AN EVALUATION OF THE SPITZ STUDENT RESPONSE
SYSTEM IN TEACHING A COURSE IN LOGICAL
AND MATHEMATICAL CONCEPTS

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

John David Brown, B.A., M.A.

(1)
Denton, Texas

May, 1971

BCT

Brown, John David, An Evaluation of the Spitz Student Response System in Teaching a Course in Logical and Mathematical Concepts. Doctor of Philosophy (College Teaching), May, 1971, 92 pp., 6 tables, 2 illustrations, bibliography, 61 titles.

The problem with which this investigation was concerned was that of determining the effect of teaching freshman mathematics with the Spitz Student Response System upon a student's anxiety level, attitude and achievement.

The subjects were in the two sections of Mathematics 1308 which were taught by the investigator. Mathematics 1308 is a general requirement for all students not majoring in engineering, science or mathematics. There were thirty-nine students in the control section and thirty-four students in the experimental section. The effects of the Spitz Student Response System upon a student's anxiety level, attitude and achievement were determined by use of statistical analysis upon pretest and posttest scores on the Mathematics Attitude Questionnaire, IPAT Anxiety Scale Questionnaire and the Southern Methodist University Mathematics 1308 Placement Test.

The hypotheses and findings of this study are as follows

(1) Hypothesis 1, that the adjusted mean achievement score of the students taught with the aid of the Spitz Student Response System would be significantly

higher than the adjusted mean achievement score of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

(2) Hypothesis 2, that the adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System would be significantly lower than the adjusted mean anxiety score of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

(3) Hypothesis 3, that the adjusted mean positive attitude score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean positive attitude score of the students taught by the regular lecture-recitation method was not confirmed at the .05 level. However, the hypothesis was confirmed at the .10 level of significance.

(4) Hypothesis 4, that the adjusted mean achievement of the students with a positive attitude toward mathematics would be significantly higher than the adjusted mean achievement of the students with a negative attitude toward mathematics was confirmed at the .025 level of significance.

(5) Hypothesis 5, that there would be significant interaction between the level of attitude and the method of instruction as variables affecting achievement in mathematics, was not confirmed at the .05 level.

(6) Subjective evaluation of the Spitz Student Response System tended to support the system as a useful teaching device and one which improved the attitude of the students toward mathematics.

The following conclusions were reached:

(1) It appeared that students learn as well using the Spitz Student Response System as by using more conventional methods.

(2) Based upon the subjective evaluation of the Spitz System by the students, one would have to conclude that the use of the System lessened anxiety in class by reinforcing the student's responses without calling attention to the individual student.

(3) Students taught by the lecture-recitation method augmented by the Spitz Student Response System definitely had a better attitude toward a required mathematics course than students taught the course by the regular lecture-recitation method.

(4) Students who had a positive attitude toward mathematics had a higher achievement level than those which had a negative attitude toward mathematics.

Because of the favorable subjective evaluation of the Spitz System, it is suggested that further research should be done using the Spitz Student Response System before it is discounted as a teaching device.

AN EVALUATION OF THE SPITZ STUDENT RESPONSE
SYSTEM IN TEACHING A COURSE IN LOGICAL
AND MATHEMATICAL CONCEPTS

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

John David Brown, B.A., M.A.

(1)
Denton, Texas

May, 1971

TABLE OF CONTENTS

	Page
LIST OF TABLES	v
LIST OF ILLUSTRATIONS	vi
 Chapter	
I. INTRODUCTION	1
Statement of the Problem	
Purposes of the Study	
Hypotheses	
Background and Significance	
Definition of Terms	
Basic Assumptions	
Procedures for Collecting Data	
Procedures for Analysis of Data	
Summary	
II. SURVEY OF THE LITERATURE	18
Studies Concerned with the Relationship of Anxiety to Achievement in Mathematics	
Studies Concerned with the Relationship of Attitude to Achievement in Mathematics	
Summary	
III. DEVICES AND METHODOLOGY	34
Description of Experimental Design and Samples	
Instruments	
Description of the Spitz Student Response System	
Procedures for Collection of the Data	
Summary	
IV. PRESENTATION AND ANALYSIS OF DATA	51
Treatment of the Data	
Data Relative to the Hypotheses	
Subjective Evaluation of the Spitz Student Response System	
Summary	

Chapter	Page
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS . . .	67
Summary	
Conclusions	
Recommendations	
APPENDIXES	74
BIBLIOGRAPHY	88

LIST OF TABLES

Table	Page
I. Analysis of Covariance Table Showing Sources of Variation for a Two-Way Classification Between Levels of Attitude and Methods of Instruction Using the Pre-Achievement Scores and the Pre-Anxiety Scores as Covariates	54
II. Table of Adjusted Means and Standard Errors for Achievement Scores Using the Pre-Achievement Scores and the Pre-Anxiety Scores as Covariates	56
III. Analysis of Covariance Table for Anxiety Scores With the Pre-Anxiety Scores as the Covariate	57
IV. Table of Adjusted Means and Standard Errors for Anxiety Scores Using the Pre-Anxiety Scores as the Covariate	58
V. Analysis of Covariance Table for Attitude Scores With the Pre-Attitude Scores as the Covariate	59
VI. Table of Adjusted Means and Standard Errors for Attitude Scores Using the Pre-Attitude Scores as the Covariate	60

LIST OF ILLUSTRATIONS

Figure	Page
1. A Diagram of the Student Responder	43
2. A Diagram of the Instructor Control Console	44

CHAPTER I

INTRODUCTION

The years which are spent as a college student are filled with many anxious and traumatic moments. It seems that the level of anxiety is significantly increased when an undergraduate student with very little background in mathematics finds himself required to take a freshman mathematics course.

Most of the research dealing with the relationships between anxiety, attitudes, and achievement in mathematics has been done on the elementary school level. Practically no research has been done with non-mathematics majors who are required to take mathematics courses in college.

It is possible that the anxiety felt by the undergraduate students in freshman mathematics is in part caused by their being required to take the course (which poses a real threat since they must pass the course) and by their attitude toward mathematics and mathematically oriented subjects. Norton and Poffenberger (16) have found that the development of attitudes toward mathematics is a summatory phenomenon with each conditioning experience building upon the one that precedes it. The initial attitudes seem to be developed in the home and are effected not only by parents, but by all the teachers of mathematics with which the student is associated. Pupils who

have done poorly or failed mathematics have deflated egos and therefore tend to develop attitudes of dislike and hostility toward mathematics.

Part of the attitude developed about mathematics is probably caused by the way in which this course has traditionally been taught. In the past few years, many new devices for teaching mathematics have been developed and some of them have shown to be helpful. One of the newest teaching devices is the Spitz Student Response System. The Spitz Student Response System is an electronic classroom communication system that individualizes group instruction by providing constant interaction between the student and his instructor, as well as allowing the instructor to know exactly how well the entire class -- and each student -- understands a particular presentation.

A Spitz Student Response System was installed at Southern Methodist University in a specially designed classroom in 1969 when Hyer Hall was refurbished. It was installed because of the successful results of some preliminary experiments conducted by Dr. W. J. Millard, of the Pan American Institute for Social Sciences and Educational Research, during the 1967-68 school year. The author of this dissertation participated in those experiments and became very interested in the use of a student response system in group instruction.

Statement of the Problem

The problem of this study was the effect of teaching freshman mathematics with the Spitz Student Response System upon a student's anxiety level, attitude and achievement.

Purposes of the Study

The purposes of this study were

(1) To compare the achievement levels of students enrolled in a required freshman mathematics course when taught by (a) regular lecture-recitation method, and (b) lecture-recitation method augmented by the Spitz Student Response System.

(2) To ascertain the effect of the Spitz Student Response System upon a student's anxiety level and his attitude toward mathematics.

(3) To analyze the effect of attitude on achievement in mathematics when the Spitz Student Response System is used.

(4) To determine whether there was any interaction between student anxiety, attitude and method of instruction as variables affecting student achievement.

Hypotheses

To carry out the purposes of this study, the following hypotheses were formulated:

(1) The adjusted mean achievement score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean achievement score of the students taught by the regular lecture-recitation method.

(2) The adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System would be significantly lower than the adjusted mean anxiety score of the students taught by the regular lecture-recitation method.

(3) The adjusted mean positive attitude score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean positive attitude score of the students taught by the regular lecture-recitation method.

(4) The adjusted mean achievement score of the students with a positive attitude toward mathematics would be significantly higher than the adjusted mean achievement score of the students with a negative attitude toward mathematics.

(5) There would be significant interaction between the level of attitude and the method of instruction as variables affecting the achievement in mathematics, when the effects of anxiety were controlled statistically.

Background and Significance

Background

Many persons report in freshman mathematics classes that they are emotionally disturbed in the presence of mathematics or mathematically oriented material. It has been the experience of the writer that reactions of this nature to mathematical materials constitute a major field of emotionality in academic situations. And yet, as Dreger and Aiken (1) point out, although there have been many studies conducted to determine the effects of anxiety and attitude on arithmetic achievement, there has been essentially no controlled research in the realm of emotional problems associated with higher level mathematics -- especially with regard to undergraduate non-mathematics majors in a mathematical situation (such as a required freshman mathematics course).

Studies dealing with mathematics (on an elementary level) and anxiety generally fall into two methodological categories. One set of studies has dealt with the somatic (body) expressions which are manifested by individuals when confronted with stimulus situations of a mathematical type. A more commonly used technique utilizes the paper-and-pencil questionnaire. The subjects' responses to introspective questions are judged to be indications of anxiety level.

Hess (12) presented mental arithmetic problems of varying degree of difficulty to students and then obtained a trace of the size of the pupil of the eye. The size of the pupil tends

to increase immediately upon presentation of the problem. The pupil reaches maximum size upon solution of the problem and then decreases in size. Milliken and Spelka (14) found that college freshmen with low mathematics scores on the ACE examination tended to exhibit changes in breathing depth, blood pressure and heart rate when presented a mathematically related task.

Most of the studies which used questionnaires have shown that there is a negative correlation between achievement in arithmetic and anxiety. Biggs (5, p. 59) concluded:

In arithmetic and mathematics the inhibition produced by anxiety appears to swamp any motivating effect, particularly where the children concerned are already anxious; or to put it another way, anxiety appears to be more easily aroused in learning mathematics than it is in other subjects.

Dreger and Aiken (1) suggest that what is really involved is "anxieties" not "anxiety". They carried out a study on college freshmen and identified a syndrome of emotional reaction to mathematics which they labeled "Number Anxiety". They found that a negative correlation existed between Number Anxiety and achievement in mathematics.

Morgan (15) found that there is no significant correlation between test anxiety and achievement in mathematics on the high school level. Riggs (19, p. 3927) found that in college freshmen ". . . anxiety and its adaptation apparently have an effect on learned responses such as adjustments and values, while they do not seemingly influence aptitudes and grade point averages.

In the past few years, anxiety and its effect on learning have played a role of primacy in investigations. In an exhaustive review of the studies of anxiety in children, Ruebush (20) pinpointed the current dilemma in which comparability of findings from different investigations was not only complicated by differences in theoretical definitions and orientation, but also by differences in operational criteria from study to study within the same theoretical framework.

Most studies dealing with anxiety in school situations assume that it has a debilitating effect on the learning process. Aaron and White (25), Woodworth (26), and Rethlingshafer (18) questioned why anxiety should be avoided or why anxiety should be scorned as an energizing determinant simply because it is unpleasant. Dabrowski (7), postulating a theory of "positive disintegration," advanced the notion that anxiety could be healthy in certain ways. Alpert and Haber (3) reported two individual scales of facilitating and debilitating anxiety and used them to measure their effect on achievement.

In contrast to the somewhat confused picture in anxiety research, the research in attitudes provides a more stable situation. Fedon (10) found that some students have definite and relatively strong positive attitudes toward elementary school mathematics, while others will have definite and relatively strong negative attitudes about the subject as early as the third grade. Faust (9), in studying more than 2,500

elementary school students, found that of the "skill subjects", they preferred arithmetic first. Bassham (4) found a positive correlation between attitude and achievement.

Poffenberger and Norton (16), in a study of college freshmen, distinguished two subgroups, one positively oriented toward mathematics, the other negatively oriented. Both subgroups were comparable in ability, support from parents, and general parental expectation. The analysis of the data dealt with sex differences, parental influence, and teacher influence on the development of attitudes toward mathematics. Sex did not seem to be a strong factor in the development of a positive attitude toward mathematics, but more than twice as many girls as boys have a strong negative attitude toward mathematics. Parents and parental expectation played an important role in the attitude formation exhibited by the student, but the other results were non-significant.

Other studies (Faust (9), Dutton (8), and Haskell (11)) seem to indicate that grade level, and sociometric grouping seem to affect attitude toward mathematics.

