FACTORS INFLUENCING MATH ANXIETY: AN INVESTIGATIVE STUDY AND ASSESSMENT OF STUDENTS' ATTITUDES TOWARD THE LANGUAGE OF MATHEMATICS AS IT RELATES TO MATH ANXIETY

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CHAPTER I

INTRODUCTION

The content curriculum of the middle-school is recommended by the State Department of Education and approved by the local administration. Regardless of recommended regulations, behavioral and intellectual interaction in the classroom is dependent upon the attitude of the teacher. Dobson and Dobson (1981, p. 65) have accurately described the classroom learning situation as, "Whether we like it or not, decisions determining the direction of schooling seem to reflect the belief systems of those who have the power to make such decisions." If students are to achieve in any academic area, they must be given an opportunity to learn. This was emphasized by Cooley and Lienhardt (1980, p. 16) when they commented that "The opportunity to learn is the most important variable in accounting for achievement."

Middle-school students often acquire a feeling toward a subject in relation to their teacher's attitude. If a teacher has a negative attitude toward mathematics, the students will likely exhibit similar feelings. Battista (1986, p. 10) concluded that teachers' negative attitudes towards mathematics may be transmitted to their students. He was concerned that, "The lack of knowledge of, and poor attitude toward, mathematics by teachers may inhibit their effective teaching of mathematics." Even if the schedule dictates that fifty-five minutes per day shall be spent in the instruction of mathematical skills and computation, there is no guarantee this amount of time will be spent on mathematics instruction. In a study of time allocations (Denham and Lieberman, 1980) one second grade teacher used sixteen minutes per day for mathematics instruction while another second grade teacher allocated fifty-one minutes for mathematics instruction.

Bulmahn and Young (1982, p. 55) stated that "Elementary school teachers are a significant part of any individual's early mathematical environment, yet it appears that for many elementary school teachers, mathematics is at best a necessary evil." Inevitably, the question arises, Is this feeling transmitted to the student, thereby, affecting the students' achievement in mathematics? Schofield (1981) expressed the belief that despite insufficient evidence, there is a direct positive relationship emanating from teacher attitudes and achievements and those of the students. Much of the research concerning the relationship of attitudes of teachers and students as they relate to achievement fails to show statistical significance. Yet, almost without exception, it was concluded that a positive relationship did exist.

Additionally, a review of the literature indicated that few studies have been conducted concerning the influence of parents' attitude in determining the attitudes of their children toward mathematics. Elmore (1985) reported that the attitudes of parents were related to the students' expectations and that parent attitude differed with the sex of the child. Sheridan and Fizdale (1981) reported that the attitude of parents toward the achievement of girls in mathematics is rather negative when compared to their expectations of the boys. Fennema and Sherman (1978) concluded that the attitude of parents toward mathematics achievement becomes significant at the high school level and that girls are affected much more than boys.

Sex-role stereotyping contributes to math avoidance and math anxiety in females. Sherman (1976) suggests that girls are under male pressure because of the belief that mathematics is a male domain and not a territory in which girls succeed. The negative effects of sex-role stereotyping of mathematics as a male domain is emphasized by Sherard (1981, p. 1) "Evidence points to the fact that math anxiety can be nurtured by the perception of mathematics as an activity which is more appropriate for males." The view that mathematics is a male domain usually appears during the early adolescent years (Fennema and Sherman, 1977). Burton (1979) relates the case of a patient at Johns Hopkins Hospital who was reared as a female, and during adolescence it was determined that the patient was genetically a male. As a female, the patient performed far below average in mathematics; as a male, the patient exceeded average expectations in mathematics.

Anxiety is defined as both an external and internal way in which students respond to stress in the environment. Mathematics anxiety has been described (Sherard, 1981, p. 106) "As a fear of mathematics or an intense, negative emotional reaction to mathematics." Mathematics anxiety, as viewed by Tishler, (1980, p. 4) is regarded as "A combination of poor attitudes toward mathematics and a low expectation of ones' own achievement in mathematics." Math anxiety is used to describe the panic, helplessness and mental disorganization felt among a majority of people as they are required to solve a mathematical problem.

The complications of the Anglo language, the language of mathematics, and mathematical symbols, concurrently with teacher influences contribute to the confusion in mathematical comprehension and retention. These factors may easily form a basis for the development of math anxiety in children which will ultimately prevail during their productive years. Aiken (1971, p. 359) stated, "It is generally recognized that not only do linguistic abilities affect performance in mathematics but that mathematics itself is a specialized language."

In summarization, many factors may create math anxiety in students such as ethnicity, teacher attitude, parent attitude, sex role and language comprehension and skills. Greenwood states, (1984, p. 669) "The major source of math anxiety lies in the impersonal, non-growth, non-rational methodologies characterized by the explain-practice-memorize paradigm." Therefore, the language prevalent in mathematics may be considered as one of the contributing factors to math anxiety in children.

Need for the Study

Considerable research exists regarding math anxiety. The literature presents conflicting conclusions, especially in the area of math anxiety and its relationship to sex roles. Few researchers focus on the language of mathematics as a causative factor of anxiety. Those who point out the difficulties caused by the language used in mathematics make the conjecture that, "the language of math" is a new language (Cocking and Mestre, 1988, Pimm, 1978, and Aiken, 1972). My research has not found any source which correlates language with students' attitude toward mathematics.

Statement of the Problem

Math anxiety is identified as a major problem for many middle-school students. Research indicates that factors such as attitudes, sex role stereotyping, and reading skills contribute to math anxiety, but research conducted concerning the effect of language as a factor influencing math anxiety is sparse. The intent of this study is to measure the effects of the language utilized in mathematics as a contributing factor in math anxiety.

Statement of Hypotheses

These hypotheses regarding the relationship of the language of mathematics and application skills as contributing factors to mathematics anxiety were tested.

1. There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for sixth grade students.

2. There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for seventh grade students.

3. There is no significant difference between male and female students in the sixth grade when comparisons are made concerning anxiety toward mathematical language and the application of mathematical language.

4. There is no significant difference between male and female students in the seventh grade when comparisons are made concerning their anxiety toward mathematical language and the application of mathematical language.

5. There is no significant relationship when comparing all subjects' level of anxiety toward mathematical language with their level of application.

6. There is no significant difference when comparing sixth grade males with seventh grade males regarding their level of anxiety toward the mathematical language with their level of application.

7. There is no significant difference when comparing sixth grade females and seventh grade females regarding their level of anxiety toward mathematical language with their level of application.

Definition of Terms

<u>Application of Mathematics Language</u> - student's ability to compute mathematical problems when solving problems on a mathematical computational test (Pimm, 1978).

<u>Attitude</u> - a learned emotionally-toned predisposition to react in a consistent way toward a person, place or thing (Levitt, 1980).

Cardinal Number - a number such as five, which indicates a definite count (Cawley, 1988, p. 85).

Interference Theory - negative expectations for success which interfere with performance by diverting the individual's attention from the task being performed (Covington and Omelich, 1987).

Language - a consistent system for representing meaning (Pimm, 1978, p. 33).

Language of Math - words that have a different connotation when used in mathematics, and words that are not commonly used in everyday conversation (Griffiths, 1975, p. 3).

Math Avoidance - a conscious or unconscious strategy used as a defense against math anxiety (Levitt, 1980, p. 34).

Math Anxiety - a combination of poor attitudes toward mathematics and a low expectation for ones' own achievement in mathematics (Tishler, 1980, p. 4).

Middle-School - a public school, grades five through eight.

Middle-School Teacher - a teacher in a public school who teaches grades five through eight.

Ordinal Number - a number, such as fifth, which indicates rank order (Cawley, 1988, p. 8).

Self-concept - what one believes about oneself or an individual's perception of self (Reyes, 1984, p. 563).

State Anxiety - the unpleasant emotional state or condition which is time and situation-specific (Reyes, 1984, p. 563).

Test Anxiety - anxiety aroused by evaluative situations (Reyes, 1984, p. 563).

Trait Anxiety - an unpleasant emotional state or condition which is neither time nor situation specific (Reyes, 1984, p. 563).

Understanding the Language of Mathematics - student's perception of their ability to perform computation as measured by a mathematics language inventory (Pimm, 1978).

Limitations

This study was limited to middle-school students, in grades six and seven, in Eastern Oklahoma. The sample was approximately 200 subjects.

Assumptions

1. It is assumed students' performance on the instruments will accurately reflect their feelings toward mathematics as it relates to the language of mathematics.

2. It is assumed that the findings of this study will be applicable to other students in grades six and seven, as referred to in this study.

Organization of the Study

Chapter I presents the introduction to the problem and the need for the study. Chapter I also presents a statement of the problem, the hypothesis to be tested, the definition of terms, the limitations, and the assumptions of the study.

Chapter II presents a selective overview of the materials pertaining to the study. Included are literature reviews and discussion of math anxiety in general, math anxiety elated to sex-role stereotyping, attitudes of parents, teachers and peers, as well as the vocabulary of mathematics and its contribution to math anxiety.

Chapter III presents the design and methodology, purpose of the study, description of the sample, description of the instruments, analysis of data, and procedures for testing the hypotheses for statistical significance.

Chapter IV presents the results of the statistical analysis of the data. The hypotheses are stated and the statistical procedures employed to test for relationships or significant difference are discussed.

Chapter V is a summation of the results, conclusions, and recommendations for further research and implementation within existing mathematical programs.

CHAPTER II

REVIEW OF THE LITERATURE

General Math Anxiety

People who experience math anxiety exhibit qualities such as avoidance of mathematics at all risks, with the ultimate effect of handicapping themselves in both everyday lives and their employment opportunities.

Mathophobia and math anxiety are terms used to describe the fear of math, Lazarus (1974, p. 16) describes mathophobia as "an irrational and impeding dread of mathematics." In an interview with mathematics anxious students, Cemen (1987) reports their reactions to math involved a nervous stomach, sweating and sweaty palms, difficulty in breathing, tension headaches and blanking-out. The fear of math usually causes the person to develop a negative attitude not only toward mathematics but also of his/her ability to succeed in math. Kincaid (1981) reported that confidence in ability to learn mathematics was significantly and positively related to the subjects' math anxiety. Math anxiety does seem to be directly related to the student's self-concept of his/her own ability in mathematics. Lorenz states "High self-esteem of one's own task specific ability reduces anxiety and vice versa, the negative correlation being quite considerable" (1982, p. 25).

