefit most from an instructional modification project.
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APPENDIX A
INSTRUMENTATION
MATH SCALES

Directions: Place an X at the point that describes the way you feel about mathematics. Each of the five points are explained below.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

1. It wouldn't bother me at all to take more math courses.

2. I have usually been at ease during math tests.

3. I get a sinking feeling when I think of trying hard math problems.

4. I haven't usually worried about being able to solve math problems.

5. My mind goes blank and I am unable to think clearly when working mathematics.
6. A math test would scare me.

7. I almost never have gotten scared during a math test.

8. Mathematics makes me feel uncomfortable and nervous.

9. Mathematics makes me feel uneasy and confused.

10. Math doesn't scare me at all.

11. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.

12. I usually have been at ease in math classes.
### Preference Pattern for Mathematics

Please rank the four subjects:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Like the most)</td>
<td>(Like the least)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
</tr>
<tr>
<td>Social Studies</td>
<td></td>
</tr>
</tbody>
</table>
MATHEMATICS QUESTIONNAIRE

Directions: Mark each statement either true (T) or false (F) according to the way you feel about mathematics. There are no right or wrong answers.

1. Mathematics will not be important to me in my life's work.
2. I would trust a girl just as much as I would trust a boy to figure out important math problems.
3. The challenge of math problems does not appeal to me.
4. Knowing mathematics will help me earn a living.
5. When a girl has to solve a math problem, it is refreshing to ask a boy for help.
6. When I have a math problem that I can't solve right away, I stick with it until I have the answer.
7. I think I could handle more difficult mathematics.
8. Boys are not naturally better than girls in math.
9. I am sure that I can learn mathematics.
10. Girls can do just as well as boys in mathematics.
11. Mathematics is for boys; arithmetic is for girls.
12. I don't understand how some people can spend so much time on math and even enjoy it.
13. I can get good grades in mathematics.
14. Math has been my worst subject.
15. Studying mathematics is just as appropriate for girls as for boys.
16. I'm not the type to do well in math.
17. Figuring out math problems does not appeal to me.
18. When a question is left unanswered in math class, I will continue to think about it afterward.
19. Mathematics is a worthwhile and necessary subject.
26. Girls are as good as boys in solving math problems.
21. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.
22. I am sure I could do advanced work in mathematics.
23. I will use mathematics in many ways as an adult.
24. Once I start trying to work on a math puzzle, I find it hard to stop.
25. I'll need mathematics for my future work.
26. I'm no good in math.
27. I would expect a woman mathematician to be a masculine type of person.
28. Generally I have felt secure about attempting mathematics.
29. I'll need a good understanding of mathematics for my future work.
30. Taking mathematics is a waste of time.
31. Mathematics is of no relevance to my life.
32. I like math puzzles.
33. Girls who enjoy studying math are a bit peculiar.
34. I have a lot of self-confidence when it comes to math.
35. It's hard to believe a girl could be a genius in mathematics.
36. I would have more faith in the answer for a math problem solved by a boy than a girl.
37. I see mathematics as a subject I will rarely use in my daily life as an adult.
38. In terms of my adult life it is not important for me to do well in mathematics in junior high school.
39. I study mathematics because I know how useful it is.
40. Girls certainly are logical enough to do well in mathematics.
1. I am challenged by math problems I can't understand immediately.
2. Most subjects I can handle O.K., but I have a knack for flubbing up math.
3. I do as little work in math as possible.
4. Mathematics is enjoyable and fun for me.
5. For some reason even though I study, math seems unusually hard for me.
6. I don't think I could do advanced mathematics.
7. Math puzzles are boring.
8. I expect to have little use for mathematics when I get out of school.
THE NOWICKI STRICKLAND PERSONAL REACTION SURVEY

Directions: Please answer each question either yes or no.