Poffenberger and Norton (16) found in their study that the development of attitudes toward mathematics is a summatory phenomenon with each conditioning experience building upon the one that preceded it. They also found that initial attitudes are developed in the home with the child's first contact with numerals as symbols. These findings have been verified by Aiken and Dreger (2) in their study along the same lines.

As far as the writer has been able to determine, there are not as yet any published studies which have utilized the Spitz Student Response System. This is probably due to the newness of the system.

Significance of the Study

Several aspects of the present study make it a potentially valuable contribution:

(1) The study added to the relatively small amount of research on the effectiveness of teaching college level mathematics.

(2) The present study added to the growing body of work on the effects of attitude on achievement in college level mathematics.

(3) The statistical results of this study tended to cast doubt on the effectiveness of the Spitz Student Response System as a teaching device in beginning college mathematics.

(4) The present study indicated that the use of the Spitz Student Response System tends to give students a more positive attitude toward mathematics.

(5) The subjective evaluation of the Spitz Student Response System tended to lend support to its use in beginning college mathematics.

Definition of Terms

For the purposes of this study, the following definitions were formulated:

(1) Manifest Anxiety was the level of general stability, security, and mental health as reflected by scores on the IPAT Anxiety Scale Questionnaire.

(2) Attitude was a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept or another person.

(3) A Negative Attitude toward mathematics represented a score level less than 60 on the Mathematics Attitude Questionnaire.

(4) A Positive Attitude toward mathematics represented a score level greater than or equal to 60 on the Mathematics Attitude Questionnaire.

(5) Achievement in mathematics was measured by a score on the Southern Methodist University Mathematics 1308 Placement Examination.

Limitations of the Study

In keeping with University policy, this study was limited to the seventy-three students who were enrolled in the two sections of Mathematics 1308 (An Introduction to Logical and Mathematical Concepts) at Southern Methodist University, during the fall of 1970.

It is possible that the results of the study were in some way affected by the Hawthorne Effect of the Spitz System.

Basic Assumptions

It was assumed that the subjects responded honestly to the instruments used to measure manifest anxiety, attitude and achievement.

It was further assumed that the students, in the section in which the Spitz System was used, cooperated fully in its use.

Based on the preliminary research by Dr. Millard, it was assumed that the operation of the Spitz Response apparatus in no way impaired a student's note-taking or class participation.

Procedures for Collecting Data

Subjects for this study were in the two sections of Mathematics 1308 which were assigned to the investigator at Southern Methodist University for the fall, 1970. Mathematics 1308 is a general requirement for all students not majoring or minoring in engineering, science or mathematics. There were thirty-nine students in the control group and thirty-four students in the experimental group. One of the sections met in the specially designed classroom which houses the Spitz Student Response System (SSRS). This was designated as the experimental section. The freshmen at Southern Methodist

University were registered for their courses through a personal conference with a University College Advisor. The actual scheduling of class sections was done by a corps of schedulers who chose these sections for the student in a random manner. The student had no control over the section of a course in which he was placed.

The investigator taught the same material to each section, but in the experimental section, most class periods started with a series of questions which could be answered on the SSRS. This allowed him to set a baseline of understanding for the previous day's lecture material. This material was then re-discussed or drilled if there was a need indicated. Throughout most of the lectures, the instructor used printed or mimeographed materials to present the instructional concepts and the related questions. In this way, the lesson was a continuous series of individual give and take, telling and asking, informing and inquiring, instructing and questioning. The investigator was able to pace himself by moving faster when the student responses were quick and sure. He stopped to amplify, clarify or redefine and explain when the responses indicated the majority of individuals did not understand.

With the SSRS, each student "communicated" with the instructor and could be questioned by the instructor -- privately. Each student had the reward of reaching his maximum level of achievement and was required to maintain full

involvement with the instructor. The SSRS allowed for instant reinforcement of the student for correct responses and an indication of wrong ones, all in a private manner.

The first class meeting was devoted to informing the students in the experimental section about the SSRS. Both classes proceeded at approximately the same rate. The order of procedure for collecting data was as follows:

(1) The IPAT Anxiety Questionnaire under the title Self Analysis Form was administered during the first and last weeks of class, to both classes.

(2) The Mathematics Attitude Questionnaire was administered during the first and last weeks of class, to both classes.

(3) The Mathematics 1308 Placement Test was administered during the first and last weeks of class, to both classes.

(4) Using the definitions given earlier for positive and negative attitudes toward mathematics, the pretest scores on the Mathematics Attitude Questionnaire were divided into two groups.

Procedures for Analysis of Data

The tenability of all hypotheses of this study were tested in the null form at the .05 level of significance (two-tailed test).

Hypotheses 1, 4 and 5 were tested by using a 2 x 2 factorial analysis of covariance with the pre-anxiety score as the covariate. This allowed for simultaneous comparisons of the effects of multiple variables and determined whether a combination of these variables used for classification produced effects not attributable to any single variable.

Hypothesis 2 was tested by means of analysis of covariance with the pretest anxiety score being used as the covariate.

Hypothesis 3 was tested by means of analysis of covariance with the pretest attitude score being used as the covariate.

Summary

The intent of this chapter was to state the problem and to present the purposes and significance of this investigation. Certain hypotheses were formulated and the methodological procedures for their testing were outlined.

Chapter Two is a comprehensive review of the literature relevant to the problem of this investigation.

CHAPTER BIBLIOGRAPHY

1. Aiken, L.R. and R.M. Dreger, "The Identification of Number Anxiety in College Populations," Journal of Educational Research, LVII (December, 1957), 344-351.
2. _____, "The Effects of Attitude on Performance in Mathematics," Journal of Educational Psychology, LII (1961), 19-24.
3. Alpert, Richard and R.N. Haber, "Anxiety in Academic Achievement Situations," Journal of Abnormal and Social Psychology, LXI (1960), 207-215.
4. Bassham, Harrell, "Teacher Understanding and Pupil Efficiency in Mathematics - A Study of Relationships," The Arithmetic Teacher, IX (November, 1962), 383-387.
5. Biggs, John B., "The Psychopathology of Arithmetic," New Approaches to Teaching Mathematics, Editor F.W. Land, New York, St. Martin's Press, 1965.
6. Buros, Oscar K., Editor, The Sixth Mental Measurements Yearbook, Highland Park, New Jersey, The Gryphon Press, 1965.
7. Dabrowski, K., Positive Disintegration, Boston, Little, Brown and Co., 1964.
8. Dutton, Wm.H., "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, LXIII (January, 1956), 18-22.
9. Faust, Claire E., "A Study of the Relationship Between Attitude and Achievement in Selected Elementary School Subjects," Dissertation Abstracts, XXIII (February, 1963), 2752-2753.
10. Fedon, Peter, "The Role of Attitude in Learning Arithmetic," The Arithmetic Teacher, V (December, 1958), 304-310.
11. Haskell, Simon, "Some Observations on the Effects of Class Size Upon Pupil Achievement in Geometrical Drawing," Journal of Educational Research, LVIII (September, 1964), 27-30.

12. Hess, Eckhard H., "Attitude and Pupil Size," Scientific American, CCXII (April, 1965), 46-54.
13. Milliken, R.L., "Mathematical-Verbal Ability Differentials of Situational Anxiety as Measured by Blood Pressure Change," Journal of Experimental Education, XXXII (September, 1964), 309-311.
14. _____ and Bernard Spelka, "Mathematical-Verbal Ability Differentials and Somatic Expressions of Situational Anxiety," Journal of Experimental Education, XXXI (September, 1962), 3-26.
15. Morgan, Jas. H., "The Relationship Between Levels of Anxiety and Mathematics Achievement in Programmed and Teacher-Directed Instruction," Dissertation Abstracts, XXV (1965), 3760.
16. Poffenberger, Thomas and Donald Norton, "Factors in the Formation of Attitudes Toward Mathematics," Journal of Educational Research, LII (January, 1959), 171-176.
17. _____, "Factors Determining Attitudes Toward Arithmetic and Mathematics," The Arithmetic Teacher, III (April, 1956), 113-116.
18. Rethlingshafer, Dorothy, Motivation as Related to Personality, New York, McGraw-Hill, 1963.
19. Riggs, Cassidy Leroy, "The Relationship of Anxiety and Anxiety Adaptation to Aptitude, Self-Concept, and Scholastic Achievement," Dissertation Abstracts, XXII (1961), 3927.
20. Ruebush, Britton K., "Anxiety!" Child Psychology, Sixty-Second Yearbook of the National Society for the Study of Education, Part 1, Chicago, University of Chicago Press, 1963.
21. Sarason, S.B., et al., Anxiety in Elementary School Children, New York, John Wiley and Sons, Inc., 1960.
22. Scheier, I.H., and R.B. Cattell, Handbook for the IPAT Anxiety Scale Questionnaire, Illinois, Institute for Personality and Ability Testing, 1967.
23. Taylor, Janet A., "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Social Psychology, XLVIII (1953), 285-290.

24. Tulock, Mary K., "Emotional Blocks in Mathematics,"
The Mathematics Teacher, L (December, 1957), 572-576.
25. White, W.F. and Robert L. Aaron, "Teacher's Motivational
Cues and Anxiety in Relation to Achievement Levels in
Secondary School Mathematics," Journal of Educational
Research, LXI (1967), 6-9.
26. Woodworth, R.S., Dynamics of Behavior, New York, Henry
Holt and Company, 1958.

CHAPTER II

SURVEY OF THE LITERATURE

In order to present a comprehensive survey of the literature related to the problem of determining the effects of anxiety and attitude on achievement in mathematics, the investigator chose to organize the relevant research into two categories. These categories will be the research related to the effect of anxiety on achievement in mathematics and the research related to the effect of attitude on achievement in mathematics. At the present time, there is no published research about the Spitz Student Response System or its effectiveness. Therefore, this dissertation will be a pioneer work in that respect.

Studies Concerned With the Relationship of Anxiety to Achievement in Mathematics

The word anxiety occurred in the English language for the first time about 1525 (20). It did not become an object of scientific consideration until the use of twentieth century experimental psychology. More has been researched and written on the subject during the past two decades than ever before (27). One of the primary reasons for this was the development of the first widely used anxiety scale in the early 1950's.

The Manifest Anxiety Scale was developed by Janet Taylor (32, 33, 34). It consisted of items selected from the Minnesota Multiphasic Personality Inventory. The scale evolved from an attempt to measure Hull's D or drive in human subjects (27).

Extensive use of this scale plus different specific needs by other researchers quickly led to the development of other scales. Freeman (11) developed the Anxiety Scale in 1953. Bendiz (7) devised a short form of Taylor's scale in 1956. Welsh (37) developed the Welsh Anxiety Index in the same year. Sarason (28), Alpert and Haber (5), and others have all developed various varieties of anxiety scales. As data accumulated from studies utilizing these scales, it became apparent that they were not all measuring the same thing (27).

Anxiety is an important construct in theories of behavior, ranging from psychoanalysis to learning theory, and most authors tend to use a theoretically derived definition, although some use empirically derived definitions. The comparability of findings from different studies is not only complicated by differences in theoretical definitions but also by differences in operational criteria from study to study within the same theoretical framework. (26, p. 461).

As a result, this resulting proliferation of anxiety studies produced increasingly divergent data. Some of the more important studies are reviewed in the following paragraphs.

It has been the experience of most mathematics teachers in required mathematics courses to note a great deal of

dislike of mathematics on the part of their students. Dislike is certainly there, but there is something else besides. A student can enter an examination in English heartily disliking the subject, but he may still come out with respectable results, whereas if he really dislikes mathematics, it is a fairly safe bet that he will fail his examinations in it. This extra factor has been variously described as "number anxiety" or "mathemaphobia".

Schonell (31) observed that backwardness in arithmetic is due as much to emotional as to intellectual factors, and psychoanalytic writers (13, 14, 23) suggest that failure in arithmetic may be related to maternal overprotection. Dreger and Aiken (9) identified a syndrome of emotional reactions to arithmetic and mathematics which they designated as "number anxiety". The Dreger and Aiken (9) study was conducted with seven hundred and four students in basic mathematics classes at Florida State University. The investigators modified the Taylor Manifest Anxiety Scale to include several items specifically designed to measure feelings of anxiety concerning working with numbers. Their findings were as follows:

- (1) Number Anxiety does appear to be a separate (composite) factor from "general anxiety".

- (2) Number Anxiety does not seem to be related to general intelligence as measured by the Wechsler-Bellevue or ACE Scales.

(3) Persons with high Number Anxiety do tend to make lower mathematics grades.