The drive theory (Levitt, 1980) of anxiety ascribes to the idea that anxiety is a constant characteristic of the individual. Anxiety, when viewed as a drive, should facilitate learning. The drive theory likely holds true in learning situations when only one response is possible, but learning typically involves complex thinking in which there are many variables. The idea of evoking anxiety in the anxious-prone individual is primarily a function or condition of the individual, as opposed to the Yale theory. The Yale theory of anxiety is described by Levitt (1980, p. 92):

1. Anxiety is a strong learned attitude that is situational evoked. Any particular circumstance or class of circumstances may be stressful for a person, although he/she may react differently to other circumstances.

2. The individual has learned or developed characteristic responses to anxiety that he/she brings with him/her to the current situation. These reactions may be task irrelevant, that is, tending to disrupt performance. Examples are feelings of inadequacy, fear of failure, or a desire to quit the situation or they may be task-relevant-facilitative of performance, because they move the person to reduce anxiety by completing the task successfully.

3. The effect of anxiety is also a function of such aspects of the situation as the attitude of the experimenter or teacher and the meaning of the task as perceived by the individual. These factors are of greater significance than the complexity of the task per se.

The drive theory heavily insinuates that anxiety facilitates performance on simple tasks, but it may disrupt learning of complex tasks. The position of the Yale theorist is the fear of failure is likely to be greater when the task is complex, and task-irrelevant anxiety is likely to occur which will interfere with performance. It is likely that the performance on simple tasks would not be affected in the same way (Levitt, 1980).

Anxiety as a trait-like entity is thought to interfere with achievement only when the particular conditions of evaluation are sufficiently threatening to the individual (Covington and Omelich, 1987). Therefore, the interference theory is based on the assumption that anxiety inhibits not only the learning, but also the performance. Anxiety and negative expectations for success interfere with performance by diverting the individual's attention from the task. There are many examples of students who claim to have mastered the material before the test, but who are unable to perform satisfactorily during the test, only to recall the material after it is too late. Studies (Covington, 1983) also indicate that achievement of high-anxious individuals deteriorates progressively as the difficulty of the material increases.

Research indicates (Covington and Omelich, 1987) that anxious students do not profit any more than other students when the threat of test-taking is minimized. Additionally, for blockage to occur, the anxious student must be reasonably well prepared prior to the test. The cause of this type of blockage probably lies in the distinction between failure-avoiding and failure-accepting attitudes of the students (Covington and Omelich, 1985). Student-teacher and student-parent relationships may create an atmosphere conducive to the positive or negative formation of subject-related attitudes.

In one particular study of mathematics anxiety in elementary teachers (Chavez and Widner, 1982) it was revealed that most elementary teachers within this group did not abhor or fear mathematics, nor did they have a non-rational distaste for or avoidance of math and math-related subjects. However, it was found that 17 percent of the females and eight percent of males were math anxious. Although this was not considered statistically significant, it is of concern that a number of children are being taught by teachers who have negative attitudes toward mathematics.

Since math anxiety inhibits the acquisition of mathematic skills, the failure to acquire these needed skills often results in developing greater math anxiety. Banks (1964) listed a number of factors which he felt influenced attitudes toward arithmetic. The attitudes of teachers and parents seemingly have a definite effect on children. The parent who sympathizes with the child who does not do well in arithmetic, conveys the message that this is an expected outcome. Comments such as, "I did not do well in math either," do little to motivate a positive attitude. This self defeating attitude precludes a high level of achievement in mathematics. Tobias (1978) found that large numbers of people manifest this anxiety. Although men are afflicted, women are particularly susceptible. This phenomenon is particularly disturbing since a large portion of elementary school teachers are female and since studies have shown the teachers demonstrate a positive relationship between attitude and achievement. Campbell and Okey (1977, p. 231) reported that "Teachers are most knowledgeable and perform best in those areas that they like best--and conversely." A high incidence of math anxiety among female elementary teachers is of grave concern.

Math as a Male Domain

The source of negative attitudes has been described in research writings in a variety of ways other than teacher oriented. The culturally-based assumption that males are supposed to be better in mathematics probably has less effect in today's world of the liberated woman. The assumed fear that boys would not want to date a girl who excelled in mathematics would likely have had much greater effect on females in the past. Children seem to learn early in school that reading is identified with the female role and mathematics is related to the male role model. Even though historically mathematics has been regarded synonymous with masculinity, there is little evidence that girls cannot compete successfully with boys in this designated field. In a survey of thirteen-year-old boys and girls, Fennema (1974) found that the girls were better at spatial visualization and computation than boys, while their problem-solving skills were almost equal. Fennema and Sherman (1977) also found that at age 13 the achievement of boys and girls in mathematics was similar. During early adolescence the achievement difference in mathematics performance becomes increasingly evident. Scott (1987) confirmed this difference in a study of seventh grade students. The boys had a significantly higher mean score on a number sense test than did girls. The suggestion is that the difference could be accounted for by the more competitive nature of boys. Interestingly, in Hawaii the Caucasian girls out-perform the Caucasian boys not only in the elementary grades but also in high school. The girls apparently spend more time relative to mathematics in the classroom and are rewarded more by their parents than boys for mathematics achievement (Brandon, Newton, and Hammond, 1985).

Math Anxiety and the Teacher

An elementary teacher who is assigned to teach mathematics in spite of his/her objection to teaching this subject cannot be expected to approach the class with the enthusiasm exhibited in other classes. If the teacher has a fear of and/or lack of understanding of the subject, it is likely that his/her attitude will be transmitted to the students. Conversely, the teacher who understands and enjoys the subject will be more likely to conduct the class in a highly positive and motivating manner.

A questionnaire given to future teachers, administered by Ernest (1976), revealed that 26 percent of these prospective teachers felt indifferent towards mathematics, while another fourteen percent stated that they actually disliked math. The students were asked to indicate the source of their attitude. Among those exhibiting extreme attitudes, the most cited reason was a teacher in their previous schooling experience. This view was also supported by Donady and Tobias (1977) in their comments about the influence of teachers and their attitude toward mathematics. In an interview, one woman remembered that her fourth-grade teacher, whom she wished to emulate, expressed her dislike of mathematics. Another woman remembered a teacher who used mathematics as a discipline control. An example is if the children exhibited good behavior as a reward, they would not have math class that day.

A basic principle of good teaching is to provide a friendly and supportive atmosphere within the classroom. This is especially true of a math class which may contain students who are suffering from math anxiety. The teacher should give encouragement and express confidence in the students; above all, mathematics should not be used as a punishment.

McAlluiffe and Trueblood (1986) conducted a study of mathematics anxiety and its relationship to other constructs. The subjects for this study were pre-service elementary and special education teachers. The results of this research indicated that mathematics anxiety, mathematics attitude, general anxiety, and test anxiety are interrelated. The authors presumed that a greater knowledge of mathematics through additional course work would decrease a person's mathematics anxiety. It remains to be determined whether recent changes in curriculum which require more mathematics will prove successful in decreasing mathematics anxiety.

This study also considered the effect evaluation plays in mathematics anxiety. Evaluation was found to have a significant role in this matter. This strong relationship between general feelings toward mathematics, feelings toward mathematics performance, and feelings toward mathematics classes suggest that consideration should be given to the influence of evaluation on mathematics. This raises questions regarding the methods used to determine the goals of mathematics evaluation.

Many students with mathematics anxiety feel that mathematics is a rigid and non-creative area of study. The teacher can alleviate this erroneous impression by encouraging creativity in problem-solving and by giving recognition for unusual solutions to a problem. Excessive emphasis on the correct final answer to a problem should be avoided; thus, partial credit should allow the student to explain his/her method of computation and encourage creative thinking.

The teacher should be aware of the possible negative effect that testing procedures may contribute to math anxiety. Over-emphasis on test scores as the only means of evaluating mathematics achievement should obviously be avoided.

Bulmahn and Young (1982) revealed that people who elect to become elementary school teachers have a decided preference for language arts or social studies rather than a preference for mathematics or science. Many beginning education students feel that elementary teachers do not really have to be proficient in mathematics beyond the basic computational skills. One solution to this problem would be for each elementary school to employ a mathematics specialist to teach in a departmentalized program. This would, however, create problems for those schools who are committed to the self-contained classroom concept.

Attitudes Toward Mathematics

In a study of sex, grade level, and the relationship between mathematics attitude and achievement in children, Schofield (1982) determined that there were very few significant correlations between mathematics attitude and achievement among girls of any grade level.

The correlations were generally low but positive. The fifth grade recorded a negative correlation between attitude and achievement. The correlation between attitude and achievement when only boys were considered was positive and significant. When both groups were compared, the relationship was low. These findings were consistent with those of Aiken (1976) who reported that the relationship between attitude and achievement was usually found to be a low positive relationship, which did not always reach a level of statistical significance.

Sex-role stereotyping of mathematics as a male domain should be avoided. This perception can cause females to avoid success in mathematics and also cause them to choose to enroll only in the minimum number of courses required for high school graduation. Differential attitudes toward male and female students may lead to diversified expectations. Ernest (1976) reported in his survey that almost one-half of the teachers expect male students to do better in mathematics while none of them expected the female students to do better. Therefore, it is only reasonable for studies to reveal that girls are generally less confident of their ability in mathematics than boys.

Fennema (1974) expresses the belief that sex differences in mathematics achievement are due, in a large part, to variance in spatial visualization skills and sex role expectation. A partial explanation for boy's superior spatial visualization skills is that boys engage in play activities which appear to include more spatial components than the play activities of girls. Society in the past has dictated that the learning and the use of mathematics are closely related with the masculine role. This sexual stereotyping, however, is declining at a decidedly rapid rate.

Gilbert and Cooper (1976) studied the relationship between teacher and student attitudes and the competency levels of sixth grade students. The students who attended rural schools demonstrated a significant correlation between attitudes toward mathematics and achievement. However, no significant relationships among the urban area students appeared to exist. In addition, some negative correlations were found between teachers' attitude toward teaching mathematics and students' attitude toward mathematics. The conclusion was that teachers' attitudes toward teaching mathematics at the sixth grade level might be as significant in affecting students' attitudes as would the teachers' attitudes toward working with and teaching children.

In review of research findings, Aiken (1976) concluded that the widespread belief that teachers' attitudes toward mathematics effect students' attitudes is difficult to confirm. The effect of teacher attitude and behavior on student attitude varies greatly from teacher to teacher. When attitude scores are used as predictors of achievement in mathematics, a low but significant positive correlation is ordinarily found.