1. Do you believe that most problems will solve themselves if you just don’t fool with them?
2. Do you believe that you can stop yourself from catching a cold?
3. Are some kids just born lucky?
4. Most of the time do you feel that getting good grades means a great deal to you?
5. Are you often blamed for things that just aren’t your fault?
6. Do you believe that if somebody studies hard enough he or she can pass any subject?
7. Do you feel that most of the time it doesn’t pay to try hard because things never turn out right anyway?
8. Do you feel that if things start out well in the morning that it’s going to be a good day no matter what you do?
9. Do you feel that most of the time parents listen to what their children have to say?
10. Do you believe that wishing can make good things happen?
11. When you get punished, does it usually seem it’s for no good reason at all?
12. Most of the time do you find it hard to change a friend’s (mind) opinion?
13. Do you think that cheering more than luck helps a team to win?
14. Do you feel that it’s nearly impossible to change your parents’ mind about anything?
15. Do you believe that your parents should allow you to make most of your own decisions?
16. Do you feel that when you do something wrong there’s very little you can do to make it right?
17. Do you believe that most kids are just born good at sports?
18. Are most of the other kids your age stronger than you are?
19. Do you feel that one of the best ways to handle most problems is just not to think about them?
20. Do you feel that you have a lot of choice in deciding who your friends are?
21. If you find a four leaf clover do you believe that it might bring you good luck?
22. Do you often feel that whether you do your homework has much to do with what kind of grades you get?
23. Do you feel that when a kid your age decides to hit you, there's little you can do to stop him or her?
24. Have you ever had a good luck charm?
25. Do you believe that whether or not people like you depends on how you act?
26. Will your parents usually help you if you ask them to?
27. Have you felt that when people were mean to you it was usually for no reason at all?
28. Most of the time, do you feel that you can change what might happen tomorrow by what you do today?
29. Do you believe that when bad things are going to happen they just are going to happen no matter what you try to do to stop them?
30. Do you think that kids can get their own way if they just keep trying?
31. Most of the time do you find it useless to try to get your own way at home?
32. Do you feel that when good things happen they happen because of hard work?
33. Do you feel that when somebody your age wants to be your enemy there's little you can do to change matters?
34. Do you feel that it's easy to get friends to do what you want them to?
35. Do you usually feel that you have little to say about what you get to eat at home?
36. Do you feel that when someone doesn’t like you there’s little you can do about it?

37. Do you usually feel that it’s almost useless to try in school because most older children are just plain smarter than you are?

38. Are you the kind of person who believes that planning ahead makes things turn out better?

39. Most of the time, do you feel that you have little to say about what your family decides to do?

40. Do you think it’s better to be smart than to be lucky?
THE REVISED TEST ANXIETY SCALE FOR CHILDREN

1. Do you worry when the teacher says that she is going to ask you questions to find out how much you know?

2. Do you worry about being promoted, that is, passing from the 4th grade to the 5th grade at the end of the year?

3. When the teacher asks you to get up in front of the class and read a report, are you afraid that you are going to make some bad mistakes?

4. When the teacher says that he is going to call upon some students in the class to do some science problems, do you hope that he will call upon someone else and not on you?

5. Do you sometimes dream at night that you are in school and cannot answer the teacher's questions?

6. When the teacher says that she is going to find out how much you have learned, does your heart begin to beat faster?

7. When the teacher is teaching you about social studies, do you feel that other children in the class understand him better than you?

8. When you are in bed at night, do you sometimes worry about how you are going to do in classes the next day?

9. When the teacher asks you to write on the blackboard in front of the class, does the hand you write with sometimes shake a little?

10. When the teacher is teaching you about English, do you feel that other children in class understand her better than you?

11. Do you think you worry more about classes than other subjects?

12. When you are at home and you are thinking about your science assignment for the next day, do you become afraid that you will get the answers wrong when the teacher calls upon you?

13. If you are sick and miss school, do you worry that you will do worse poorly in your classes than other students when you return to school?

14. Do you sometimes dream at night that other students in your classes can do things you cannot do?
15. When you are home and you are thinking about your English assignment for the next day, do you worry that you will do poorly on the assignment?

16. When the teacher says that he is going to find out how much you have learned, do you get a funny feeling in your stomach?

17. If you did very poorly when the teacher called on you, would you probably feel like crying even though you would try not to cry?