Biggs (8) points out that it is well known that anxiety can exert two fundamentally different effects on learning -- on the one hand, it can be used to motivate the learner, and so improve his learning, but on the other, too much anxiety can inhibit and depress learning. Biggs further points out that other things being equal, we can expect the best performance in a given learning task to come from the learner who is relatively anxious. Obviously, both those who "could not care less" how well they did, and those who were absolutely terrified of making a mistake, would perform badly in comparison. Naturally, there are wide individual differences in reaction to anxiety some people can cope with a very high level of anxiety before going to pieces but, in general, it is clear that whether anxiety motivates or inhibits in a given situation depends upon the degree of anxiety involved.

Sarason, Mendler, and Craighill (29) imply that measurable anxiety responses, when present, are debilitating on performance. Alpert and Haber (5) developed a scale that measured both facilitating and debilitating anxiety in academic achievement situations. It was determined in their study that prediction of academic achievement was much increased when both scales were used. Phillips (22) in his study entitled "Sex, Social Class, and Anxiety as Sources of Variation in School Achievement", found that sex differences

existed in level of anxiety with males having lower anxiety scores than females; also, differences in the achievement of subjects with high and low anxiety were found, with high anxiety being associated with lower achievement. In general, he found that anxiety as a debilitating factor was more evident in relation to teacher grades than in relation to achievement tests, with the achievement of lower-class males being less affected than the achievement of other adolescents. These findings might best be interpreted in light of the speculation by Sarason, Davidson, Lighthall, and Waite (30) that the expression of anxiety is incongruous to the male's conception of himself, and this causes him to be more defensive in admitting anxiety and thus obtain a lower anxiety score than females.

McKeachie (15) demonstrated that the classroom atmosphere set by the teacher directly affected the anxiety level of freshmen students and their test grades. Riggs (25) showed that anxiety and its adaptation apparently have an effect on learned responses such as adjustments and values, while they do not seemingly influence aptitudes and grade point averages to any significant degree.

Again, as Biggs (8) points out, it is clear that there are wide individual differences in reactions to anxiety but, in general, it is clear that whether anxiety motivates or inhibits in a given situation depends upon the degree of anxiety involved. Miller and Dollard (16) stated that

completely self-satisfied people are poor learners. Anxiety belongs in the learning situation. In fact, anxiety (mild) can be looked upon as an essential condition for learning. Anxiety can have positive, healthy values and serve as a challenge to spark intelligent and creative behavior.

The significant thing is that this general relationship has been found to apply to learning of all kinds -- except, it seems, arithmetical and mathematical learning. Biggs (8) notes that in arithmetic and mathematics, the inhibition produced by anxiety appears to swamp any motivating effect, particularly where the children concerned are already anxious; to put it another way, anxiety appears to be more easily aroused in learning mathematics than it is in other subjects. He feels that the reason for this is found in a combination of two factors: the manner of learning that the current teaching methods encourage, and the nature of mathematics itself. Milliken and Spilka (17) showed that breathing rate increases, blood pressure elevates and heart rate increases when a student finds himself in a mathematical type situation. Milliken (18) also found that to the extent that students exhibited mathematical deficit they did increase in anxiety under stressful mathematics testing for both sexes, as contrasted with only a slight increase during verbal testing. Hess (12) found that the pupil size of the eye increased upon the presentation of a mathematical problem and it decreased upon solution of the problem. Zweibelson and Lodato (37)

have pointed out that personal anxiety resulting from negative attitudes toward arithmetic produce a specific deterrent to arithmetic achievement. This deterrent appears specific enough to be called "arithmetic anxiety" or "number anxiety". It seems likely that these negative attitudes toward mathematics and the subsequent avoidance or fear of mathematics may account for a lack of achievement in mathematical type work. Zweibelson and Lodato (37) further point out that this anxiety toward mathematics may well develop prior to formal schooling. "One explanation of this may be found in the fact that exposure to the preciseness of arithmetic (mathematics) may cause anxiety which is generated by a fear of failure or of being wrong" (37, p. 140). Their study did find results to support the hypothesis that anxiety and arithmetic achievement were negatively correlated.

The above results are somewhat diminished by several studies such as the one by Morgan (19) in which no significant relationship between anxiety level and mathematics achievement was found. However, the majority of research still agrees with the findings of Zweibelson and Lodato (37).

Studies Concerned with the Relationships of Attitude to Achievement in Mathematics

There have been several studies -- Aiken (3), Dreger and Aiken (9), Dutton (10), Poffenburger and Norton (24), and Tulock (35) -- which suggest that performance in mathematics

is influenced by non-intellective as well as intellective variables. The simplest explanation for this fact is that pronounced fears in the presence of mathematics and other negative fears toward mathematics result from experiences specific to the learning of mathematics, in particular that the manner in which significant others, viz., teachers and parents, instruct children in mathematics is the primary determinant of their attitudes toward the subject (1).

Norton and Poffenburger (24) have shown that the development of attitudes toward mathematics is a summatory phenomenon with each conditioning experience building upon the one that precedes it. Initial attitudes are developed in the home with the child's first contact with numerals as symbols. When a child is confronted by numbers, he is affected not only by his teachers but also by the reactions of his parents to this newly introduced subject.

Aiken, (4, p. 589), in a very complete and detailed review of the research literature on attitudes toward mathematics, found that

Although it is certainly unfair to indict teachers too strongly as creators of negative student attitudes toward mathematics, the results of research have suggested that the teacher, perhaps even more than the parents, is an important determiner of student attitudes. ...To provide further information on the effects of teacher attitudes, more direct measures of teacher attitudes and their consequences (e.g., by classroom observation) should be obtained. Student reports of perceived teacher attitudes and teacher reports of their own attitudes are useful, but direct observation of teacher-pupil interaction in mathematics classes is also needed. In addition, more attention

should be paid to the mathematics training of elementary school teachers. If the law of primacy holds, the influence of elementary teachers on pupil attitudes should be even greater than that of secondary teachers.

In addition, Aiken (2) found that attitudes are determined by teaching methods in mathematics, although individual differences in general intelligence and temperament may affect the development of such attitudes. Evidence in his work also led to the conclusion that females tend to have a more negative attitude toward mathematics.

Anttonen (6) made a longitudinal study to examine the stability of mathematics attitude over a six-year period. The period he chose extended from the fifth and sixth grade level to the eleventh and twelfth grade level. His study involved 1,017 students in St. Paul, Minnesota. He found that attitude toward mathematics changed over the six-year period and that the elementary and secondary attitude scores were positively correlated. Anttonen (6) also found that the secondary attitude score had a high positive correlation with the mathematics achievement scores on the secondary level. Aiken and Dreger (1, p. 19) have shown that

1. Math attitude scores made a significant contribution to the prediction of final grades in a mathematics course.

2. Math attitude scores predict gains in scores from initial to final administration of a mathematics achievement test when training has intervened.

3. Math attitudes are positively correlated with numerical ability.

4. Math attitudes are positively correlated with subject's ratings of former mathematics teachers.

5. Math attitudes are positively correlated with subject's reports of early parental encouragement of mathematics endeavors.

Neidt and Hedlund (21) investigated the relationship between change in a student's attitude toward a class in which he was participating and his final achievement in that class, with ability held constant. They postulated that certain periods during a learning experience might be identified during which attitudes toward the learning experience were clearly related to final achievement. The expected model of this relationship was one of increasing congruence between attitudes and final achievement as the class progressed. The results of their study show that student attitudes toward a particular learning experience do become progressively more closely related to achievement in the learning experience as the period of instruction progresses. It was also found that attitudes are significantly related to final course grades rather early in the period of instruction.

Aiken (4) reviewed most of the research on attitudes toward mathematics since 1960. Among his criticisms of research on attitudes toward mathematics were the use of crude measures of attitudes, excessive reliance on correlational methods, improper use of covariance analysis, inadequate control of extraneous variables, and failure to use adequate measures of change.

It is clear that serious thought must be given to experiments concerned with temporary and more permanent effects of preschool and early school experiences on attitude toward and performance in mathematics. In both the development and modification of attitudes, and in training and remedial work, a question is how to make mathematics more interesting. New methods may be initially motivating, but their effects will not last if the teachers are poorly trained, the parents are not sympathetic, and the students are not successful in mastering the subject. (4, p. 591).

Summary

It has been the purpose of this chapter to review the professional literature relative to two points. The first point concerned the effects of anxiety on achievement in mathematics. The findings are somewhat contradictory, but the majority of studies seem to indicate that anxiety and achievement are negatively correlated. The relationship is not a simple one, however, as other variables such as mathophobia, sex, attitudes and prior experience with mathematics were found to interact.

The second point concerned the effects of attitude on achievement in mathematics. The findings are more consistent and conclusive for attitudes than for anxiety. The research seems to indicate that the more positive a person's attitude, the better will be his achievement level in mathematics. An attitude score is an excellent predictor of mathematical achievement. In general, attitudes are a summatory phenomenon with each conditioning experience building upon the one that

precedes it (24). It has been found that girls seem to have a more negative attitude toward mathematics than boys.

Chapter Three is a description of the experimental design, the instruments, and the Spitz Student Response System. Also, the procedure used in the treatment of the data will be discussed.

CHAPTER BIBLIOGRAPHY

1. Aiken, L.R., Jr., and R.M. Dreger, "The Effects of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII (1961), 19-24.
2. Aiken, L.R., Jr., "Mathemaphobia and Mathemephilia: An Analysis of Personal and Social Factors Affecting Performance in Mathematics," Dissertation Abstracts, 1960, p. 1992.
3. _____, "Affective Factors in Mathematics Learning: Comments on a Paper by Neale and a Plan for Research," Journal for Research in Mathematics Education, I (1970), 251-255.
4. _____, "Attitudes Toward Mathematics," Review of Educational Research, XL (1970), 551-596.
5. Alpert, R., and R.N. Haber, "Anxiety in Academic Achievement Situations," Journal of Abnormal and Sociological Psychology, LXI (1960), 207-215.
6. Anttonen, R.G., "A Longitudinal Study in Mathematics Attitude," Journal of Educational Research, LXII (1969), 467-471.
7. Bendiz, A.W., "The Development of a Short Form of the Manifest Anxiety Scale," Journal of Consulting Psychologists, XX (1956), 384.
8. Biggs, John, "The Psychopathology of Arithmetic," New Approaches to Mathematics Teaching, Editor F.W. Land, New York, St. Martin's Press, 1965.
9. Dreger, R.M. and L.R. Aiken, Jr., "The Identification of Number Anxiety in a College Population," Journal of Educational Research, XLVIII (1957), 344-351.
10. Dutton, W.H., "Measuring Attitudes Toward Arithmetic," Elementary School Journal, 1954-55, 24-32.
11. Freeman, M.J., "The Development of a Test for the Measurement of Anxiety: A Study of its Reliability and Validity," Psychology Monographs, Editor H.S. Conrad, New York, American Psychology Association, 1953.

12. Hess, Eckhard H., "Attitude and Pupil Size," Scientific American, CCXII (1965), 46-54.
13. Klein, E., "Psychoanalytic Aspects of Scholastic Problems," Psychoanalytic Study of the Child, Editors A. Freud and H. Hartman, III-IV, New York, International Universities Press, 1949, 369-390.
14. Levy, D.M., Maternal Overprotection, New York, Columbia University Press, 1947.
15. McKeachie, W.J., "Maturation, Teaching Methods and College Learnings," Nebraska Symposium on Maturation, Editor M.R. Jones, Lincoln, University of Nebraska Press, 1961, 111-146.
16. Miller, N.E. and J. Dollard, Social Learning and Imitation, New Haven, Yale University Press, 1941.
17. Milliken, R.L., and Bernard Spilka, "Mathematical - Verbal Ability Differentials and Somatic Expressions of Situational Anxiety," Journal of Experimental Education, XXXI (1962), 3-6.
18. Milliken, R.L., "Mathematical-Verbal Ability Differentials of Structional Anxiety as Measured by Blood Pressure Change," Journal of Experimental Education, XXXII (1964), 309-311.
19. Morgan, J.H., "The Relationship Between Levels of Anxiety and Mathematics Achievement in Programmed and Teacher Directed Instruction," Dissertation Abstracts, XXVI (1965-66), 3760.
20. Murray, Jas.A.H., et.al., The Oxford English Dictionary, London, University of Oxford Press, 1933.
21. Neidt, C.O., and D.E. Hedlund, "The Relationship Between Changes in Attitude Toward a Course and Final Achievement," Journal of Educational Research, LXI (1967), 56-58.
22. Phillips, B.N., "Sex, Social Class, and Anxiety as Sources of Variation in School Achievement," Journal of Educational Psychology, LIII, 316-322.
23. Plank, E.N., and R. Plank, "Emotional Components in Arithmetical Learning as Seen Through Autobiographies," Psychoanalytic Study of the Child, Editors A. Freud and E. Kris, IX, New York, International Universities Press, 1952.