Tishler (1980) investigated whether attitudes toward mathematics as exhibited by a group of pre-service elementary teachers could be improved through remedial mathematics instruction. The underlying assumption of the investigation was that achievement and attitude in mathematics are positively correlated. Positive changes in attitudes were obtained, but these changes were not statistically significant. Therefore, the assumption that relates teachers' achievement and attitude in mathematics was not supported.

A study was conducted by Messina (1980) to determine the attitudes of students and teachers toward sex role stereotyping in career preferences which utilized mathematical ability. The evaluation was conducted by randomly selecting students to participate in a control group and creating an experimental group at each grade level in grades three through six. The research findings concluded that the improvement noted in the experimental group concerning attitudes toward mathematics and the achievement of students far exceeded the findings within the control group. The findings indicated that attitudes of teachers within the experimental group had also improved considerably.

Since women make up the majority of elementary school teachers, it is important that consideration be given to their mathematics anxiety and math avoidance. Tomhave and Kelly (1985) conducted a study to determine if elementary education students would produce a mathematics anxiety rating scale higher than any other groups. The significance of this study is that elementary education males scored lower on the anxiety rating scale than any other groups and the female population scored the highest.

Sovchick, Meconi, and Steiner (1981) reviewed the literature related to mathematics avoidance and anxiety. They cited a study at the University of California which revealed that 57 percent of the first-year male students had taken four years of high school mathematics while only eight percent of the females had completed the same course content. The freshman females could only major in five of the 20 available fields because they lacked the pre-requisite skills in mathematics. This could be one of the fundamental factors explaining why females are more predominate in elementary education.

Tobias and Weisbrod (1980) reported on the new attention given to mathematics avoidance and mathematics anxiety and the link between poor mathematics skill and the cultural, educational, and occupational barriers experienced by females. A discovery that persistence rather than ability could account for male/female differences in mathematical performance was also viewed as new and important. Women who have only an average amount of mathematics anxiety do not enroll in mathematics and science courses in large numbers. It was also noted that the intervention strategists believe that for some people (probably more women than men) past negative experiences with mathematics would cause mathematics anxiety severe enough to effect decisions relative to college curriculum.

In a study of relationships between math anxiety, math attitude, and mathematics achievement for high and low math-anxious students, Kincaid (1981) concluded that for both high and low math-anxious students, confidence in ability to learn mathematics was significantly and positively related to math anxiety. The low math-anxious group held consistently positive attitudes toward mathematics and appeared to be influenced by the perceived attitude of their parents and teachers. The high-anxious group was less consistent in their attitude toward mathematics which may indicate that sources other than their attitude toward mathematics could be contributing to their math anxiety.

Hilton and Berglund (1974) reported a positive relationship between a student's perception and his/her performance in mathematics and the relationship between attitudes and performance is the consequence of a reciprocal influence. Other studies have substantiated the relationship of attitude and achievement in mathematics (Campbell and Martinez-Perez, 1977, Sells, 1978, and Fennema, 1979). Attitudes toward mathematics are probably acquired over a long period of time, and it is unlikely that significant changes can be made through short-term courses. In a study of math-anxious pre-service elementary teachers, Tishler (1980) found that attitudes toward mathematics were not significantly improved but positive changes were indicated.

Negative attitudes toward mathematics apparently are acceptable for adults, and some teenage girls may even consider it to be a social attribute. Lazarus (1974, p. 19) reports, "It is particularly unusual for a well-educated person to admit to an intellectual deficiency. Nevertheless, when the subject of math comes up, people of all intellectual estates speak freely of their own difficulties with the subject of mathematics in school."

Little difference was found to exist in the attitude toward mathematics between boys and girls at the elementary school level (Fennema and Sherman, 1977). This was not consistent at the high school level, and the difference probably should be attributed to social factors. Aiken (1976) stated the mathematical achievement of girls is more predictable from their attitudes than is boys' achievement. This is likely a reflection that mathematics is perceived as a male domain and boys would be reluctant to admit a deficiency in their considered field of expertise.

Fear of failure causes many students to avoid mathematics even though they possess the skills necessary to achieve success. Elementary teachers often choose their field because of the minimal mathematical requirements. Later in their career they may discover that a knowledge of mathematics is necessary to achieve desired job performance effectively.

Many people believe the myth the some persons have a "math mentality", and that if both parents excel in mathematics, this is a genetic trait and will be inherited by their children. These people also believe that those who are competent in mathematics find math easy and are always correct even when solving unfamiliar problems. This theory is refuted by Hunt (1985, p. 34): "Even competent mathematic teachers sometimes experience math anxiety, and the fear of being unable to solve a problem one has never seen and this seems to be common among mathematic teachers at all levels". Math-anxious elementary teachers should realize anxiety related to mathematics can be reduced, but it may never be fully eliminated. However, it need not be devastating since all persons, while in the field of mathematics, must learn to cope (Burton, 1971).

Language of Math

The appropriate age-use of language is critical because language acquisition also influences developmental processes related to cognitive understanding. "The relationship between the language of instruction and the child's ability to respond adequately to this language often determines a preschool child's success in schooling" (Lehrer and de Bernard, 1987, p. 42). We must be concerned not only with the language used in mathematics but also with the language development of the child.

Long and repetitive assignments of homework would only serve the purpose of teaching that mathematics is a boring subject, if the child understands the concept needed to solve a mathematical problem. This procedure would enhance the already embedded antagonism created by prior mathematical experiences. This concept is further stressed from Piaget's school of genetic epistemology. Emphasis is placed on the successful stages of learning concepts from their non-existence in the mind to the level of mastery (Gattegno, 1984). This view seems to be in conflict with the methods of teaching used by mathematics teachers who stress rote memory and symbolic reflex level of students' reactions.

Piaget was concerned with how children learn new concepts and the fundamental structures which would allow the teacher to confirm that the student understands a new concept or operation. Piaget's developmental stages include the pre-operational thinker who often indulges in fantasy that may have no basis in fact.

At the concrete operational state the child does not depart from reality. He creates a world all his own in which reality plays little or no part (Piaget, 1964). There is more concern with data obtained from objects and the mental experiments he/she can do with them. At the formal operational level the child is no longer restricted to concrete objects and events because thinking is now in the abstract. Therefore, Renner and others conclude "A pre-operational thinker cannot think about what he/she thinks. A concrete operational thinker can think about his/her thinking, as long as objects are present for him/her to manipulate, and a formal operational thinker can think about the consequences and/or implications of his/her thinking" (1976, p. 65).

At the same time, language is developed through social interaction with other human beings which Piaget calls social transmission. Words used obtain their meanings from the person hearing the words. For example the greeting "How are you today?' is usually interpreted as a friendly "hello." However, some people may respond by giving you a history of their physical condition. The seemingly prevalent belief that "Every teacher should be a teacher of language" can be interpreted in many ways, but the usual connotation is that grammar and language are synonymous. A broader meaning is given by Renner et al. (1976, p. 65), who state,

> If teachers would interpret the universal direction to teach language to mean that they are responsible for leading a child to describe and receive information about his/her environment, they would be doing much more than teaching language; they would be moving the learner into a position where he/she could have his/her cognitive thinking changed through disequilibration-equilibration process.

The implications are that language development occurs only as a result of the experiences of the learner. According to Piaget (1964) experience has an influence upon cognitive-structure development; and there are two kinds of experience, physical and logico-mathematical. Physical experience through the interaction with objects is essential for young learners. Basic cognitive structures must be developed in which information is obtained from the objects themselves. Logico-mathematical experiences occur by the manipulation of the objects in which the learning comes from the actions instead of the objects themselves. These experiences result from the operations.

"Piaget regards language as insufficient for the development of operational thought" (Almy, 1979, p. 179). The child may repeat a correct response to a given question without fundamentally understanding what he/she has said. Verbal training by the teacher does not guarantee understanding by the child. Children in mathematics classes may be able to explain the correct procedure for solving a problem without explicitly understanding the concept involved. It is the responsibility of the teacher to critically analyze the cognitive development of the student involved in these situations. "There is the clearest evidence of the many difficulties adolescents have in answering questions that would appear easy to an inexperienced mathematics teacher or one unaware of Piaget's work" (Lovell, 1979, p. 199).

The language of mathematics also is a factor which influences the child's ability to successfully solve math problems. Children are faced with the dilemma of not only interpreting mathematical language issues but also mastering the symbols of math. Cocking and Mestre (1988) view math as a language and consider language-learning issues as very important in thinking about the various strands of math representations. Both math and language are generally viewed as symbol systems. The letters of the alphabet have no meaning until these symbols are entwined and given meaning. The symbols of math operate in a similar manner. It is likely that many teachers attempt to teach math symbols before the children fully understand the language involved. Spencer and Russell (1960) reinforce the claim that many of the difficulties children encounter in math are due to the specialized language for expressing ratios, fractions, and decimals; thus, the English statements must be converted into math statements before the problems can be solved. Usually the child can correctly ascertain that the symbol "÷" represents division but may be without the understanding of the division process. The words "divisor" and "dividend" are not commonly used in everyday conversation and could be viewed by the child as a different language entirely.

Surely mathematicians can formulate less confusing terms for expressing mathematical terms. The term "squaring a number" does not give the child any concrete clue as to the computation required, nor can it be related to any visual geometric figure such as a circle or a square.

Lower elementary children become quite familiar with geometric figures and have no trouble visualizing objects which are round. Yet, in the field of mathematics all of this changes as the "rounding" of numbers has no relationship to a circle which could be colored or transformed into a happy-face. However, the world of mathematics has a new meaning for words; learning these meanings is similar to learning a new language. The written mathematical symbols are standardized throughout the industrial nations of the world, (Pimm, 1978) and can be understood by persons who do not have a common language except the language of mathematics. Thus, an Englishman, a Frenchman, and a German would be able to converse in the written symbols of mathematics, even though none of them was bilingual.

Cardinal or ordinal numbers when used in noun phrases follow basic grammatical patterns. Both types of numbers usually appear before the noun in a noun phrase. The child needs to have an understanding of pre-articles, non-definite articles, and definite articles which precede the cardinal or ordinal numbers. As an example, "one of the boys" and "the first boy" both indicate oneness, but there may be a vast difference when used in written mathematical problems.