18. Do you sometimes dream at night that the teacher is angry because you do not know your assignments?

19. Are you afraid of school tests?

20. Do you worry a lot before you take a test?

21. Do you worry a lot while you are taking a test?

22. After you have taken a test, do you worry about how well you did on the test?

23. Do you sometimes dream at night that you did poorly on a test you had in class that day?

24. When you are taking a test, does the hand you write with shake a little?

25. When the teacher says that she is going to give the class a test, do you become afraid that you will do poorly?

26. When you are taking a hard test, do you forget some things you knew very well before you started taking the test?

27. Do you wish a lot of times that you didn't worry so much about tests?

28. When the teacher says that she is going to give the class a test, do you get a nervous or funny feeling?

29. While you are taking a test do you usually think you are doing poorly?

30. While you are on your way to school, do you sometimes worry that the teacher may give the class a test?
APPENDIX B

SELF-INSTRUCTIONAL MODIFICATION:
Introductory Lectures, Set of Positive Statements,
and Examples of Negative Statements
INTRODUCTORY LECTURE ONE

The math project you're about to become a part of has come about because there are many people who feel anxious or uncomfortable with mathematics. All of you were selected because you indicated on the math questionnaires that you often felt anxious about math and in turn did not always feel confident approaching math problems.

You may have experienced things that made you feel that girls just aren't very good in math. For instance, do you ever remember a teacher who always seemed to call on the boys to answer the hard problems? Has your Mom ever said that she just can't do math or does it seem that your father or a brother are the only ones who feel comfortable helping you with your math homework? If your mom does deal with math a lot, did people tell you "That's amazing?" Have you ever heard the statement that girls aren't as logical as boys?

These are just a few examples of situations that could lead you to feel that girls can not do math and that you just can't figure out math problems without a lot of "hassles."

Generally when you feel anxious or frustrated about math and it seems that it's just not worth all the trouble, it stems from the fact that you're telling yourself negative things. For example, you may be telling yourself things such as "I can't do it - I'm not good at it and it's too confusing." What kinds of things do you think of while you're working on a math test, for example? Has your mind ever gone blank for
a minute or two! What did you think about when it happened?
I'd like you to write down some of these things on a piece of
paper now and we'll discuss them in a little bit. We're
going to go over some examples now and if you think of any
others while we're talking be sure to write them down.

Consider these statements. "Math has been my worst subject" or
"I'm not the type to do well in math." It may well be
that your grades in math are not as high as in your other
subjects. However, what do you think happens when you tell
yourself over and over that "Math is my worst subject - I'm
not the type to do well in math?" The chances are, on a math
test or a set of problems, you're not going to perform as well
as you could. It may be hard to concentrate, and you may
feel anxious about how you are doing. Statements such as
these are called "negative self-statements" - you're telling
yourself negative things.

The same situation goes for a softball game or a game of
cards. If you tell yourself that you're going to lose, most
of the time you're not going to play very well. What you
say to yourself affects how you do. You've probably noticed
that most teams don't tell themselves that they're going to
lose this contest or that game is really going to go "down
the tubes." Instead they try to "psych" themselves up for
it. For those of you who watched the Olympics, you may have
heard the American hockey team being described as less talented
than the other teams. Yet, they psyched themselves up for
the games and ended up beating them all, including the top
rated team from Russia.

Now if instead of telling yourself negative things, you told yourself positive self-statements what do you think might happen? What is you tried to "psych" yourself up with statements such as "I can learn mathematics" or "I can get good grades in math"? When the players on a team cheer themselves on and say "Hey, we can make it - we can do it!", they usually feel more confident and positive about "attacking" or competing against the other team, just as you might feel more confident about attacking your math problems. The result is better playing, a winning game, or in the case of doing math, a better performance.
INTRODUCTORY LECTURE TWO

The technique we will be using with positive self-statements is called "self-instruction." It works basically like this. Each one of you will be making up a set of positive self-statements at the next session. This set of statements will be used in math situations which make you anxious or uncomfortable. The purpose of these statements is to get you to talk to yourself while you're working on a problem so that you can concentrate on what you're doing. If you're concentrating on the problem at hand, you won't be able to think about your feelings of anxiety. This internal conversation will follow these general guidelines:

1. First, ask yourself, "What should I be doing in this problem?"

2. Answer the above question, "I am supposed to solve this word problem on percentages."

3. Talk to yourself through each step of the problem. For example, "First, I need to change this percent to a decimal fraction. Then, I need to set up the problem so I can multiply. Next, I . . ."