24. Poffenburger, T.N., and D. Norton, "Factors Determining Attitudes Toward Arithmetic and Mathematics," The Arithmetic Teacher, III (1956), 113-116.
25. Riggs, L.R., "The Relationship of Anxiety and Anxiety Adaptation to Aptitude, Self Concept, and Scholastic Achievement," Dissertation Abstracts, 1961, 3923.
26. Ruebush, B.K., "Anxiety," Child Psychology, Sixty-Second Yearbook of the National Society for the Study of Education, Part I, Chicago, University of Chicago Press, 1963.
27. Sarason, Irwin G., "Empirical Findings and Theoretical Problems in the Use of Anxiety Scales," Psychological Bulletin, LVII (1960), 403-415.
28. _____, "Interrelationships Among Individual Differing Variables, Behavior in Psychotherapy, and Verbal Conditioning," Journal of Abnormal and Sociological Psychology, LVI (1958), 339-344.
29. Sarason, S.B., G. Mandler, and P.B. Craighill, "The Effect of Differential Instructions on Anxiety and Learning," Journal of Abnormal and Sociological Psychology, XLVII (1952), 561-565.
30. Sarason, S.B., K. Davidson, et.al., "Classroom Observation of High and Low Anxious Children," Child Development, XXIX (1958), 287-296.
31. Schonell, F.J., Diagnosis of Individual Differences in Arithmetic, Edinburgh, Oliver and Boyd, 1937.
32. Taylor, Janet A., "The Relationship of Anxiety to the Conditional Eyelid Response," Journal of Experimental Psychology, XLI (1951), 81-92.
33. _____, "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Sociological Psychology, XLVIII (1953), 285-290.
34. _____, "Drive Theory and Manifest Anxiety," Psychology Bulletin, LIII (1956), 303-320.
35. Tulok, M.K., "Emotional Blocks in Mathematics," Mathematics Teacher, V (1957), 572-576.
36. Welsh, Geo. S., "An Anxiety Index and an Internalization Ratio for the MMPI," Journal of Consulting Psychologists, XVI (1962), 65-72.

37. Zweibelson, Irving and F.J. Lodato, "Relationship of Pupil Anxiety and Attitude to Arithmetic Readiness and Achievement," Psychology in the Schools, II (1965), 140-142.

CHAPTER III

DEVICES AND METHODOLOGY

The purpose of this chapter is to describe the experimental study which was conducted. The chapter is divided into sub-sections: the description of the subjects and the experimental design, the instruments used to evaluate the relative effectiveness of the two teaching methods, student anxiety and attitude, the Spitz Student Response System, and the procedures used in the collection of the data.

Description of the Experimental

Design and Sample

The subjects involved in this study were 73 freshmen students at Southern Methodist University, Dallas, Texas. Subjects were enrolled in an Introduction to Logical and Mathematical Concepts, Math 1308, during the Fall Semester, 1970. An Introduction to Logical and Mathematical Concepts is a required course for non-mathematics and non-science majors and minors. The course was designed to include the basic concepts of elementary mathematics and special emphasis was given to symbolic logic and its application in mathematics. Total enrollment in the course was approximately 800 students. The experimental group and control group were the two sections of Math 1308 which were taught by the investigator. The

students had no knowledge of who the teacher would be until the first day of class. The control group met before the experimental group to keep any knowledge gained in the experimental group from being used on the control group inadvertently. Both classes were kept together in the presentation of the material.

The basic experimental scheme of the study was a 2 x 2 factorial analysis of covariance design. There were two levels of attitude and two groups - a control group and an experimental group. This type of statistical design allowed simultaneous comparisons of the effects of multiple variables and determined whether a combination of these variables used for classification produced effects not attributable to any single variable.

According to Winer (9), factorial experiments permit the experimenter to evaluate the combined effect of two or more experimental variables when used simultaneously. Information is more complete than single factor designs due to the evaluation of interaction effects. An interaction effect is an effect attributable to the combination of variables above and beyond that which can be predicted from the variables considered singly, i.e., in addition to the information about the operation of experimental variables in isolation, the experimenter can predict what will happen when two or more variables are used in combination. Also, according to Winer, if one uses a factorial design, the results are more generalizable

than if a single factor experiment is used because the estimates of the effects are obtained by averaging over a relatively broad range of other relevant experimental variables without having to hold them constant.

In addition to using a factorial design, the investigator chose to use analysis of covariance as a means of introducing an additional factor into the factorial experiment. As Lindquist (4, p. 334) points out,

most people employ analysis of covariance to increase the precision of the experiment and to adjust for initial differences between the groups and not because the relationship of the control and criterion measures was of any interest in itself. In many instances, however, the X-factor may be introduced for exactly the same reasons that any other "factor" is introduced in a factorial experiment - that is, in order to study its relationship to the other factors or the manner in which it may affect the comparisons within any of the other classifications.

In the case of the present study, the anxiety score was introduced as a covariate so that by the method of analysis of covariance the mean scores on the criterion achievement tests could then be adjusted so as to study the effect of anxiety on achievement for the comparison of the subclasses.

Instruments

After reviewing the availability of standardized tests (2) in mathematics, it was decided that there were no appropriate standardized achievement tests to measure the outcome of the course, An Introduction to Logical and Mathematical Concepts. The course stresses the understanding

of logical and mathematical concepts rather than skill in performing basic operations. Most of the available standardized tests evaluate basic skills. Those standardized tests which do evaluate concepts do not include all the concepts taught in the course, An Introduction to Logical and Mathematical Concepts, Mathematics 1308. The instrument chosen was the Placement Test used at Southern Methodist University. This test is given at the beginning of each semester to those students who wish to take it. If a student scores 70 or higher on this Placement Test, he is granted credit for Mathematics 1308. The instrument is considered to have content validity in the judgment of the investigator for the following reasons:

- (1) The investigator was a member of the committee which designed the course and feels competent to judge the test.

- (2) The investigator was co-author of the text for the course.

- (3) The investigator has taught the course over twenty times to over 700 students using essentially the same questions on the instrument as a basis for evaluating student achievement in the course.

- (4) The instrument is the result of pooling items suggested by all faculty involved in teaching the course. The faculty is in full agreement that the instrument measures the concepts and aims of the course.

(5) The instrument is highly refined through constant revision, discarding inappropriate items and adding new items through common agreement by the faculty involved in teaching the course.

(6) It is assumed that the content of the present course did not differ significantly from that of previous courses and that the investigator conducted the course using his usual approach.

The test was found to be internally consistent because a split-halves reliability coefficient of .81 was determined for this test.

Norms have been established for the examination with a mean of 71.69 and a standard deviation of 13.35. A copy of the Placement Test appears in Appendix A.

The present study made use of the Mathematics Attitude Scale which was developed by Dr. Lewis R. Aiken, Jr., (Women's College of the University of North Carolina), and Dr. Ralph M. Dreger (Jacksonville University) for use in several papers which they wrote. It is an opinionnaire which makes use of a five-point scale from strongly disagree to strongly agree on each item. The Mathematics Attitude Scale is actually two scales in one. There is a ten item scale to measure positive attitude and a ten item scale to measure negative attitude. The test was scored to yield a positive attitude score which is the sum of the values on all twenty items. An arbitrary cutoff point of 60 was used to divide

the scores into two levels. The scores of 60 and above were said to represent a positive attitude toward mathematics while those scores less than 60 were said to represent a negative attitude toward mathematics.

According to Aiken and Dreger (1) this psychometric instrument of twenty items was constructed by the Likert attitude scaling technique. The test retest reliability was found to be $r = .94$. In addition, a test of independence between the scores on the attitude scale and scores on four items designed to measure attitudes toward academic subjects in general suggested that attitudes specific to mathematics were being measured ($\chi^2 = .80$, $df = 1$).

According to Aiken and Dreger (1), the instrument has face or content validity. Also, a partial correlation was determined between scores on the Mathematics Attitude Scale and retest scores on the Mathematics Pretest for College Students, partialling out the effects of initial scores on the latter test. They treated the data separately for one hundred males and one hundred females and found concurrent validity for the instrument in the form of significant partial correlation coefficients of .33 and .34 for males and females respectively.

Aiken and Dreger (1) also established predictive validity coefficients of .67 and .63 for males and females respectively. The predictive coefficient for males turned out to be slightly insignificant (at .01 level of significance), but

the Mathematics Attitude Scale was found to be a good predictor of achievement for females. A copy of the Mathematics Attitude Scale appears in Appendix B.

The present study also used the IPAT Anxiety Questionnaire which was designed and constructed by Dr. R. B. Cattell of the Institute for Personality and Ability Testing. The Cattell Anxiety Scale consists of forty items and is presented in a test booklet labeled The Self Analysis Form (for it is considered undesirable for subjects to realize that it intends to measure anxiety). The main three scores are overt anxiety (symptomatic anxiety), covert (not consciously displayed), and total anxiety. The total anxiety scores are to be used in the present study. The manual specifically distinguishes between anxiety and neuroticism, and described the anxiety factor as being "a feature of neurosis (especially anxiety neurosis, but it is far from being the only feature of neurosis" (7).

The manual reported split-half reliability of .84 on 240 normal adults and .91 on 120 subjects in a mixed population of normals and hospitalized neurotics. Construct validity was estimated at .85 to .90 for the total scale. Females were reported to consistently average slightly higher on a free anxiety level as compared to males. However, Cattell suggested that in correlational studies and in some types of research, no corrections for sex are necessary. The norm tables for the separate sexes were suggested for use in

counseling, where one might wish to know how a person stood in relation to a defined population. The manual also suggests corrections for ages over 60 years. This will not be necessary, as no subjects in this study are that old. Thus, no corrections will be made to the raw scores.

This instrument was chosen for several reasons. First, it was developed as the result of extensive research using Cattell's factor analysis technique. The forty items included in the final scale were selected from over four thousand original items. Second, the Cattell Anxiety Scale was developed for the stated purpose of diagnosis of anxiety. Third, it has received excellent reviews in Buros (2) by Jacob Cohen, J. P. Guilford and E. Lowell Kelly. A copy of the Cattell (IPAT) Anxiety Scale appears in Appendix C.

Description of the Spitz Student

Response System

One of the newest teaching devices is the Spitz Student Response System. The Spitz Student Response System is an electronic classroom communication system, that individualizes group instruction by providing constant interaction between the student and his instructor, as well as allowing the instructor to know exactly how well the entire class - and each student - understands a particular presentation.

A Spitz Student Response System was installed at Southern Methodist University in 1969 in an amphitheatre-type

classroom in a refurbished building. The Spitz System was developed by the Spitz Laboratories, Inc., Chadds Ford, Pennsylvania, which is a division of the McGraw-Hill Book Company.

The Spitz installation at Southern Methodist University was installed at a cost of approximately \$18,000. The System has sixty-eight individual student stations with a central console and a teleprinter installed at the center of the front of the room.

A diagram of the individual student responder is shown in Figure 1, and a diagram of the central console unit is shown in Figure 2.

The Spitz Student Response System establishes student-teacher interaction. It provides the instructor with a means of receiving instant responses from the class as a whole and from each individual in the class.

The response system is a general purpose question-and-answer tool. The following are the basic values of the system as listed in the Spitz literature (8).

1. The Spitz Student Response System provides continuous student feedback to the instructor and gives him a permanent record of the responses.
2. The Spitz Student Response System involves all the students in the class and requires active, fulltime participation. The instructor knows at what point student interest or comprehension falls down, and he can immediately stop or restate, redefine, clarify or drill.
3. The student has the pleasure and reward of immediate and private reinforcement - plus a continuous awareness of his own achievement.

FIGURE I

STUDENT RESPONDER

FIGURE II

INSTRUCTOR

CONTROL

4. From a practical point of view, the system provides for individualized instruction within the large group teaching situation. It strengthens communication between teacher and student.

In this study, the system was used as follows: At the beginning of each class period, each student was presented a list of three or more questions dealing with the major points in the preceding day's lecture and class work. With the aid of the Spitz System, the investigator was able to determine the level of group understanding for the concepts tested. The scaling device on the console gave an indication of the percentage of correct responses to each question. It was arbitrarily decided that any topic represented by a question which received 60 percent or more correct responses, would not be discussed any further unless some student made a special request for its discussion. Any topic represented by a question which received less than 60 percent correct responses was amplified and clarified through the review of the topic and the presentation of additional examples. This procedure allowed the investigator to get a base line for the learning level of the class on the preceding day's material.

Since the individual responders furnished instant reinforcement for correct answers, the student was aware of his correct responses as well as the incorrect ones. Because the student was furnished a list of the questions, he had the list with the correct responses indicated, as well as his weak points, for further study and reference. These lists

proved invaluable, because when a student came in for a private conference, the investigator could refer to his specific problem areas and drill him on them.