The grammatical construction of written math problems often gives a fractional relationship of numbers. Language skill is essential in solving such problems. Knight and Hargis (1977) concluded the difficulty encountered in math story problems is as much coping with language as it is coping with math. This conclusion was also reached by Call and Wiggin (1966, p. 157): "Even very good readers, as measured by the Cooperative Test, have difficulty in the interpretation of different kinds of reading found in word problems". These conclusions suggest that mathematics teachers need to be educated in teaching the language of math. Children are taught to skim over reading materials and to look for verbal clues. The mastery of this process is essential in becoming a good reader, but it only leads to disaster in solving mathematical problems.

Hunt (1985) suggests that the language of mathematics may be one of the causes of math anxiety as many young boys and girls who have advanced skills still experience difficulties in mathematics. The reason could be that many words in mathematics seem ambiguous because of their many connotations. Aiken states, "The majority of mathematicians are apparently not interested in attempting to devise or agree upon a completely consistent, adequately descriptive set of mathematical notations" (1972, p. 374).

Not only is the language confusing to the child but the process itself can create difficulties. The child is taught the "basic facts" stating that when a number is subtracted from another number that the difference is smaller than the subtrahend. Conversely, when solving the problem $4-(-2) = 6$ the above logical conclusion does not hold true. Also when a fraction is multiplied by a whole number, the process is one of division. Most children seem to accept these concepts without question, but to students who ask questions about the process, this can lead to confusion and anxiety about mathematics in general. The elementary teacher who has a limited knowledge of math may be hard pressed to answer such questions as, "Why do we call it subtraction when we really must add, or why do we call it multiplication when the solution calls for division"?

Children learn that mathematics is an exact science and it is, but the language of math has many connotations. "The problem is not that there is anything wrong with math; it is that we are not properly initiated into its vocabulary and rules of grammar" (Tobias, 1978, p. 49). We may question the exactness of mathematics when confronted with finding the area of a circle. The best we can do is to arrive at an approximate area. However, only the more inquisitive students will recognize this seeming flaw in mathematics as an exact science because we have programmed them not to question mathematical processes.

Children are first taught that zero is a number that indicates nothingness; it cannot be added or subtracted. Later they must learn that a zero is a place-holder and it does have value. Tobias (1978) gives several examples of the problems related to the language of mathematics. There is even confusion over the meaning the word "circle". Children color circles for years before they are introduced to the one that must be measured. Where does "pi" come from and why can we not use common everyday language? This is confusing not only to children, but to many adults as well. Tobias states, "I can still remember how bothered I was the first time a teacher told me about 'pi'. I was in the seventh grade; and until then, I trusted mathematics" (1987, p. 57). "Pi" is introduced as an approximate fraction of 22/7 or decimal 3.14159 and the formula, $A = \pi r^2$ is used in obtaining the area of a circle. The child who does not understand the solution would probably ask if the formula would work equally well with large circles and small circles. As stated previously, most students just memorize the facts and ignore the details. Many junior high school boys remember this formula, even if they forget all of the others, they seem to love the common joke, "pi are not square, pie are round."

Common Words--Specialized Meanings

The effective teaching of reading and the effective teaching of mathematics follow a similar pattern. Children are taught that words are symbols with a variety of meanings until they appear in context (Call and Wiggins, 1966). The words derive their meaning from the whole of which the words are only a part. The syntax of comparative construction is an area of language skill necessary for solving many reading problems in mathematics. Comparative constructions comprise the most common syntactical frames used in arithmetic reasoning problems (Hargis, 1977). The word "equal" is represented by the mathematical symbol "=" and may be presented in a variety of ways in mathematical problems. The use of terms such as, "as many, as far, and as big" is a conceptual matter. This construction operates from a conceptual basis of equality being "the same or the same as" (Knight and Hargis, 1977).

In mathematics the symbol for equal "=" represents equality as being exactly the same although children have been taught that being equal does not mean being identical. Girls are equal to boys does not mean that boys and girls are exactly the same. The teaching of the concept of "equal" as representing an approximation and the mathematical connotation of equal as being an exact representation may be contributions to the cause of confusion in children. Children learn that mathematics is an exact science and that any deviation from correct procedures results in incorrect answers. This line of reasoning operates very well when computing the area of a square or a triangle, but the formula for obtaining the approximate area of a circle, (πr^2) results only in obtaining the approximate area of a circle, at least as expressed in cardinal numbers. Not only is the word "equal" a source of much interpretation but the exactness of a mathematical solution also becomes questionable.

In order to solve "reading" problems in mathematics, the child must first learn the meaning of words from the context by seeing the relationship between the parts and the whole. The mathematical signs are symbols not only of relationships but also of operations as well. The relationship between the parts must be understood before the meaning of words can be translated to mathematical symbols.

Call and Wiggin (1966) concluded that students need special reading skills in order to solve word problems in mathematics. From their study of students in mathematics classes the following inferences were made:

> 1. There is merit in teaching special reading skills for the solution of mathematical problems.
> 2. Even good readers, as measured by the Cooperative Reading Test, have difficulty in the interpretation of the kinds of reading found in word problems.
> 3. Part of the difficulty which teachers encounter in the teaching of mathematics comes from a special kind of reading disability which does not appear on standard measuring instruments.
> 4. Part of the difficulty which teachers encounter in the teaching of mathematics is that they are not equipped to teach reading.
> 5. If by teaching reading, instead of mathematics, we can get better results, it seems reasonable to infer that the competent mathematics teachers might get better results if he/she were to teach reading of the kind encountered in mathematical problems (p. 157).

The general use of the word "of" in the solving of problems with fractions indicates the process of division, yet the solution requires multiplication. In the case of multiplication of improper fractions the solution involves multiplying some of the numbers and dividing others. The majority of mathematic students will probably memorize the rules without any questions as to why it must be this way; so, to the inquiring mind, this could be a source of math anxiety. The word "cancel" also has different meanings. If we cancel something we no longer use it, but the cancellation of fractions connotes a whole new meaning.

Most students complete high school with the erroneous impression that mathematics teachers arbitrarily choose "x" or "a" or "delta". Only the teacher knows that the letters at the end of the alphabet designate unknowns, letters at the beginning of the alphabet usually signify constants, and "delta" means "change" or "difference". In the more complex studies of mathematics the meanings of words and symbols become even more critical. An illustration of this was made when Tobias expressed her confusion with the symbolic language of math; "For me, the fateful moment struck when I was confronted by an operation I could neither visualize or translate into meaningful words. The expression $X-2=1/X^2$ did me in" (1978, p. 52).

The relationship between the language of instruction and the child's ability to respond adequately to this language often determines a child's success in school (Lehrer and de Barnard, 1987). Aiken (1972) concludes that it is generally recognized that linguistic abilities affect performance in mathematics; in addition, mathematics itself is a specialized language.

Each numerical concept has many meanings which may be confusing to the child. Fuson and Hall (1983) list several interpretations of numbers. Cardinal and ordinal numbers have different connotations, which derive their meaning from the way in which the number is used. For example, the number "nine" on the jersey of a football player indicates that he is a quarterback and the number 50 designates a center who is not eligible as a pass receiver. One aspect of the meaning of numbers may facilitate the interpretation of another. Thus, the study of arithmetic allows tracking the emergence of interconnecting meanings in a complex field.

The view that mathematics is a specialized language is often expressed but this belief is by no means universally accepted. However, many mathematician do concur with this concept. "All mathematicians, even the very young students very near the beginning of their mathematical learning know that mathematics has a language of its own (in fact, it is one), and an author must have a thorough mastery of the grammar and vocabulary of that language as well as the vernacular" (Steenrod and others, 1973, p. 32). It is well known that mathematics often uses common English words and assigns them specialized meanings. Small children learn that the word "and" when used in mathematics connotates the operation of addition as well as its use as a conjunction. The word "of" indicates the process of division which is far different in meaning from that of the vernacular language. It has been my experience to note that many teachers try to solve the complexities of mathematical language by the use of rote memory of mathematical rules. This method of teaching utilizes reflex reactions and precludes any critical thinking by the student. Perhaps this type of teaching is necessary for the many teachers who do not themselves understand the specialized and often contradictory meanings of the language used in mathematics.

Metaphors and Mathematics

We cannot escape the use of metaphors in our language because metaphors are part of our language. Metaphor refers to a particular set of linguistic processes whereby aspects of one object are transferred to another object, so the first object is spoken of as if it were the second object (Hawkes, 1972). Metaphors are a figurative language that does not really mean what is really stated. As an example, students who may not understand the components of an atom may be introduced to the following metaphor, "The atom is a miniature solar system". This metaphor would aid the student in moving from the more familiar to the less familiar, as the atom does have characteristics which are similar to that of a solar system. Unless there is an understanding of the solar system, the above example would only serve to confuse the student. He/She may conclude that the teacher did not understand the difference in an atom and the solar system.

One of the characteristics of the metaphor is that it is inherently false, but it may be useful in the extension of what is known to an insight of the unknown. "Metaphors convey a relationship between two things using a word or words figuratively, not literally; that is, in a special sense which is different from the sense it has in the context noted by the dictionary" (Hawkes, 1972, p. 71).

Although comparisons may be helpful in bridging the gap from the familiar to the unfamiliar, it also poses its own hazards. Suppose the child takes the statement literally, and later finds that it is false? Teachers are not supposed to give false information to their students. Even the phrase, "bridging the gap" does not convey the intended message if taken literally. The disturbance the student feels by such statements may be easily removed only if the child already possesses a cognitive structure sufficient to render intelligible the comparison contained in the metaphors (Petrie, 1979). If the student does not possess the cognitive structure to interpret the metaphor in a comparative way, a conflict in the child's mind may be created. The teacher is responsible for determining if the student is capable of functioning at the formal operational level, which is required for understanding many metaphors used in the classroom. This view is also expressed by Pimm, when he states, "Our concern as mathematics teachers is surely with the creation and loss of meaning. The unexplained extension of concepts can too often result in the destruction rather than the extension of meaning" (1980, p. 50).

In the use of metaphors, the teacher must realize there are two points of view: the view of the teacher, and the view of the student. The effective use of metaphors as a means of communication requires that the teacher be aware that the students possess the knowledge addressed in the metaphor (Sticht, 1979). This problem is especially critical when working with children of different cultures or with children of different ages. In order to avoid confusion, the student must know that a metaphor exists between two objects even though the objects may be quite different in many aspects. The student must find some basis for similarities between the two domains in the metaphor and realize that a literal interpretation would render the statement false.