For example, I have a set of positive self-statements which I might use in aiding me with that problem. (See demonstration card) From this sequence you can see how we fit these statements in as we proceed through the problem in order to reduce anxiety. Whenever you begin to feel anxious in a math situation, that will be your cue to begin using self-
During the next few sessions, we will be going through some exercises to help you become more skilled at using this technique. Let's consider some of the examples of negative self-statements on the chart and discuss why they are illogical or self-defeating. Then we'll discuss some of the examples which you have written down.

From our discussion, we can see that negative self-statements aren't very productive and hinder our performance. The goal in this project is to change the negative statements you make to yourself to positive ones so that you can do the best job of which you are capable. This is a method which you can use to help yourself in other areas besides mathematics, such as if you're anxious about cheerleading tryouts or if you wish to get together with that guy in your class and it makes you feel nervous. We'll be discussing that aspect of positive self-instructional statements in a couple of weeks.
<table>
<thead>
<tr>
<th>Card Number</th>
<th>Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What should I be doing in this problem?</td>
</tr>
<tr>
<td>2</td>
<td>Just do it step by step.</td>
</tr>
<tr>
<td>3</td>
<td>I'm going to take my time and go slowly.</td>
</tr>
<tr>
<td>4</td>
<td>I know I can do this</td>
</tr>
<tr>
<td>5</td>
<td>If I just keep working at it I'll get it right</td>
</tr>
<tr>
<td>6</td>
<td>I know I can get a good grade on this if I just try</td>
</tr>
<tr>
<td>7</td>
<td>Don't worry about how much time is left - that won't help</td>
</tr>
<tr>
<td>8</td>
<td>This really isn't that bad.</td>
</tr>
<tr>
<td>9</td>
<td>There, I'm getting it</td>
</tr>
<tr>
<td>10</td>
<td>Good job!</td>
</tr>
</tbody>
</table>
EXAMPLES OF NEGATIVE SELF-STATEMENTS

1. "These problems are too hard."
   a. If you tell yourself they are too hard, you'll get nervous and won't do very well.
   b. All you need to do is to take it bit by bit and you'11 be able to work the problem out.
      - What positive self-statement could you tell yourself instead?
      i.e. If I just keep working at it, I'll get it right.

2. "My mind is going blank; now I'll never be able to finish the test."
   a. Getting nervous won't help; it's keeping me from concentrating.
   b. I have to quit assuming that I can't do the problems and stop telling myself that I'll get them wrong.
      - What could you tell yourself instead?
      i.e. "Don't worry about how much time is left; that won't help."

3. "I hate math."
   a. Telling yourself that you hate it won't get you anywhere.
   b. If you tell yourself you hate it, you probably won't do very well because you'll be concentrating on that instead of the problem.
      - What can you tell yourself?
      i.e. "Problem solving is fun! This really isn't that bad."
b. "I can never get hard problems correct."
   a. That's not true: I can't say that I've never done
      a hard problem correctly.
   b. If I keep telling myself that I won't get it right,
      I probably won't get it right.
      - What can you tell yourself at this point?
      i.e. "I'm just going to take my time and go slowly."
APPENDIX C
TUTORED SUBJECT AREAS
SUBJECT AREAS

1. Proportions
2. Common fractions
   a. Multiplication, division
   b. Changing improper fractions to mixed numbers and back
3. Decimals
   a. Reading and writing decimals
   b. Adding, subtracting, multiplying, and dividing them
   c. Multiplication of decimals by 10 and 100
   d. Dividing decimals by 10 and 100
   e. Changing common fractions to decimals and back
4. Percent
   a. Changing percents to decimals and back
   b. Changing common fractions to percents and back
   c. Finding a percent of a number
   d. Finding a number when the percent is known
5. Borrowing money
   a. Simple interest
   b. Calculating the amount of a simple loan with down payment on a house, car, and other valuables