During the course of some of the lectures, other question and answer sessions were conducted and this allowed the lesson to be a continuous series of individual give and take. This procedure also allowed the investigator to pace himself and move more quickly when the student responses were quick and sure.

Student participation was called for frequently, and each student had to maintain involvement. This process of almost daily questioning over the preceding day's material forced the students to study the material daily and not procrastinate. The level of class comprehension seemed, in the opinion of the investigator, to be better and faster than the control group. The need for daily study might have been the factor involved in this phenomenon. The daily question lists had the added advantage of giving the student a preview of typical examination questions as well as pinpointing areas of particular importance.

Because of the use of the mimeographed lists of questions, there was no need for the automatic printout data. The Teleprinter is an extremely noisy instrument and this noise is a great distraction. The investigator feels that this is a decided weakness in the system.

Procedures for Collecting Data

Subjects for this study were in the two sections of Mathematics 1308 which were assigned to the investigator at Southern Methodist University for the fall of 1970. Mathematics 1308 is a general requirement for all students not majoring or minoring in engineering, science or mathematics. There were thirty-nine students in the control group and thirty-four students in the experimental group. The experimental section met in the specially designed classroom which houses the Spitz Student Response System. The freshmen at Southern Methodist University were all registered for their courses through a personal conference with a University College Advisor. The actual scheduling of class sections was done by a corps of schedulers who chose these sections for the student in a random manner. The student had no control over the section of a course in which he was placed.

The investigator taught the same material to each section, but in the experimental section, each class period started with a series of questions which could be answered on the Spitz Student Response System. This allowed him to set a base line of understanding for the previous day's lecture material. This material was re-discussed or drilled if there was a need indicated. Throughout the lecture, the instructor used printed or mimeographed materials to present the instructional concepts and the related questions. In this way, the lesson was a continuous series of individual information and

inquiry. The investigator was able to pace himself by moving faster when the student responses were quick and sure. He stopped to amplify, clarify or define and explain when the responses indicated the majority of individuals did not understand.

With the Spitz Student Response System, each student "communicated" with the instructor and could be questioned by the instructor privately. Each student had the reward of reaching his maximum level of achievement and was required to maintain full involvement with the instructor. The Spitz Student Response System allowed for instant reinforcement of the student for correct responses and an indication of wrong ones, all in a private manner.

The first class meeting was devoted to informing the students in the experimental section about the Spitz Student Response System. Both classes proceeded at approximately the same rate.

The order of procedure for collecting data was as follows:

(1) The IPAT Anxiety Questionnaire under the title Self Analysis Form was administered during the first and last weeks of class, to both classes.

(2) The Mathematics Attitude Questionnaire was administered during the first and last weeks of class, to both classes.

(3) The Mathematics 1308 Placement Test was administered during the first and last weeks of class, to both classes.

Summary

In order to secure the data utilized in this study, anxiety, attitude and achievement instruments were selected and administered to a control section and an experimental section of An Introduction to Logical and Mathematical Concepts, Mathematics 1308. The control group consisted of thirty-nine students and the experimental group had thirty-four students. The independent variables for the study were the anxiety score, attitude score, and group membership. The criterion measure was the achievement test given during the last week of class. The .05 level of significance was used to test all hypotheses.

In Chapter Four the data and the results of the statistical treatment of the data will be discussed in detail.

CHAPTER BIBLIOGRAPHY

1. Aiken, L.R., and R.M. Dreger, "The Identification of Number Anxiety in a College Population," Journal of Educational Research, LVII (1957), 344-351.
2. Buros, Oscar K., Editor, The Sixth Mental Measurements Yearbook, Highland Park, Illinois, The Gryphon Press, 1965.
3. Campbell, D.T., and J.C. Stanley, Experimental and Quasi-Experimental Designs for Research, Chicago, Rand McNally & Co., 1966.
4. Lindquist, E.F., Design and Analysis of Experiments in Psychology and Education, Boston, Houghton-Mifflin & Co., 1956.
5. Roscoe, J.T., Fundamental Research Statistics, Dallas, Holt, Rinehart and Winston, 1969.
6. Sax, G., Empirical Foundations of Educational Research, New Jersey, Prentice-Hall, 1968.
7. Scheier, I.H. and R.B. Cattell, Handbook for the IPAT Anxiety Scale Questionnaire, Illinois, Institute for Personality and Ability Testing, 1967.
8. "Spitz Student System for Large Group Instruction" An Advertisement by Spitz Laboratories, Inc., Chadds Ford, Pennsylvania, A Division of McGraw-Hill, Inc.
9. Winer, B.J., Statistical Principles in Experimental Design, New York, McGraw-Hill, 1962.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The basic purposes of this study were

(1) To compare the achievement levels of students enrolled in a required freshman mathematics course when taught by (a) regular lecture-recitation method, and, (b) lecture-recitation method augmented by the Spitz Student Response System.

(2) To ascertain the effect of the Spitz Student Response System upon a student's anxiety level and his attitude toward mathematics.

(3) To analyze the effect of attitude on achievement in mathematics when the Spitz System was used.

(4) To determine whether there was any interaction between student anxiety, attitude and method of instruction as variables affecting student achievement.

To carry out the purposes of this study, the following hypotheses were formulated

(1) The adjusted mean achievement of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean achievement of the students taught by the regular lecture-recitation method.

(2) The adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System would be significantly lower than the adjusted mean anxiety score of the students taught by the regular lecture-recitation method.

(3) The adjusted mean positive attitude score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean positive attitude score of the students taught by the regular lecture-recitation method.

(4) The adjusted mean achievement of the students with a positive attitude toward mathematics would be significantly higher than the adjusted mean achievement of the students with a negative attitude toward mathematics.

(5) There would be significant interaction between the level of attitude and the method of instruction as variables affecting achievement in mathematics when the effects of anxiety were controlled statistically.

The purpose of this chapter is to present the statistical data relative to these hypotheses.

Treatment of the Data

The tenability of all the hypotheses of this study was tested in the null form at the .05 level of significance.

(two-tailed test)

Both the control group and the experimental group were given, in a pre-test and post-test situation, the Cattell (IPAT) Anxiety Scale, the Mathematics Attitude Questionnaire, and the Mathematics 1308 Placement Test.

The following definitions were used to determine the levels for the classification variables as required by the 2 x 2 factorial design.

(1) Manifest Anxiety was the level of general stability, security and mental health as reflected by scores on the IPAT Anxiety Scale Questionnaire.

(2) Attitude was a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept or another person.

(3) A Negative Attitude toward mathematics represented a score level less than 60 on the Mathematics Attitude Questionnaire.

(4) A Positive Attitude toward mathematics represented a score level greater than or equal to 60 on the Mathematics Attitude Questionnaire.

(5) Achievement in mathematics was measured by a score on the Southern Methodist University Mathematics 1308 Placement Examination.

Data Relative to the Hypotheses

Table I indicates the results of the analysis of covariance for a two-way design between levels of attitude and methods of instruction using the pre-achievement scores and the pre-anxiety scores as the covariates.

TABLE I

ANALYSIS OF COVARIANCE TABLE SHOWING SOURCES OF VARIATION
FOR A TWO-WAY CLASSIFICATION BETWEEN LEVELS OF
ATTITUDE AND METHODS OF INSTRUCTION USING
THE PRE-ACHIEVEMENT SCORES AND THE
PRE-ANXIETY SCORES AS
COVARIATES

Sources of Variation	Degrees of Freedom	Adjusted Sum of Squares	Adjusted Mean Squares	F Ratios	p
(1) Between levels of Attitude	1	5487.42	5487.42	9.78	.025
(2) Between methods of instruction	1	37.94	37.94	.07	N.S.
Interaction between (1) and (2)	1	127.50	127.50	.23	N.S.
Within Replicates	74	41496.75	560.77		

Hypothesis 1 was tested by (2) in Table I. Hypothesis 4 was tested by (1) in Table I. Hypothesis 5 was tested by the interaction between (1) and (2) in Table I.

As indicated in Table I, the F-ratio for Hypothesis 4 was significant at the .025 level of significance. Since the .025 level of significance is a greater level of precision than the .05 level, research Hypothesis 4 was accepted as tenable. That is, the adjusted mean achievement of the students with a positive attitude toward mathematics was significantly higher than the adjusted mean achievement of the students with a negative attitude toward mathematics when holding pre-anxiety and pre-achievement scores constant.

Since the other two F-ratios in Table I failed to be significant at the .05 level, research Hypotheses 1 and 5 were rejected. This indicates that the mean achievement of the students taught by the aid of the Spitz Student Response System was not significantly higher than the adjusted mean achievement of the students taught by the regular lecture-recitation method and also that there was no significant interaction between the level of attitude and the method of instruction as variables affecting achievement in mathematics.

For the two-way design between levels of attitude and methods of instruction, the subjects were divided into four groups, as follows:

	Control Group	Experimental Group
Negative Attitude	I	II
Positive Attitude	III	IV

In Table II is presented the means and adjusted means for the four groups.

TABLE II
TABLE OF ADJUSTED MEANS AND STANDARD ERRORS
FOR ACHIEVEMENT SCORES USING THE
PRE-ACHIEVEMENT SCORES AND
THE PRE-ANXIETY SCORES
AS COVARIATES

Group	Group Mean	Adjusted Mean	SE Adjusted Mean
I	51.50	47.94	4.74
II	44.70	49.59	4.74
III	66.00	62.63	4.70
IV	63.50	65.54	4.72

In computing the adjusted means, the groups were treated as separate entities using analysis of covariance with pre-achievement and pre-anxiety as covariates. In this procedure, the F-ratio of $F = 3.483$ was not significant at the .05 level. This would lend support to the data presented in Table I which indicated that there was no significant interaction between level of attitude and method of instruction. An analysis of covariance with the pre-achievement score as the covariate was run on these same four groups and the F-ratio was $F = 2.052$. This would tend to indicate that the

TABLE III
ANALYSIS OF COVARIANCE TABLE FOR ANXIETY SCORES
WITH THE PRE-ANXIETY SCORES AS
THE COVARIATE

Source	DF	YY	Adjusted Sum- Squares (DUE)	Adjusted Sum- Squares (ABOUT)	Adjusted DF	Adjusted Mean Square	F-Ratios (1, 70)	p
Treatment (Between)	1	223.19	..	..	..	..	..	
Error (Within)	71	7717.47	5343.63	2373.85	70	33.9121	..	
Treatment + Error (Total)	72	7940.66	5554.42	2386.23	71	..	..	
Difference For Testing Adjusted Treatment Means	..	..	..	12.3846	1	12.3846	.365	N.S.

anxiety of a student did affect his achievement level, but the effect was not statistically significant at the .05 level.

Hypothesis 2 was tested by means of analysis of covariance with the pretest anxiety score being used as the covariate. Table III indicates the results of the analysis of covariance relevant to Hypothesis 2. As the F-ratio indicates in Table III, there was no significant difference between the adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System and the adjusted mean anxiety score of the students taught by the regular lecture-recitation method.

The data presented in Table IV further substantiates the findings of Table III when one notices that the adjusted mean anxiety scores are essentially the same.

TABLE IV

TABLE OF ADJUSTED MEANS AND STANDARD ERRORS FOR
ANXIETY SCORES USING THE PRE-ANXIETY
SCORES AS THE COVARIATE

Group	Group Mean	Adjusted Mean	SE Adjusted Mean
Control	31.56	30.32	.94
Experimental	28.06	29.49	1.01

TABLE V
ANALYSIS OF COVARIANCE TABLE FOR ATTITUDE SCORES
WITH THE PRE-ATTITUDE SCORES AS
THE COVARIATE

Source	DF	YY	Adjusted Sum- Squares (DUE)	Adjusted Sum- Squares (ABOUT)	Adjusted DF	Adjusted Mean Square	F-Ratio (1, 70)	p
Treatment (Between)	1	528.28	..	..	..	..	..	
Error (Within)	71	28166.98	18242.45	9924.53	70	141.78	..	
Treatment + Error (Total)	72	28695.26	18362.67	10332.60	71	..	..	
Difference For Testing Adjusted Treatment Means	..	..	..	408.06	1	408.06	2.88	N.S.*

*Significant if $p = .10$

Hypothesis 3 was tested by means of analysis of covariance with the pretest attitude scores being used as the covariate. Table V indicates the results of the analysis of covariance relevant to Hypothesis 3.

The F-ratio, $F = 2.88$, is not significant at the .05 level, but it is significant at the .10 level. In this study, the tenability of all the research hypotheses was tested at the .05 level. Therefore, research Hypothesis 3 must be rejected. This indicates that at the .05 level, there was no significant difference between the adjusted mean positive attitude scores of the students taught with the aid of the Spitz Student Response System and the adjusted mean positive attitude scores of the students taught by the regular lecture-recitation method.