A metaphor may be used in counting numbers, such as, there are five farm hands. The meaning of the statement indicates that there are five farm workers. A small child may erroneously conclude there are two workers with two hands each and one worker has only one hand. However, this metaphor is not necessary to convey a message or to extend meaning in this situation.

The concept of number sets lends itself very well to the use of metaphors. The word "set" and the variations of "set" have a number of meanings in the English language, and it also has a special meaning in the language of mathematics. But in the explanation of negative numbers used in mathematical problems, the use of metaphors or any other device, may not suffice. There seems to be no other situational meaning to guide the operation. In the example, -4 x -2, there is no imaginary, past experience, or intuition to be used in solving the problem. It is difficult for a child, or an adult, to understand any object as being less than zero. How can we multiply two objects representing a value of less than zero? If you multiply -4 x -2, the answer becomes a +8; as has been stated before, "you can't trust mathematics".

A metaphor can be used in the addition and the subtraction of negative numbers. As a example, negative numbers are a debit in your bank account. Similar characteristics do exist and this comparison may be helpful for the student. The teacher can only hope that the student does not ask why the same concept cannot be applied to the multiplication of negative numbers. It doesn't make sense that -4 + -2 = -6, while -4 x -2 = +8. Not only is the process used in mathematics confusing, but language itself seems to be a contributing factor which leads to mathematics anxiety.

I view the language of mathematics as a specialized language rather than a language of its own. It is not a separate language with its own syntax, but a specialized variant of the language in which it is spoken. It seems that the language of mathematics is esoteric in nature. A conversation concerning mathematics can be readily understood by other mathematicians, but persons without a good mathematical background may have difficulty entering into the conversation.

Coping

Most of the research concerning math anxiety reveals the prevalence of anxiety, the relationship of anxiety to performance, sex and attitude factors. Far less literature seems to exist on the prevention of math anxiety, although some researchers have definite ideas on both the cause and cure of this dilemma. Sherard (1981) offers these practical suggestions for teachers:

A. Provide students with sound counseling about the math requirements of the program of study in higher education.

B. Classroom teachers should stress the learning of mathematics with understanding rather than the memorization of facts.

C. Teach the vocabulary of mathematics, giving special attention to words used differently in ordinary English.

D. Avoid placing an over-emphasis on tests as a means of evaluation of mathematics achievement (p. 107).

Tishler places much of the blame of math anxiety on teachers and teaching methods when she states, "It has become painfully apparent that math anxiety can be a contagious as well as a debilitating condition for which some teachers are carriers" (1980, p. 6).

Tomhave and Kelly (1985) express the belief that students should be confronted with their math anxiety as soon as it appears and that teachers who are positive and excited about mathematics will produce very few math anxious students. Bulmahn and Young (1982) also point out the need for effective teachers in mathematics and suggest that all elementary schools should employ mathematics specialists to teach math classes and to serve as a resource person to other teachers. Mathison (1977) views the most common cause of math anxiety as being related to past experiences in mathematics classes, and suggests that faculty selection may be the most crucial consideration in preventing math anxiety.

Many students in mathematics classes never let it be known that they do not understand the solution for a mathematical equation for fear of ridicule from classmates or the teacher. On the other hand, the better female mathematics students may not ask questions because of the fear of appearing too bright. Tobias (1978, p. 59) gives an excellent example;

> My nightmare, one remembers, was one day in math class I would innocently ask a question and the teacher would say 'now that's a fascinating question, one that mathematicians spent years trying to figure out,' and if that happened, I surely would have had to leave town, because my social life would have been ruined.

Teaching for understanding would solve many of the problems associated with mathematics, however, much of the teaching procedures are detached from mathematical reasoning. Burns (1986, p. 1) states, "Elementary grade children spend an estimated 90 percent of their school mathematics time on pencil-and-paper computation practice, most often learning computation skills by rote". The goal of mathematics instruction is often to produce correct answers; this is also the goal of textbooks which stress correct answers rather than an understanding of why the procedures work.

Teachers often neglect teaching for understanding due to the pressures of accountability. Local and state mandated test results are often used as a measure of the effectiveness of the teacher without regard for the students' understanding of the process. When students learn mathematics in the context of meaning and application, their understanding and skills can then be applied to the learning of new skills (Burns, 1986). Thus, many of the frustrations in learning of mathematics would be avoided.

The emphasis toward the importance of understanding the process was also cited by Morris when she states, "For the anxious, then, mathematics becomes a rigid, authoritarian subject consisting of rules to be memorized and obeyed and formulas to be applied blindly. Memorization replaces understanding" (1981, p. 414). The teacher should create a friendly atmosphere in which students feel free to ask questions. Students who are math-anxious and especially those who have a low self-concept are reluctant to take the risk of asking questions in class.

The prevention of math anxiety among students would eliminate the need to cope with this debilitating problem which affects so many students. A number of suggestions have been made (Morris, 1981) that may be regarded as helpful preventative measures, such as, creating a positive classroom atmosphere, stressing both product and process, and making sure each concept is understood before introducing a new concept. Effective teaching procedures would eliminate much of the need for treatment programs used to reduce math anxiety.

A study was conducted (Bander et al., 1982) regarding the effective treatment of math anxiety through the use of study skills training, cue-controlled relaxation, and study skills plus cue-controlled relaxation. The researchers found that the study skills group demonstrated the greatest reduction in self-reported math anxiety. The combination and the relaxation groups did not differ from the control group. In the follow-up, the relaxation group continued to improve and was assessed as being superior to the other two groups. "The results from follow-up assessment suggests that math anxiety treatment programs oriented toward the alleviation of generalized test anxiety may be superior to those focusing on the mathematics fear per se" (Bander et al., 1982, p. 102).

Pearson (1980) describes the feeling of an elementary teacher who was unskilled in mathematics and suffering from mathematics anxiety: "There are occasions, in fact, when fear of embarrassment and feelings of helplessness caused by her inability to do math made her break out in a cold sweat" (p. 34). Intervention programs could be helpful for these persons, but it is probably these teachers who represent the group least likely to seek help. Tobias (1987) has surmised that the teacher who recovers from math anxiety may be a better teacher than the teacher who perceives herself as being gifted in mathematics. Fennema and Sherman (1977) propose that teachers' enthusiasm and high expectations for students' success go a long way in dispelling anxiety toward mathematics. Also Taylor and Brooks (1986) have suggested that the affective domain may be used to address math anxiety such as looking at teachers' personal math-life history and how these experiences have affected them.

The teacher should carefully analyze the level of cognitive development as well as the level of mastery of language utilized by the child in mathematics. There are many problems relating to the understanding of mathematics concepts, such as, understanding how new concepts are assimilated with older concepts in moving from the known to the unknown, and a knowledge of the student's conceptual level of cognitive processes. In addition, there is the ever present problem created by the use of figurative language which is often used in the form of metaphors.

Cuevas, (1984) states that the relationship between language factors and mathematical achievement is not clearly understood, but it is reasonable to assume that a mastery of mathematical concepts is dependent upon the mastery of the language used to express, characterize, and apply those concepts. It is important to consider the role played by language in the assessment of mathematical achievement; this is especially true when the students are assigned written problems. It may also be true that language is a contributing factor to mathematics anxiety.

Summary of the Literature

Math anxiety has be described in many ways, such as, emotional reaction involving sweating palms, nervous stomach, and difficulty in breathing. Others have described it as a fear which causes persons to avoid mathematics. There are degrees of math anxiety that seems to affect different people in various ways, all which lead to the avoidance of mathematics. Thus, many students preclude their entry into many professions which require an understanding of mathematical concepts.

Math anxiety seems to be a learned attitude which is situationally evoked. This anxiety is accompanied with low expectations for success, so the student is doomed to failure even before the task has begun. Volumes have been written as to the causes of math anxiety. Included are: cultural effects, parents' attitudes, teacher attitude, and sex-role stereotyping.

The language of mathematics seems to be the only area concerning math anxiety which has been largely neglected. A few researchers have addressed the problem and all of them have concluded that the language used in mathematics is a source of confusion and frustration.

Some researchers have concluded that the language and symbols of mathematics constitute a new language of its own. The most popular view seems to be that mathematics is a specialized language which takes words from the vernacular and gives them new meaning. Common English words, such as, "round" and "square" have different meanings when the student is asked to "round-off" numbers or to "square" a number.

Rote-memory is often used in the teaching of mathematics. Memorize the rules seems to be the order of the day. Such teaching methods preclude the teaching for understanding. The student who dces not understand the process involved in mathematics and who is confused by the language used in mathematics is a prime candidate for math anxiety.

CHAPTER III

DESIGN AND METHODOLOGY

The intent of this chapter is to: (a) state the purpose of the study, (b) describe the sample, (c) describe of both instruments used for assessing students' attitude toward the language used in mathematics and their application skills, (d) present the rationale and method of data collection and (e) present the statistical technique utilized to test the significance of the data.

Purpose of the Study

The purpose of this study was to investigate the variables of anxiety toward language of mathematics in regard to sixth and seventh grade students. Unlike most studies of math anxiety, the major emphasis of this research focused on mathematical language and its possible contribution to math anxiety.

Description of Sample

The Mathematical Language Attitude Inventory and Mathematical Language Application Inventory were administered to 202 students in grades six and seven on May 8, 1991. The distribution according to gender and grade level are listed below:

A. Sixth grade males --- 52

B. Sixth grade females --- 53

C. Seventh grade males --- 51

D. Seventh grade females --- 46

E. Total number -- 202

Permission to conduct the survey was obtained from school administrators and classroom teachers. The purpose and content of the inventories were fully explained to the administrators, teachers, and students. The inventories were administered by the researcher to each group of students in a classroom setting. Efforts were made to ensure that students' responses to each item were an accurate assessment of their feelings. Therefore, students were assured that they were not being tested, but that the purpose of the inventories were to determine their feelings toward the language used in mathematics.

The students in Spiro Public School were selected for the following reasons:

1. The school administrators and classroom teachers were supportive and interested in the study.

2. The number of students in the sixth and seventh grades provided an adequate sample.

3. The number of students in the sixth and seventh grades were approximately the same.

4. The ratio of male to female students at each grade level was approximately the same.

5. The students were located in the same building and the teachers used similar methods of teaching.

Description of the Instruments

After a review of literature and review of various instruments, two instruments for this study were drafted. An attitude inventory (See Appendix A) was developed for the purpose of assessing the students' feelings toward the language used in mathematics. The Mathematical Language Attitude Inventory contained 20 items, using the vocabulary found in a fifth-grade mathematics textbook. A fifth grade textbook was chosen to insure that students would be exposed to the mathematical language utilized prior to administration of both instruments.

A companion application inventory (See Appendix B) consisting of twenty items was developed, using the same vocabulary contained in attitude inventory. The purpose of the Mathematical Language Application Inventory was to compare application skills; such as, problem-solving ability to correctly identify and execute the proper mathematical procedures utilizing mathematical language.

The instrument was developed and deemed appropriate by a panel of experts to establish content validity (Sprinthall, Schmutte, and Sirois). The panel consisted of the following persons:

a. six teachers: three from grade level six and three from grade level seven.

b. two elementary principals

c. three college professors working in the area of mathematical methods at the elementary level.

d. one psychologist from testing services.

Suggestions and adaptations were proposed by the panel members and modifications and corrections were made accordingly. After the inventories had been judged for appropriateness by the panel of experts, a pilot study was conducted in order to field-test the instruments. Only minor changes were made after the pilot test.

Rationale and Treatment of Data

To determine anxiety toward mathematical language the mid-point was used to distinguish between high and low anxiety levels. Specifically, students who checked "yes" on 11 to 20 items on the Mathematical Language Attitude Inventory were considered to have a low level of anxiety, if the student checked "yes" on 1 to 10 items of the Mathematical Language Attitude Inventory, a high level of anxiety was indicated.

To determine application scores, the mid-point was used to distinguish between high and low levels of application. Specifically, students who answered 11 to 20 items correctly on the Mathematical Language Application Inventory portion of the survey were considered to have high application skills; and those who answered 0 to 10 items correctly were considered to have low application skills.

The above criteria were selected in order to stratify the groups by high or low anxiety rather than using more groups which would compromise the analysis results of the study with moderate levels of anxiety which this study chose not to address.

Sixth and seventh grade students were selected for this study because of possible change in attitude of students in this age group. This researcher has taught both sixth and seventh grade students and noticed a change of attitude toward mathematics. Seventh grade females seem to attain higher on social skills than do their counterparts in the sixth grade. However, sixth grade females seem more competitive in areas of academia.

Based on the above information, this study appealed to the researcher and was believed to be worthy of investigation.

Analysis of Data

The Mathematical Language Attitude Inventory and Mathematical Language Application Inventory were used to obtain the data from sixth and seventh grade students regarding their anxiety toward mathematical language. The responses to the Mathematical Language Attitude Inventory and the Mathematical Language Application Inventory were scored according to the procedures developed by the researcher. The responses chosen by both sixth and seventh grade students on the 20-item instruments were tallied to produce raw scores which yielded the necessary information to determine the students' anxiety level toward mathematical language.

The data for the study were coded, entered, verified and processed by the Oklahoma State University Computer Center. The computer system used for analyzing the data was the <u>Statistical Analysis System</u> (SAS).

The analysis of data consisted of statistical tests for each hypothesis. In consideration of the survey instruments used, the data obtained, the hypotheses tested and considered, the most appropriate statistical tests were analysis of variance and the Pearson product-moment. A cross-nested analysis of variance was performed for Hypothesis III, IV, VI and VII. The Pearson product-moment was applied for Hypothesis I, II and V. The hypotheses were statistically treated for determining significant results. The statements and statistics for testing are discussed below.

Hypothesis I

There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for sixth grade students.

Variable A -- Anxiety toward mathematic language

Scale of measurement -- Interval

Variable B -- Application of the language of mathematics

Scale of measurement -- Interval

Statistical test -- Pearson product-moment

Hypothesis II

There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for seventh grade students.

Variable A -- Anxiety toward mathematic language

Scale of measurement -- Interval

Variable B -- Application of the language of mathematics

Scale of measurement -- Interval

Statistical test -- Pears on product-moment

Hypothesis III

There is no significant difference between male and female students in the sixth grade when comparisons are made concerning anxiety toward mathematical language and the application of mathematical language.

Variable A -- Anxiety toward mathematical language and its application.

Scale of measurement -- Interval

Variable B -- Gender

Scale of Measurement -- Nominal

Statistical test -- ANOVA

Hypothesis IV

There is no significant difference between male and female students in the seventh grade when comparisons are made concerning anxiety toward mathematical language and the application of mathematical language.

Variable A -- Anxiety toward mathematical language and its application

Scale of measurement -- Interval

Variable B -- Gender

Scale of measurement -- Nominal

Statistical test -- ANOVA

Hypothesis V

There is no significant relationship when comparing all subjects' level of anxiety toward the language of mathematics with their level of application.

Variable A -- Anxiety toward mathematical language

Scale of measurement -- Interval

Variable B -- Application of the language of mathematics

Scale of measurement -- Interval

Statistical test -- Pearson product-moment

<u>Hypothesis VI</u>

There is no significant difference when comparing sixth grade males with seventh grade males regarding their level of anxiety toward mathematical language with their level of application.

Variable A -- Anxiety toward mathematical language and its application.

Scale of measurement -- Interval

Variable B -- Grade level

Scale of measurement -- Nominal

Statistical test -- ANOVA

<u>Hypothesis VII</u>

There is no significant difference when comparing sixth grade females with seventh grade females regarding their level of anxiety toward mathematical language with their level of application.

Variable A -- Anxiety toward mathematical language and its application.

Scale of measurement -- Interval

Variable B -- Grade level

Scale of measurement -- Nominal

Statistical test -- ANOVA

Summary

The procedures used in developing the instruments, implementing, and measuring the relationship of anxiety toward the language of mathematics and it application are presented in this chapter. Methods and procedures for testing the hypotheses are also included.

CHAPTER IV

RESULTS

The results from testing the seven hypotheses are presented in this chapter. All of the hypotheses were related to the relationship of students' feelings toward the language used in mathematics and its application. The following hypotheses were tested.

Hypotheses

Hypothesis I

There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for sixth grade students.

The variables are divided into two categories: anxiety toward mathematical language and application. The Pearson product-moment correlation was performed comparing the two variables (See Table I).

A Pearson product-moment correlation analysis was performed to obtain a coefficient to establish the relationship between anxiety toward mathematical language and the application of the language used in mathematics. The Pearson product-moment correlation between the two variables was .59 and was significant at the .01 level; therefore, Hypothesis I was rejected.

TABLE I

SUMMARY OF PEARSON PRODUCT-MOMENT CORRELATION FOR THE RELATIONSHIP BETWEEN LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND THE LEVELS OF APPLICATION ON SIXTH GRADE STUDENTS

Variables	df	Mean	Standard Deviation
Anxiety	103	12.09524	4.067337
Application	103	12.60953	3.124382

$r = .59$ ($p < .01$)

<u>Hypothesis II</u>

There is no significant relationship between anxiety toward mathematical language and the application of mathematical language for seventh grade students.

The variables are divided into two categories: anxiety toward mathematical language and application. The Pearson product-moment correlation was performed in order to compare the variables (See Table II).

A Pearson product-moment correlation analysis was performed to obtain a coefficient to establish the relationship between anxiety toward mathematical language and the application of the language used in mathematics. The Pearson product-moment correlation between the two variables was .39 and was significant at the .01 level; therefore, Hypothesis II was rejected.

TABLE II

SUMMARY OF PEARSON PRODUCT-MOMENT CORRELATION FOR THE RELATIONSHIP BETWEEN LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND THE LEVELS OF APPLICATION ON SEVENTH GRADE STUDENTS

Variables	df	Mean	Standard Deviation
Anxiety	97	10.49484	3.239982
Application	97	10.8412	3.151304

r = .39 ($p < .01$)

<u>Hypothesis III</u>

There is no significant difference between male and female students in the sixth grade when comparisons are made concerning anxiety toward mathematical language and the application of mathematical language.

Gender is the independent variable which was divided into two sub-categories: male and female. A cross-nested analysis of variance was performed regarding the anxiety toward mathematical language and its application on the two groups (See Table III).

The results of the analysis of variance were tested at the 0.05 level of confidence and the F was found to be statistically significant ($F = 5.79$ ($\underline{p} < .05$; df 1, 103). Since there is a significant interaction effect when gender is compared with anxiety toward mathematical language and application, Hypothesis III was rejected.

TABLE III

SUMMARY OF ANOVA FOR EFFECT OF GENDER ON LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND LEVELS OF APPLICATION IN SIXTH GRADE

Source	df	SS	MS	F
Male/Female	1	31.48	31.48	1.52
Anxiety & Application	1	13.49	13.49	2.47
Variables Combined	1	31.62	31.62	5.79*

*p < .05

In the sixth grade the difference between anxiety and application scores depends on gender. Specifically, males and females do not differ on anxiety scores; however, females achieve at a significantly higher level on the application inventory.

The anxiety inventory indicated that females are more anxious-prone than males; but the application inventory revealed that females perform at a higher level on application skills.

<u>Hypothesis IV</u>

There is no significant difference between male and female students in the seventh grade when comparisons are made concerning anxiety toward mathematical language and the application of mathematical language.

Gender is the independent variable which was divided into two sub-categories: male and female. A cross-nested analysis of variance was performed on the anxiety toward mathematical language and its application on the two groups (See Table IV).

TABLE IV

SUMMARY OF ANOVA FOR EFFECT OF GENDER ON LEVELS OF ANXIETY TOWARDS MATHEMATICAL LANGUAGE AND LEVELS OF APPLICATION IN SEVENTH GRADE

Source	df	SS	MS	F
Male/Female	1	17.68	17.68	1.23
Anxiety & Application	1	5.59	5.59	.91
Variable Combined	1	17.12	17.12	2.78

An analysis of variance statistical test was used to analyze the significance of the results at the 0.05 level. The F score indicated that the hypothesis was not statistically significant (F = 2.79 p . >.05; df 1, 95). Therefore, the null hypothesis was accepted.

Hypothesis V

There is no significant relationship when comparing all subjects' level of anxiety toward mathematical language with their level of application.

The variables are divided into two categories: anxiety toward mathematical language and its application. The Pearson product-moment correlation was computed to determine significant relationships at the 0.05 level of significance as shown in Table V.

TABLE V

SUMMARY OF PEARSON PRODUCT-MOMENT CORRELATION FOR THE RELATIONSHIP BETWEEN LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND LEVELS OF APPLICATION ON ALL SUBJECTS

Variables	Mean	Standard Deviation
Anxiety	11.32675	3.778767
Application	11.74259	3.264382

$r = .53$ ($p < .01$)

A significant positive correlation between anxiety toward mathematical language and application did exist. A Pearson product-moment correlation coefficient ($r = .53$ $p < .01$) was found to be significant: therefore Hypothesis V was rejected.