As is indicated in Table VI, there is a sizeable difference between the means of the two groups, but as

TABLE VI
TABLE OF ADJUSTED MEANS AND STANDARD ERRORS FOR
ATTITUDE SCORES USING THE PRE-ATTITUDE
SCORES AS THE COVARIATE

Group	Group Mean	Adjusted Mean	SE Adjusted Mean
Control	58.87	59.18	1.91
Experimental	64.26	63.92	2.05

has already been indicated, it fails to be significant at the .05 level.

Subjective Evaluation of the Spitz

Student Response System

During the last week of class, an evaluation form adapted from the one given by Phillips (3) in his book, Evaluation in Education, was given to both the control and experimental groups. A copy of the evaluation form used in the control group is found in Appendix D and a copy of the form used in the experimental group is found in Appendix E. The basic difference in the two forms is found in question 21. This question appears only on the form used in the experimental section and it requests that the student evaluate the Spitz Student Response System. Most of the other information gained from the evaluation is of little relevance to this study and will not be reported in this dissertation. The forms were filled out anonymously.

Out of the thirty-four students in the experimental section, only two students made somewhat negative remarks about the Spitz Student Response System. These remarks were as follows:

(1) I can see no reason for its use in the course except for the teacher's own evaluation of the classes' progress.

(2) It was interesting and valuable, but not entirely necessary for the course.

Typical of the remarks of the other thirty-two students are these that follow:

(1) A good educational device. Hope to see it used more in other classes.

(2) More like a game than a quiz - not so frightening.

(3) I think it is excellent; it tests, but is not as frightening as pop tests.

(4) It is O.K. I found it valuable because the student can tell immediately whether he has done a problem correctly.

(5) I don't really know if I benefited from it, but I kind of enjoyed working with it and it helped make the class a little different and more interesting.

(6) Different and interesting and more fun than the usual.

(7) The Spitz System is really great. It gives the student and teacher both a good idea as to where he and the class are going and what the student's weak points are. I think the system is extremely effective and would like to see it continued.

(8) The Spitz System made it possible to effectively direct attention to the areas in which students were experiencing difficulty. It also gave students the opportunity for frequent and valuable practice on problems.

(9) Good for class participation. Could, and should, be used more often.

(10) Helpful - you don't feel as if you're on the spot, especially if afraid of mistakes being obvious to the rest of the class.

Based upon the anonymous remarks of the students, the Spitz Student Response System was a successful teaching aid. In the opinion of the investigator, its use helped to keep the students studying day by day because of the almost daily

question and answer sessions. The experimental class was ahead of the control group in its grasp of essential concepts. This was due to the additional drill and work in class, when in the question and answer session, it was indicated as being necessary. The class seemed to be enthusiastic about the system and its use and it had a very marked effect on their attitudes about mathematics. In the opinion of the investigator, the students in the experimental section seemed to be less anxious about their mathematics class than those students in the control section.

Summary

It has been the purpose of this chapter to present the data of the study. The data is summarized in the following points:

(1) Research Hypothesis 1, that the adjusted mean achievement of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean achievement of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

(2) Research Hypothesis 2, that the adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System would be significantly lower than the adjusted mean anxiety score of the

students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

(3) Research Hypothesis 3, that the adjusted mean positive attitude score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean positive attitude score of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level. However, the hypothesis was confirmed at the .10 level of significance.

(4) Research Hypothesis 4, that the adjusted mean achievement of the students with a positive attitude toward mathematics would be significantly higher than the adjusted mean achievement of the students with a negative attitude toward mathematics, was confirmed at the .025 level of significance.

(5) Research Hypothesis 5, that there would be significant interaction between the level of attitude and the method of instruction as variables affecting achievement in mathematics, was not confirmed at the .05 level.

(6) Subjective evaluation of the Spitz Student Response System by the students tended to support the system as useful as a teaching device and one which improved the attitude of the students toward mathematics.

Chapter Five is a summary of the experiment, including conclusions and recommendations pertinent to the findings of this study.

CHAPTER BIBLIOGRAPHY

1. Cooley, Wm. W., and P.R. Lohnes, Multivariate Procedures for the Behavioral Sciences, New York, John Wiley and Sons, Inc., 1966.
2. Lindquist, E.F., Design and Analysis of Experiments in Psychology and Education, Boston, Houghton-Mifflin Co., 1956.
3. Phillips, Ray C., Evaluation in Education, Ohio, Charles E. Merrill Publishing Co., 1968.
4. Winer, B.J., Statistical Principles in Experimental Design, New York, McGraw-Hill Book Co., 1962.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is to summarize the findings of this study, to draw conclusions based on these findings, and to make recommendations for implementation and further research.

Summary

The problem of this study was the effect of teaching freshmen mathematics with the Spitz Student Response System upon a student's anxiety level, attitude and achievement. The purposes of the study were to compare the achievement level, attitude levels and anxiety levels of students enrolled in a beginning college mathematics course when taught by the regular lecture-recitation method and the regular lecture-recitation method augmented by the Spitz Student Response System.

The subjects participating in this investigation consisted of seventy-three students enrolled in the investigator's two sections of An Introduction to Logical and Mathematical Concepts, Mathematics 1308, at Southern Methodist University, Dallas, Texas, during the fall of 1970. An Introduction to Logical and Mathematical Concepts is a required course for all non-mathematics, non-engineering and non-science majors.

The experimental group consisted of thirty-four students and met in the specially designed classroom which housed the Spitz Student Response System. The control group consisted of thirty-nine students and met in a different room earlier in the day. The investigator taught both sections.

Five hypotheses consistent with the stated purposes were formulated. Following are restatements of the hypotheses with a summary of the findings. The tenability of all hypotheses of this study was tested in the null form at the .05 level of significance (two-tailed test).

Hypotheses 1, 4 and 5 were tested by a 2 x 2 factorial analysis of covariance with the pre-anxiety and pre-achievement scores as covariates. Hypotheses 2 and 3 were tested by analysis of covariance.

Research Hypothesis 1, that the adjusted mean achievement of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean achievement of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

Research Hypothesis 2, that the adjusted mean anxiety score of the students taught with the aid of the Spitz Student Response System would be significantly lower than the adjusted mean anxiety score of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level.

Research Hypothesis 3, that the adjusted mean positive attitude score of the students taught with the aid of the Spitz Student Response System would be significantly higher than the adjusted mean positive attitude score of the students taught by the regular lecture-recitation method, was not confirmed at the .05 level. However, the hypothesis was confirmed at the .10 level of significance.

Research Hypothesis 4, that the adjusted mean achievement of the students with a positive attitude toward mathematics would be significantly higher than the adjusted mean achievement of the students with a negative attitude toward mathematics, was confirmed at the .05 level of significance.

Research Hypothesis 5, that there would be significant interaction between the level of attitude and the method of instruction as variables affecting achievement in mathematics, was not confirmed at the .05 level.

Conclusions

Consistent with the purposes of this study and based on the analysis of the experiment, certain conclusions are offered with reference to the population studied:

- (1) Even though differences existed in the level of student achievement in a beginning college mathematics course taught with the aid of the Spitz Student Response System and one taught by the lecture-recitation method,

the differences were not statistically significant. It appears that students learn as well using the Spitz Student Response System as by using more conventional methods. The daily review and drill of the previous day's work and the question and answer sessions in class did not significantly improve the level of achievement of students taught with the aid of the Spitz Student Response System.

(2) Even though differences existed in the level of student anxiety in a beginning college mathematics course taught with the aid of the Spitz Student Response System and one taught by the lecture-recitation method, the differences were not significant. Based upon the subjective evaluation of the Spitz System by the students, one would have to conclude that the use of the system lessened anxiety in class by reinforcing the students' responses without calling attention to the individual student. This latter conclusion would be an important consideration in the continued use of this teaching device. Even though the use of the system does not lower anxiety, it tended to lessen the trauma associated with a mathematics class for a non-mathematics major.

(3) Students taught by the lecture-recitation method augmented by the Spitz Student Response System definitely had a better attitude toward a required mathematics course than students taught the course by

the regular lecture-recitation method. This conclusion was not only substantiated by the statistical results, but also by the daily observation of the two classes by this investigator. The use of the Spitz Student Response System tended to remove some of the fear from mathematics class and it added an element of interest and fun. The students seemed to thoroughly enjoy the use of the system and were especially delighted with the private reinforcement they received on each of their responses.

(4) Students who had a positive attitude toward mathematics had a significantly higher achievement level than those students who had a negative attitude toward mathematics. Even so, those students who were taught with the aid of the Spitz System and who had a positive attitude toward mathematics did not achieve significantly better than their counterparts in the control group. The statistical data of this study tended to support the idea that the effect of attitude on achievement was independent of the method of instruction. The Spitz System tended to significantly raise the students' attitude level, but did not concomitantly raise their achievement level significantly.

Recommendations

Further research is recommended in several areas relative to the effectiveness of teaching beginning college mathematics with the aid of the Spitz Student Response System. Further testing in the area of levels of student achievement is urged. Even though no statistically significant differences existed, there were differences. Perhaps one could design a course to make better use of the Spitz System by using the best features of programmed lessons combined with the best features of lecture-recitation method. With this design, problem areas in the course could be more quickly discovered and more effectively handled in a personal way by the teacher through this combination of programmed and teacher-led instruction. The lessons would have the feature of small step learning combined with expanded explanation by the teacher for troublesome points.

A second area of research interest indicated by the present study involves the measurement of change in a student's anxiety level in mathematics courses taught by a variety of techniques. According to the subjective evaluation of the Spitz System by the students, the system tended to lessen the situational anxiety caused by being in a mathematics course. Perhaps, if an instrument could be designed to measure situational anxiety as it pertains to a mathematics class, it could demonstrate a significant change in the student's anxiety level in a course in which a device such as

the Spitz System was used. The investigator was unable to locate such an instrument and had to settle for the IPAT test which, according to all the authorities, is the best in existence.

Due to the favorable subjective evaluation of the Spitz System by the students, it is the opinion of this investigator that further research should be done using the Spitz Student Response System before it is discounted as a teaching device for beginning mathematics courses.

APPENDIX A

MATHEMATICS 1308 PLACEMENT EXAMINATION

PART I

ANSWER ALL QUESTIONS. N represents the set of natural numbers. Questions 1-4 answer true or false. In questions 5-14, fill in the blanks.

1. The statement $[(\phi \in \{1\}) \rightarrow (\phi \in \{1\})]$ is _____.
2. For each $x \in N$, there is a unique $x^{-1} \in N$.
3. The operation $x \circ y = x$, for $x, y \in N$, is commutative.
4. $\{1, 2, 3\}$ is equivalent to $\{8, 9, 10\}$.
5. $[-2, 3) = \{x \mid \text{_____}\}$.
6. Write a statement logically equivalent to the statement, "It does not rain or we play bridge."
7. If $f(x) = 2x - 1$, $x \in N$ and $A = \{1, 3, 5\}$, then $f(A) = \text{_____}$.
8. f and f^{-1} are both functions if and only if _____.
9. Evaluate: $||[2, 1]||$ _____.
10. Find x which simultaneously satisfies all three conditions:
 $x \in \{1, 2, 3\}$, $x \in \{2\}$, $\{x, 3\} \not\subset \{2, 3\}$. x is _____.
11. If $A = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 4 & 1 & 2 & 3 \end{pmatrix}$ then $A \circ A = \text{_____}$.
- 12 and 13. Given $U = \{1, 2, 3, 4, 5, 6\}$, $S \subset U$, $T \subset U$. Find sets S and T which simultaneously satisfy all three conditions:
 $S \subset T'$, $T \subset S' = \{1\}$, $S \subset T$. S is _____. T is _____.
14. The negation of $r \leftrightarrow \sim t$ is equivalent to _____.

PART II

ANSWER ALL QUESTIONS

1. Prove using the direct method of proof.

$$\begin{array}{l} \sim p \rightarrow q \\ \sim p \vee r \\ s \vee \sim r \\ \hline q \vee s \end{array}$$

2. Prove using the indirect method of proof.

$$\begin{array}{l} \sim p \rightarrow q \\ s \vee \sim r \\ \sim p \vee r \\ \hline q \vee s \end{array}$$

3. (a) What can you conclude about p and about q , given that $[(p \vee q) \wedge (\rightarrow q)]$ is true. Explain your answers.
 (b) Write the negation of $[\sim(p \vee q) \rightarrow (q \leftrightarrow \sim p)]$ and simplify the result.
4. (a) Prove using set theorems: $B \cup (C \cup B)' = B \cup C'$.
 (b) Simplify using set theorems: $[(C \cap D') \cup (C' \cap D')]'$ = ?.
5. (a) Use the element inclusion method to prove: If $(S \cup T) \subset T$, then $S \subset T$.
 (b) Let $\text{dom } g = \{-2, -1, 0, 1, 2\}$ and $g(x) = x^3$.
 (1) Graph g . (2) Write $\text{rng } g$. (3) Find the preimage of 8. (4) Is g a function? Write out g^{-1} .
6. Given the following:

$$f(x) = \begin{cases} \sqrt{(-x)-1} & \text{for } x \in (-3, 1] \\ -2 & \text{for } x \in (1, 2] \\ |3-x| & \text{for } x \in (2, 5] \end{cases}$$

- (a) Sketch the graph of f .
 (b) $\text{rng } f =$ _____.
 (c) Image of 1 = _____.
 (d) Preimage of 1 is _____.
 (e) The type of correspondence is _____.

7. Fill in the reasons in the following proof:

Theorem: If $x \in F$, then $-1 \cdot x = -x$.

Proof:

1. $x \in F$
2. $-x \in F$
3. $x + (-1 \cdot x) = (1 \cdot x) + (-1 \cdot x)$
4. $\quad = (1 + (-1)) \cdot x$
5. $\quad = 0 \cdot x$
6. $\quad = x \cdot 0$
7. $\quad = 0$
8. $\therefore x + (-1 \cdot x) = 0$
9. $-1 \cdot x = -x$

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

8. Do any two of the following three problems:
 - (a) Prove: If $a \in R$ and $a \neq 0$, then $-a \neq 0$.
 - (b) Prove: If 1 is the multiplicative identity of $R - \{0\}$, then, $(-1)(-1) = 1$.
 - (c) Prove: If $a, b, c \in F$, then $a(b-c) = ab-ac$.
9. (a) If $f = \{(1,1), (2,5), (3,9), (4,13), (5,17), (6,21)\}$, then write the formula for $f(x)$.
 (b) Given $R = \{(x,y) \mid x \leq y\}$ defined on $\{1,2,3\}$.
 (1) Is $\text{dom } R = \text{rng } R$? (2) Is R reflexive? (3) Is R symmetric? (4) Is R transitive? (5) Name type of correspondence, and determine whether $\text{dom } R$ is equivalent to the $\text{rng } R$.
10. Given: $U = \{1,2,3,4,5,6\}$, $A = \{2,3,4,6\}$, $B = \{4,4,6\}$,
 $C = \{3,4\}$, $D = \{1,5\}$.
 (a) Write out the following: (1) $C - (A \cup B)$. (2) $(A \cup B)'$.
 (3) $U \cap C'$. (4) $(B \cap C) - A$. (5) $(A - B) - C$.
 (6) $D \times B$.
 (b) If $R = (C - D) \times {}^{-1}D$, then (1) Write out R ; (2) $\text{dom } R = ?$ (3) Is R^{-1} a function? (4) Is R reflexive on $C \cup D$?

APPENDIX B

MATH ATTITUDE SCALE

Lewis R. Aiken, Jr.

Woman's College of the University of North Carolina

Greensboro, North Carolina

and Ralph Mason Dreger

Jacksonville University

Jacksonville, Florida

NAME _____

O P I N I O N N A I R E

DIRECTIONS: Please write your name in the upper right hand corner. Each of the statements on this opinionnaire expresses a feeling which a particular person has toward mathematics. You are to express, on a five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feeling. The five points are: Strongly disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly agree (SA). You are to encircle the letter(s) which best indicates how closely you agree or disagree with the feeling expressed in each statement AS IT CONCERNS YOU.

1. I do not like mathematics. I am
always under a terrible strain in
a math class.	SD D U A SA
2. I do not like mathematics, and it
scares me to have to take it.	SD D U A SA
3. Mathematics is very interesting to
me. I enjoy math courses.	SD D U A SA
4. Mathematics is fascinating and fun.	SD D U A SA

5. Mathematics makes me feel secure, and at the same time it is stimulating.	SD D U A SA
6. I do not like mathematics. My mind goes blank, and I am unable to think clearly when working math.	SD D U A SA
7. I feel a sense of insecurity when attempting mathematics.	SD D U A SA
8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	SD D U A SA
9. The feeling that I have toward mathematics is a good feeling.	SD D U A SA
10. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD D U A SA
11. Mathematics is something which I enjoy a great deal.	SD D U A SA
12. When I hear the word math, I have a feeling of dislike.	SD D U A SA
13. I approach math with a feeling of hesitation - hesitation resulting from a fear of not being able to do math.	SD D U A SA
14. I really like mathematics.	SD D U A SA
15. Mathematics is a course in school which I have always liked and enjoyed studying.	SD D U A SA
16. I don't like mathematics. It makes me nervous to even think about having to do a math problem.	SD D U A SA
17. I have never liked math, and it is my most dreaded subject.	SD D U A SA
18. I love mathematics. I am happier in a math class than in any other class.	SD D U A SA

19. I feel at ease in mathematics,
and I like it very much.

SD D U A SA

20. I feel a definite positive
reaction to mathematics; it's
enjoyable.

SD D U A SA

SELF ANALYSIS FORM

NAME _____ TODAY'S DATE _____
First Middle Last

SEX _____ AGE _____ OTHER FACTS _____
(Write M or F) (Nearest Year) (Address, Occupation, etc., as instructed)

CONFIDENTIAL

Inside this booklet you will find forty questions, dealing with difficulties that most people experience at one time or another. It will help a lot in self-understanding if you check Yes, No, etc., to each, frankly and truthfully, to describe any problems you may have.

Start with the two simple examples just below, for practice. As you see, each inquiry is actually put in the form of a sentence. By putting a cross, X, in *one* of the three boxes on the right you show how it applies to you. Make your marks now.

1. I enjoy walking _____ Yes ☐ Occasionally ☐ No ☐

A middle box is provided for when you cannot definitely say Yes or No. But use it as little as possible.

2. I would rather spend an evening:
(A) talking to people, (B) at a movie _____ A ☐ In between ☐ B ☐

About half the items inside end in A and B choices like this. B is always on the right. Remember, use the "In between" or "Uncertain" box only if you cannot possibly decide on A or B.

Now:

1. Make sure you have put your name, and whatever else the examiner asks, in the place at the top of this page.
2. Never pass over an item but give some answer to every single one. Your answers will be entirely confidential.
3. Do not spend time pondering. Answer each immediately, the way you want to at this moment (not last week, or usually). You may have answered questions like this before; but answer them as you feel *now*.

Most people finish in five minutes; some, in ten. Hand in this form as soon as you are through with it, unless told to do otherwise. As soon as the examiner signals or tells you to, turn the page and begin.

STOP HERE—WAIT FOR SIGNAL

1. I find that my interests, in people and amusements, tend to change fairly rapidly..... True ☐ In between ☐ False ☐
2. If people think poorly of me I can still go on quite serenely in my own mind..... True ☐ In between ☐ False ☐
3. I like to wait till I am sure that what I am saying is correct, before I put forward an argument..... Yes ☐ In between ☐ No ☐
4. I am inclined to let my actions get swayed by feelings of jealousy..... Sometimes ☐ Seldom ☐ Never ☐
5. If I had my life to live over again I would:
(A) plan very differently, (B) want it the same..... A ☐ In between ☐ B ☐
6. I admire my parents in all important matters..... Yes ☐ In between ☐ No ☐
7. I find it hard to "take 'no' for an answer", even when I know what I ask is impossible..... True ☐ In between ☐ False ☐
8. I doubt the honesty of people who are more friendly than I would naturally expect them to be..... True ☐ In between ☐ False ☐
9. In demanding and enforcing obedience my parents (or guardians) were: (A) always very reasonable, (B) often unreasonable..... A ☐ In between ☐ B ☐
10. I need my friends more than they seem to need me..... Rarely ☐ Sometimes ☐ Often ☐
11. I feel sure that I could "pull myself together" to deal with an emergency..... Always ☐ Often ☐ Seldom ☐
12. As a child I was afraid of the dark..... Often ☐ Sometimes ☐ Never ☐
13. People sometimes tell me that I show my excitement in voice and manner too obviously..... Yes ☐ Uncertain ☐ No ☐
14. If people take advantage of my friendliness I:
(A) soon forget and forgive, (B) resent it and hold it against them..... A ☐ In between ☐ B ☐
15. I find myself upset rather than helped by the kind of personal criticism that many people make..... Often ☐ Occasionally ☐ Never ☐
16. Often I get angry with people too quickly..... True ☐ In between ☐ False ☐
17. I feel restless as if I want something but do not know what..... Very rarely ☐ Sometimes ☐ Often ☐
18. I sometimes doubt whether people I am talking to are really interested in what I am saying..... True ☐ In between ☐ False ☐
19. I have always been free from any vague feelings of ill-health, such as obscure pains, digestive upsets, awareness of heart action, etc..... True ☐ Uncertain ☐ False ☐
20. In discussion with some people, I get so annoyed that I can hardly trust myself to speak..... Sometimes ☐ Rarely ☐ Never ☐

CONTINUE ON NEXT PAGE.

A Score

21. Through getting tense I use up more energy than most people in getting things done..... True ☐ Uncertain ☐ False ☐
22. I make a point of not being absent-minded or forgetful of details..... True ☐ Uncertain ☐ False ☐
23. However difficult and unpleasant the obstacles, I always stick to my original intentions..... Yes ☐ In between ☐ No ☐
24. I tend to get over-excited and "rattled" in upsetting situations..... Yes ☐ In between ☐ No ☐
25. I occasionally have vivid dreams that disturb my sleep..... Yes ☐ In between ☐ No ☐
26. I always have enough energy when faced with difficulties..... Yes ☐ In between ☐ No ☐
27. I sometimes feel compelled to count things for no particular purpose..... True ☐ Uncertain ☐ False ☐
28. Most people are a little queer mentally, though they do not like to admit it..... True ☐ Uncertain ☐ False ☐
29. If I make an awkward social mistake I can soon forget it..... Yes ☐ In between ☐ No ☐
30. I feel grouchy and just do not want to see people:
(A) occasionally, (B) rather often..... A ☐ In between ☐ B ☐
31. I am brought almost to tears by having things go wrong..... Never ☐ Very rarely ☐ Sometimes ☐
32. In the midst of social groups I am nevertheless sometimes overcome by feelings of loneliness and worthlessness..... Yes ☐ In between ☐ No ☐
33. I wake in the night and, through worry, have some difficulty in sleeping again..... Often ☐ Sometimes ☐ Never ☐
34. My spirits generally stay high no matter how many troubles I meet..... Yes ☐ In between ☐ No ☐
35. I sometimes get feelings of guilt or remorse over quite small matters..... Yes ☐ In between ☐ No ☐
36. My nerves get on edge so that certain sounds, e.g., a screechy hinge, are unbearable and give me the shivers..... Often ☐ Sometimes ☐ Never ☐
37. If something badly upsets me I generally calm down again quite quickly..... True ☐ Uncertain ☐ False ☐
38. I tend to tremble or perspire when I think of a difficult task ahead..... Yes ☐ In between ☐ No ☐
39. I usually fall asleep quickly, in a few minutes, when I go to bed..... Yes ☐ In between ☐ No ☐
40. I sometimes get in a state of tension or turmoil as I think over my recent concerns and interests..... True ☐ Uncertain ☐ False ☐

STOP HERE.

BE SURE YOU HAVE ANSWERED EVERY QUESTION.

B Score

Q₈(-)

C(-)

L

O

Q₄

Name _____ Sex _____ Age _____ Date _____ Examiner _____

Raw Scores: A Score (Covert, indir.) _____ (p. 2 score) B Score (Overt, manifest, sympt.) _____ (p. 3 score) **TOTAL RAW SCORE** _____ (A + B)

$Q_3(-)$ _____, C(-) _____, L _____, O _____, Q_4 _____, Overt-Covert Ratio $\left(\frac{B}{A}\right)$ _____

Stems: $Q_3(-)$ _____, C(-) _____, L _____, O _____, Q_4 _____

TOTAL, STANDARD STEN SCORE _____ (from Table 4)

Qualitative Observations:

Diagnostic Summary:

APPENDIX D

STUDENT EVALUATION SCALE

Directions: Do not sign your name to the questionnaire. Indicate your evaluation of the teaching and learning situation in this class by placing a circle around the appropriate number for each item, using the following system:

5	4	3	2	1
Outstanding	Above Average	Average	Below Average	Poor

0

If undecided or no opportunity to observe

1. Ability to create interest in the subject matter and to stimulate thinking.....	5	4	3	2	1	0
2. Value of lectures and class activities to your understanding.....	5	4	3	2	1	0
3. Value of outside assignments to understanding of the course.....	5	4	3	2	1	0
4. Teacher's knowledge of his subject matter.....	5	4	3	2	1	0
5. Demonstration of knowledge through teaching.....	5	4	3	2	1	0
6. Organization and presentation of course material.....	5	4	3	2	1	0
7. Ability to simplify and explain complex subject matter.....	5	4	3	2	1	0
8. Accessibility and willingness of teacher to help students individually.....	5	4	3	2	1	0
9. Impartiality and fairness in dealings with students.....	5	4	3	2	1	0
10. Well-balanced coverage of course material in tests.....	5	4	3	2	1	0
11. Fairness in grading of tests.....	5	4	3	2	1	0
12. Return of tests within a reasonable length of time.....	5	4	3	2	1	0
13. Effective use of textbooks and/or supplementary material to enhance student learning.....	5	4	3	2	1	0

14. General appearance of teacher (neat, clean, well-groomed).....5 4 3 2 1 0
15. Willingness to allow students to express their views.....5 4 3 2 1 0
16. Considering everything, evaluate the teacher's general teaching effectiveness.....5 4 3 2 1 0
17. Considering everything, compare the teacher's effectiveness with that of other courses of this type.....5 4 3 2 1 0
18. What suggestions would you offer for the improvement of this course?
19. What is the general "climate" of the classroom (eg. relaxed, tense, warm, co'd, friendly, hostile, etc.)?
20. Draw a circle around the X that most nearly expresses your feeling about the course.