<u>Hypothesis VI</u>

There is no significant difference when comparing sixth grade males with seventh grade males regarding their level of anxiety toward mathematical language with their level of application.

Grade level was the independent variable in this analysis. A cross-nested analysis of variance was performed to compare the effects of male gender for sixth and seventh graders on anxiety toward mathematical language and application (See Table VI).

TABLE VI

SUMMARY OF ANOVA EFFECTS OF GRADE LEVELS ON LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND LEVELS OF APPLICATION FOR SIXTH AND SEVENTH GRADE MALES

Source	df	SS	MS	F
Sixth/Seventh	1	131.63	131.63	8.76*
Anxiety & Application	1	3.54	3.54	.59
Variable Combined	1	3.16	3.16	5.30

*$p < .01$

The results of the analysis of variance were found to be statistically significant ($F = 8.764$ $p < .01$, df 1 , 101). Since the difference found between sixth and seventh grade male-scores for anxiety toward mathematical language and application were significant, the hypothesis was rejected.

Hypothesis VII

There is no significant difference when comparing sixth grade females with seventh grade females regarding their level of anxiety toward mathematical language with their level of application.

Grade level was the independent variable in this analysis. A cross-nested analysis of variance was performed to compare the effects of female gender for sixth and seventh graders on anxiety toward mathematical language and application (See Table VI).

TABLE VII

SUMMARY OF ANOVA EFFECTS OF GRADE LEVELS ON LEVELS OF ANXIETY TOWARD MATHEMATICAL LANGUAGE AND LEVELS OF APPLICATION FOR SIXTH AND SEVENTH GRADE FEMALES

Source	df	SS	MS	F
Sixth/Seventh	1	1.54	1.54	7.54*
Anxiety & Application	1	60.56	60.56	10.74*
Variable Combined	1	1.49	1.49	.27

*$p < .01$

The results of the analysis of variance were tested at the 0.05 level of significance. There was a statistically significant main effect for females in grade levels six and seven ($F = 7.54$ $p < .01$; df = 1, 97). Since there was a statistically significant main effect difference for anxiety toward mathematical language and application ($F = 10.74$ $p < .01$; df 1, 97), the hypothesis was rejected.

Summary of the Results

The hypotheses were tested for significant statistical differences and relationships. Results from these testings showed a significant difference between anxiety and application when comparisons were made of sixth and seventh grade students.

The females in the sixth grade are slightly more anxious than males in the sixth grade; however, the females in the sixth grade performed at a much higher level on application skills than did their male counterparts. Males and females in the seventh grade did not show significant differences when comparisons were made concerning anxiety toward mathematical language. However, both males and females did show a positive relationship regarding anxiety and application.

The results from testing for significant differences when comparing all subjects show a significant positive relationship. A comparison of males in the sixth grade with males in the seventh grade failed to reach statistical significance.

Testing for statistical difference between females in the sixth grade did show a significant difference.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter V includes a statement of the problem, the researcher's conclusions based on the findings, and recommendations for further study.

Statement of the Problem

Math anxiety is identified as a major problem for many middle-school students. Research indicates that factors such as teacher attitudes, parent attitudes, and sex-role stereotyping are contributors to math anxiety. However, research conducted concerning the effects of mathematical language as a participating factor is sparse. The intent of this study was to measure the effects of the language utilized in mathematics as a contributing factor to math anxiety.

Purpose of the Study

The purpose of the study was to investigate the correlative relationship between math anxiety and the language used in mathematics and to determine if this relationship was of significance. Unlike most studies of math anxiety, this research focused on mathematical language and its possible contribution to math anxiety.

Summary of Findings

The purpose of this study was to investigate the language used in mathematics as a possible contributing factor in math anxiety.

Testing of Hypothesis I showed a significant positive relationship between the expressed feelings of sixth grade students toward the language used in mathematics and their performance on mathematical computation problems. The Pearson product-moment correlation showed $r = .59$ which was significant at the .01 level of confidence.

Testing of Hypothesis II showed a significant positive relationship between the expressed feelings of seventh grade students toward the language used in mathematics and their performance in mathematical computation. The Pearson product-moment correlation showed $r = .30$ which was significant at the .01 level of confidence.

Testing of Hypothesis III disclosed a significant difference between males and females in the sixth grade when comparison were made using the variables of feelings toward the language of mathematics and its application in solving mathematical problems. A cross-nested analysis of variance showed $F = 5.75$ which was significant at the .05 level of confidence.

Testing of Hypothesis IV revealed no significant difference concerning anxiety and application when gender was the independent variable. A cross-nested analysis of variance disclosed no significant difference ($p > 0.05$) when comparisons were made between males and females in the seventh grade concerning their feelings toward the language used in mathematics and its application.

Testing of Hypothesis V revealed a significant difference when comparing all subjects' level of anxiety with their level of application. The Pearson product-moment correlation showed $r = .53$ which was significant at the .01 level of confidence.

Testing of Hypothesis VI disclosed a significant difference between sixth-grade males and seventh-grade males when comparisons are made concerning anxiety and application. A cross-nested analysis showed $F = 8.7$ ($p > .01$, df = 1, 101).

Testing of Hypothesis VII revealed a significant main effect for grade levels sixth and seventh. Cross-nested analysis of variance showed $F = 7.54$ ($p >.01$: df = 1, 97).

Conclusions

The following conclusions were deduced as a result of this study:

1. There is a significant relationship between anxiety toward mathematical language and its application in the sixth grade. Lower levels of anxiety tend to be associated with higher levels of application while higher levels of anxiety tend to be associated with low scores on application.

2. There is no significant correlation between anxiety toward mathematical language and its application in the seventh grade. Lower levels of anxiety tend to be associated with higher scores on application. Higher levels of anxiety tend to be associated with lower scores on application.

3. There is a significant interaction effect when comparing

gender with anxiety levels and application scores in the sixth grade. The females and males at this grade level do not differ significantly on anxiety levels, but females do significantly better on application skills.

4. Males in the sixth grade seem to over-estimate their performance on problem solving, while females at this grade level seem to underestimate their performance on problem solving.

5. There is no significant main effect or interaction effect between males and females at the seventh grade level.

6. When comparisons are made of all subjects in the sixth grade and seventh grade, a significant correlation was found. Low levels of anxiety tend to be associated with high application scores and high levels of anxiety tend to be associated with low application scores.

7. Sixth grade females scored lower on anxiety levels and higher on application skills than did the seventh grade females.

8. Females in both sixth and seventh grade scored higher on application skills than their anxiety level scores indicated they would score.

9. Based upon anticipated anxiety scores and application scores there seems to be a positive correlation between levels of anxiety and expected outcomes.

Recommendations

The following recommendations for further study are proposed concerning anxiety toward the language employed in mathematics and its application:

1. As a means for reducing mathematics anxiety levels, more instructional time should be spent defining mathematical language and the purpose that the proper interpretation serves in solving written mathematical problems.

2. A study should be made comparing the achievement of students who have had additional exposure to mathematical language with those students who have not had this experience.

3. An intensive in-service program must be provided for teachers concerning the following:

a. The teaching of reading as it relates to written mathematical problems.

b. Instructional skills in the effective use of metaphors in explaining mathematical concepts.

c. The teaching of the language of mathematics for understanding.

4. This study should be replicated in other parts of the country to determine if the study was culturally biased.

5. This study should be replicated in a school which contains a high percentage of minority students.

6. A study should be made concerning the effects of math anxiety toward the language of mathematics and its application with the additional variable of academic ability.

7. This study should be replicated using students in the fifth and sixth grades.

8. A study should be made of the effects of the symbols used in mathematical skills to determine their role, if any, in math anxiety.

9. Teachers should be allowed to participate in workshops designed to answer such mathematical questions as:

a. How do we explain the mathematical concepts involved in problems utilizing negative numbers?

b. Why must we use multiplication in solving a problem involving the division of fractions?

c. How did mathematicians arrive at such terms as "rounding" and "squaring" of numbers?

d. Why do mathematicians use "a" to represent the known and "x" to represent the unknown?

10. The understanding and use of the specialized language of math and mathematical symbols should become an integral part of college courses in elementary school mathematics methods.

11. Follow-up research should include a qualitative study regarding math teachers' feelings toward the language used in mathematics as a possible source of math anxiety.

12. Follow-up research should include a qualitative study involving sixth and seventh grade students concerning their feelings toward the language used in mathematics and its application in solving mathematical problems.

13. Replicate this study using high, medium, and low levels of anxiety compared with high, medium, and low levels of application.

Summary

Mathematics anxiety has been recognized as a causative factor in the avoidance of and the low scores produced in solving mathematical problems. Few studies have been made related to the language of mathematics and math anxiety.

This study reveals a positive relationship between the anxiety toward the language of mathematics and its relation to solving mathematical problems. Students who scored near the mid-point level on the Mathematics Language Attitude Inventory demonstrated higher levels of application on the Mathematics Language Application Inventory. This was true for both males and females. The implications are that some degree of anxiety is conducive to high application skills.

However, females tended to underestimate their ability to solve mathematical problems, while the males tended to overestimate their ability. This was probably due, in part, to the fact that males at this age wish to express male superiority and consider females inferior in mathematical ability. Although the girls achieved higher levels of application skills, they seemed reluctant to give proper credit to themselves.

A low level of computation skills was found to exist at both sixth and seventh grade levels. A mean score of 11.74 for computation should be of concern to both school administrators and teachers. The vocabulary and metaphors used in mathematics has been recognized as a source of difficulty for students. This conclusion was expressed by Tobias (1987), Pimm (1978), and Hawkes (1972).

The solution to this problem may involve the following: (a) students should be involved in an informal setting in which they are encouraged to express their feelings toward mathematics in general. Attempts should be made to assess their views toward the vocabulary used in written mathematical instructions and problems, (b) teachers should be encouraged to conduct qualitative and quantitative research in the classroom to address determination of student difficulty whether it be math-apathy, math anxiety, insufficient knowledge of math concepts or failure of understanding regarding mathematical vocabulary, (c) a conference should be held with school administrators who are assigned to supervise sixth and seventh grade faculty and students, and inform them of research findings related to math anxiety, (d) teachers should recognize that the language used in mathematics is confusing to students, (e) efforts should be made to determine that students thoroughly understand the language of mathematics before teaching the concepts involved in computation, and (f) rote-memorization is never a substitution for explanation.