Very Satisfied	Quite Satisfied	So-So	Somewhat Satisfied	Very Dissatisfied
X	X	X	X	X

APPENDIX E

STUDENT EVALUATION SCALE

Directions: Do not sign your name to the questionnaire. Indicate your evaluation of the teaching and learning situation in this class by placing a circle around the appropriate number for each item, using the following system:

5	4	3	2	1
Outstanding	Above Average	Average	Below Average	Poor

C

If undecided or no opportunity to observe

1. Ability to create interest in the subject matter and to stimulate thinking.....	5	4	3	2	1	0
2. Value of lectures and class activities to your understanding.....	5	4	3	2	1	0
3. Value of outside assignments to understanding of the course.....	5	4	3	2	1	0
4. Teacher's knowledge of his subject matter.....	5	4	3	2	1	0
5. Demonstration of knowledge through teaching.....	5	4	3	2	1	0
6. Organization and presentation of course material.....	5	4	3	2	1	0
7. Ability to simplify and explain complex subject matter.....	5	4	3	2	1	0
8. Accessibility and willingness of teacher to help students individually.....	5	4	3	2	1	0
9. Impartiality and fairness in dealings with students.....	5	4	3	2	1	0
10. Well-balanced coverage of course material in tests.....	5	4	3	2	1	0
11. Fairness in grading of tests.....	5	4	3	2	1	0
12. Return of tests within a reasonable length of time.....	5	4	3	2	1	0
13. Effective use of textbooks and/or supplementary material to enhance student learning.....	5	4	3	2	1	0

14. General appearance of teacher (neat, clean, well-groomed).....5 4 3 2 1 0
15. Willingness to allow students to express their views.....5 4 3 2 1 0
16. Considering everything, evaluate the teacher's general teaching effectiveness.....5 4 3 2 1 0
17. Considering everything, compare the teacher's effectiveness with that of other courses of this type.....5 4 3 2 1 0
18. What suggestions would you offer for the improvement of this course?
19. What is the general "climate" of the classroom (eg. relaxed, tense, warm, cold, friendly, hostile, etc.)?
20. Draw a circle around the X that most nearly expresses your feeling about the course

Very Satisfied	Quite Satisfied	So - So	Somewhat Satisfied	Very Dissatisfied
X	X	X	X	X

21. Evaluate the Spitz Student Response System and its use in this course.

BIBLIOGRAPHY

Books

- Biggs, John B., "The Psychopathology of Arithmetic," New Approaches to Teaching Mathematics, Editor F.W. Land, New York, St. Martin's Press, 1965.
- Buros, Oscar K., Editor, The Sixth Mental Measurements Yearbook, Highland Park, Illinois, The Gryphon Press, 1965.
- Campbell, D.T. and J.C. Stanley, Experimental and Quasi-Experimental Designs for Research, Chicago, Rand McNally & Co., 1966.
- Cooley, Wm. W. and P.R. Lohnes, Multivariate Procedures for the Behavioral Sciences, New York, John Wiley & Sons, Inc., 1966.
- Dabrowski, K., Positive Disintegration, Boston, Little, Brown & Co., 1964.
- Edwards, Allen L., Techniques of Attitude Scale Construction, New York, Appleton-Century-Crofts, Inc., 1957.
- Freeman, M.J., "The Development of a Test for the Measurement of Anxiety: A Study of its Reliability and Validity," Psychology Monographs, Editor H.S. Conrad, New York, American Psychology Association, 1953.
- Klein, E., "Psychoanalytic Aspects of Scholastic Problems," Editors A. Freud and H. Hartman, Psychoanalytic Study of the Child, III-IV, New York, International Universities Press, 1949.
- Levy, D.M., Maternal Overprotection, New York, Columbia University Press, 1947.
- Lindquist, E.F., Design and Analysis of Experiments in Psychology and Education, Boston, Houghton-Mifflin & Co.,
- McKeachie, W.J., "Motivation, Teaching Methods and College Learnings," Editor M.R. Jones, Nebraska Symposium on Motivation, Lincoln, University of Nebraska Press, 1961.

- Miller, N.E., and J. Dollard, Social Learning and Imitation, New Haven, Yale University Press, 1941.
- Murray, Jas. A.H., et.al., The Oxford English Dictionary, London, University of Oxford Press, 1933.
- Phillips, Ray C., Evaluation in Education, Ohio, Charles E. Merrill Publishing Co., 1968.
- Plank, E.N. and R. Plank, "Emotional Components in Arithmetical Learning as Seen Through Autobiographies," Editors A. Freud and E. Kris, Psychoanalytic Study of the Child, IX, New York, International Universities Press, 1952.
- Rethlingshafer, Dorothy, Motivation as Related to Personality, New York, McGraw-Hill, 1963.
- Roscoe, J.T., Fundamental Research Statistics, Dallas, Holt, Rinehart and Winston, 1969.
- Ruebush, B.K., "Anxiety," Child Psychology, Sixty-Second Yearbook of the National Society for the Study of Education, Part I, Chicago, University of Chicago Press, 1963.
- Sarason, S.B., et.al., Anxiety in Elementary School Children, New York, John Wiley and Sons, Inc., 1960.
- Sax, G., Empirical Foundations of Educational Research, New Jersey, Prentice-Hall, 1968.
- Scheier, I.H. and R.B. Cattell, Handbook for the IPAT Anxiety Scale Questionnaire, Illinois, Institute for Personality and Ability Testing, 1967.
- Schonell, F.J., Diagnosis of Individual Differences in Arithmetic, Edinburgh, Oliver and Boyd, 1937.
- Shaw, M.E., and J.M. Wright, Scales for the Measurement of Attitude, New York, McGraw-Hill, 1967.
- Winer, B.J., Statistical Principles in Experimental Design, New York, McGraw-Hill, 1962.
- Woodworth, R.S., Dynamics of Behavior, New York, Henry Holt and Company, 1955.

Articles

- Aiken, L.R., Jr. and R.M. Dreger, "The Effects of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII (1961), 19-24
- Aiken, L.R., Jr., "Mathemaphobia and Mathemaphilia: An Analysis of Personal and Social Factors Affecting Performance in Mathematics," Dissertation Abstracts, 1960, p. 1992.
- _____, "Affective Factors in Mathematics Learning: Comments on a Paper by Neale and a Plan for Research," Journal For Research in Mathematics Education, I (1970), 251-255.
- _____, "Attitudes Toward Mathematics," Review of Educational Research, XL (1970), 551-596.
- Albert, R. and R. N. Haber, "Anxiety in Academic Achievement Situations," Journal of Abnormal and Sociological Psychology, LXI (1960), 207-215.
- Anttonen, R.G., "A Longitudinal Study in Mathematics Attitude," Journal of Educational Research, LXII (1969), 467-471.
- Bassham, Harrell, "Teacher Understanding and Pupil Efficiency in Mathematics - A Study of Relationships", The Arithmetic Teacher, IX (November, 1962), 383-387.
- Bendiz, A.W., "The Development of a Short Form of the Manifest Anxiety Scale," Journal of Consulting Psychologists, XX (1956), 384.
- Dreger, R.M. and L.R. Aiken, Jr., "The Identification of Number Anxiety in a College Population," Journal of Educational Research, XLVIII (1957), 344-351.
- Dutton, W.H., "Attitudes of Junior High School Pupils Toward Arithmetic," School Review, LXIII (January, 1956), 18-22.
- _____, "Measuring Attitudes Toward Arithmetic," Elementary School Journal, 1954-55, 24-32.
- Faust, Claire E., "A Study of the Relationship Between Attitude and Achievement in Selected Elementary School Subjects," Dissertation Abstracts, XXIII (February, 1963), 2752-2753.
- Pedon, Peter, "The Role of Attitude in Learning Arithmetic," The Arithmetic Teacher, V (December, 1958), 304-310.

- Haskell, Simon, "Some Observations on the Effects of Class Size Upon Pupil Achievement in Geometrical Drawing," Journal of Educational Research, LVII (September, 1964), 27-30.
- Hess, Eckhard H., "Attitude and Pupil Size", Scientific American, CCXII (April, 1965), 46-54.
- Milliken, R.L., "Mathematical-Verbal Ability Differentials of Situational Anxiety as Measured by Blood Pressure Change," Journal of Experimental Education, XXXII, (September, 1964), 309-311.
- _____ and Bernard Spelka, "Mathematical-Verbal Ability Differentials and Somatic Expressions of Situational Anxiety," Journal of Experimental Education, XXXI (September, 1962), 3-26.
- Morgan, Jas. H., "The Relationship Between Levels of Anxiety and Mathematics Achievement in Programmed and Teacher-Directed Instruction," Dissertation Abstracts, XXV (1965), 3760.
- Neidt, C.O., and D.E. Hedlund, "The Relationship Between Changes in Attitude Toward a Course and Final Achievement," Journal of Educational Research, LXI (1967),
- Phillips, B.N., "Sex, Social Class, and Anxiety as Sources of Variation in School Achievement," Journal of Educational Psychology, LIII, 316-322.
- Poffenberger, Thomas and Donald Norton, "Factors in the Formation of Attitudes Toward Mathematics," Journal of Educational Research, LII (January, 1959), 171-176.
- _____, "Factors Determining Attitudes Toward Arithmetic and Mathematics," The Arithmetic Teacher, III (April, 1956), 113-116.
- Rethlingshafer, Dorothy, Motivation as Related to Personality, New York, McGraw-Hill, 1963.
- Riggs, Cassidy Leroy, "The Relationship of Anxiety and Anxiety Adaptation to Aptitude, Self-Concept, and Scholastic Achievement," Dissertation Abstracts, XXII (1961), 3927.
- Sarason, Irwin G., "Empirical Findings and Theoretical Problems in the Use of Anxiety Scales," Psychological Bulletin, LVII (1960), 403-415.

Sarason, Irwin G., "Interrelationships Among Individual Differing Variables, Behavior in Psychotherapy, and Verbal Conditioning," Journal of Abnormal and Sociological Psychology, LVI (1958), 339-344.

Sarason, S.B., G. Mandler, and P.G. Craighill, "The Effect of Differential Instructions on Anxiety and Learning," Journal of Abnormal and Sociological Psychology, XLVII (1952), 561-565.

_____, K. Davidson, et.al., "Classroom Observation of High and Low Anxious Children," Child Development, XXIX (1958), 287-296.

"Spitz Student System for Large Group Instruction". An Advertisement by Spitz Laboratories, Inc., Chadds Ford, Pennsylvania, A Division of McGraw-Hill, Inc.

Taylor, Janet A., "The Relationship of Anxiety to the Conditional Eyelid Response," Journal of Experimental Psychology, XLI (1951), 81-92.

_____, "A Personality Scale of Manifest Anxiety," Journal of Abnormal and Sociological Psychology, XLVIII (1953), 285-290.

_____, "Drive Theory and Manifest Anxiety," Psychology Bulletin, LII (1956), 303-320.

Tulok, M.K., "Emotional Blocks in Mathematics," Mathematics Teacher, V (1957), 572-6.

Welsh, Geo. S., "An Anxiety Index and an Internalization Ratio for the MMPI," Journal of Consulting Psychologists, XVI (1962), 65-72.

White, W.F. and Robert L. Aaron, "Teacher's Motivational Cues and Anxiety in Relation to Achievement Levels in Secondary School Mathematics," Journal of Educational Research, LXI (1967), 6-9.

Zweibelson, Irving and F.J. Lodeto, "Relationship of Pupil Anxiety and Attitude to Arithmetic Readiness and Achievement," Psychology in the Schools, II (1965), 140-2.