In conclusion, I believe that until we as educators grapple with the concept that mathematical language is a problematic issue, we will continue to see the proliferation of math anxiety.

REFERENCES

Aiken, L. R. (1976). Updates on attitudes and other affective variables in learning mathematics. Review of Educational Research, 46, 293-311.

Aiken, L. R. (1972). Research on attitude toward mathematics. Arithmetic Teacher, 19, 229-234.

Aiken, L. R. (1971). Language factors in learning mathematics. Review of Educational Research, 42, 359-377.

Almy, M. (1979). The Impact of Piagetian Theory. Edited by F. B. Murray, Baltimore: University Park Press.

Bander, R. S., Russell, R. K. and Zamostny, K. P. (1982). A comparison of cue-controlled relaxation and study skills counseling in the treatment of mathematics anxiety. Journal of Educational Psychology, 4, 96-103.

Banks, J. H. (1964). Learning and Teaching Arithmetic. Boston: Allyn and Bacon.

Battista, M. T. (1986, January). The relationship of mathematical knowledge to the learning of mathematical pedagogy by pre-service elementary teachers. School Science and Mathematics, 86, 10-13.

Brandon, P. R., Newton, B. J. and Hammond, O. W. (1985, April). The superiority of girls over boys in mathematical achievement in Hawaii. Paper presented at the annual of the American Educational Research Association, Chicago, IL. ERIC ED 260906.

Bulmahn, B. J. and Young, D. M. (1982, November). On the transmission of mathematics anxiety. Arithmetic Teacher, 30, 55-56.

Burton, M. G. (1979). Getting comfortable with mathematics. Elementary School Journal, 79, 129-135.

Burns, M. (1986). Teaching "what to do" in arithmetic -vs-teaching "what to do and why." Educational Leadership, 47, 34-38.

Call, R. H. and Wiggin N. A. (1966, February). Reading and mathematics. The Mathematics Teacher, 149-157.

Campbell, R. L. and Martinez-Perez, L. (1977, September). Self-concept and attitudes as factors in achievement of pre-service teachers. Journal of Research in Science Teaching, 14, 455-459.

Campbell, R. L. and Okey, J. R. (1977). Influencing the planning of teachers with instruction of science process skills. Journal of Research in Science Teaching, 14, 231-234.

Cawley, F., Fitzmarurice-Hayes, A. M., and Shaw, R. A. (1988). Mathematics for the Mildly Handicapped. Boston: Allyn and Bacon, Inc.

Cemen, P. B. (1987). The nature of mathematics anxiety. Paper presented to Oklahoma State University, 1-18, ERIC ED 287729.

Chavez, A. and Widner, C. C. (1982). Math anxiety: Elementary teachers speak for themselves. Educational Leadership, 387-388.

Cocking, R. R. and Mestre, J. P. (1988). Linguistic and Cultural Influences on Learning Mathematics. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cooley, W. W. and Leinhardt, G. (1980). The instructional dimensions study. Educational Evaluation Policy Analysis, 2, 7-25.

Covington, M. V. (1983). Anxiety task difficulty and childhood problem solving: a self-worth interpretation. In H. M. Ploeg, R. Schwartzer and C. D. Speilberger (Eds.) Advances in test anxiety research. New York: Erlbaum.

Covington, M. V. and Omelich, C. L. (1985). Ability and effort valuation among failure-avoiding and failure-accepting students. Journal of Educational Psychology, 77, 446-459.

Covington, M. V. and Omelich, C. L. (1987). I knew it cold before the exam: A test of the anxious-blockage hypothesis. Journal of Educational Psychology, 79, 393-400.

Cuevas, G. J. (1984). Mathematics learning in English as a second language. Journal of Research in Mathematics Education, 15, 134-144.

Denham, D. and Lieberman, A. (1980). Time to Learn. U.S. Department of Education, National Institute of Education.

Dobson, R. and Dobson, J. (1981). The Language of Schooling. Washington, DC: University Press, Inc.

Donady, B. and Tobias, S. (1977, November). Math anxiety. Teacher, 95, 71-84.

Elmore, P. B.; and Others. (1985). A longitudinal study of career interest and mathematics for students at the eighth and twelfth grade levels. Paper presented at the annual meeting of the American Educational Research Association (69th), Chicago, IL>

Ernest, J. (1976, October). Mathematics and sex. American Mathematics Monthly, 83, 595-614.

Fennema, E. (1974, December). Sex differences in mathematics learning: Why? Elementary School Journal, 75, 184-190.

Fennema, E. (1979, November). Women and girls in mathematics--equity in mathematics education. Educational Studies in Mathematics, 10, 389-393.

Fennema, E. and Sherman, J. (1978). Sex-related differences in mathematics achievement and related factors: A further study. Journal for Research in Mathematics Education, 9, 189-203.

Fennema, E. and Sherman J. A. (1977, May). Sexual stereotyping and mathematics learning. The Arithmetic Teacher, 14, 369-372.

Fuson K. C. and Hall J. W. (1983). The acquisition of early number word meanings: A conceptual analysis and review. In H.P. Ginsburg (Ed.), The development of mathematical thinking, 49-107, New York: Academic Press.

Gattegno, C. C. (1984, June). Curriculum and epistemology. For the Learning of Mathematics, Montreal, Quebec, and Canada: FLM Publishing Association.

Gilbert, C. D. and Cooper, D. (1976). The relationship between teacher/student attitudes and the competency levels of sixth grade students. School and Science and Mathematics, 6, 469-476.

Greenwood, J. (1984, December). My anxieties about math anxiety. Mathematics Teacher, 77, 663.

Griffiths, H. B. (1975). Mathematics education today. International Journal of Mathematics Education and Technology, 6, 3-15.

Hawkes, T. (1972). Metaphors. Metheum: London.

Hilton, T. L. and Berglund, G. A. (1974, January). Sex differences in mathematical achievement: A longitudinal study. The Journal of Educational Research, 67, 331-337.

Hunt, G. E. (1985, Spring). Math anxiety--Where do we go from here? Focus on Learning Problems in Mathematics, 7, 29-39.

Kincaid, M. B. (1981, January). Relationships between math attitudes, parents' occupation and math anxiety in female college freshman. Paper presented at the Southwest Educational Research Association Meeting, Dallas, TX. ERIC ED 199105.

Knight, L. N. and Hargis C. H. (1977, April). Math language ability: Its relationship to reading in math. Language Arts, 54, 423-428.

Lazurus, M. (1974, January). Mathophobia: Some personal speculations. National Association of Elementary Principal, 53, 16-22.

Lehrer, R. and deBarnard A. (1987). Language of learning and language of computing: The perceptual-language model. Journal of Educational Psychology, 79, 41-48.

Levitt, E. E. (1980). The Psychology of Anxiety. New Jersey: Lawrence Erlbaum Associates.

Lorenz, J. H. (1982, July). Research since 1976 on affective student characteristics. For the Learning of Mathematics, 3, 24-27.

Lovell, K. (1979). The Impact of Piagetian Theory. Edited by F. B. Murray. Baltimore: University Park Press.

Mathison, M. A. (1977). Curricular interventions and programming innovations for the reduction of mathematics anxiety. A paper presented at the Annual Convention of the American Association, San Francisco, CA. ERIC ED 154330.

McAlluiffe, E. A. and Trueblood, C. R. (1986, April). Factor analysis: A tool for studying mathematics anxiety. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Messina, A. J. (1980). Expanding career choices for students by reducing mathematics anxiety. Paper presented to the U. S. Department of Health, Education, and Welfare, National Institute of Education.

Morris, J. (1981, September). Math anxiety: Teaching to avoid it. Mathematics Teacher, 413-417.

Pearson, C. (1980, January). New hope for math-fearing teachers. Learning, 8, 34-36.

Petrie, H. G. (1979). Metaphor and learning. In A. Ortony (Ed.) Metaphor and Thought. Cambridge: Cambridge University Press.

Piaget, J. (1964). Development and learning. Journal of Research in Science Teaching, 2, 176-186.

Pimm, D. (1980, August). Metaphor and analogy in mathematics. An expanded version of a talk given at the fourth annual conference of the International Group for the Psychology of Mathematics Education held in Berkeley, CA.

Pimm, D. (1978). Language Symbols and Meanings in Mathematics. Master of Science Thesis, Cornell University, Ithaca, NY.

Reyes, L. H. (1984). Affective variables and mathematics education. Elementary School Journal, 84, 558-581.

Renner, J. W., Stafford, D. G., Lawson, A. E., McKinnon, J. W., Friot, F. E., and Kellogg, D. (1976). Research, Teaching, and Learning with Piaget Model. Norman: University of Oklahoma Press.

Steenrod, N. E. (and others). (1973). How to Write Mathematics. Providence: A.M.S.

Schofield, H. L. (1981). Teacher effects on cognitive and affective pupil outcomes in elementary school mathematics. Journal of Educational Psychology, 73, 463-471.

Scott, M. (1987). The Impact of a Number Sense Program on Mathematics Achievement Test Scores and Attitudes Toward Mathematics of Eighth-Grade Students, New Mexico State University, Las Cruces, NM.

Sells, L. W. (1978, February). Mathematics: A critical filter. The Science Teacher, 28-29.

Sherard, W. H. (1981, November). Math anxiety in the classroom. Clearing House, 55, 106-110.

Sheridan, M. and Fizdale, B. (1981). Cultural and sex differences in reading and mathematics. Paper presented to the U.S. Department of Education, Educational Resources Information Center, ERIC ED 205936.

Sherman, J. (1976). Girls' attitudes toward mathematics: Implications for counseling. Presented at the Symposium "Women's and Adolescent's Self-Concept: Implications for Teaching and Therapy", APA Convention, Washington, D.C.

Sprinthall, R. C., Schmutte, G. T., and Sirois L. (1991). New Jersey: Prentice-Hall, Inc.

Sovchick, R., Meconi, L. J. and Stiener, E. (1981, December). Math anxiety of pre-service elementary mathematics methods students. School Science and Mathematics, 50, 643-647.

Spencer, P. L. and Russell, D. (1960). Reading in arithmetic. Instruction in Arithmetic. Twenty-fifth yearbook of the National Council of teachers of Mathematics. Washington, D.C.

Sticht, T. G. (1979). Educational uses of metaphor. In A. Ortony (Ed.) Metaphor and Thought. Cambridge: Cambridge University Press.

aylor, L. and Brooks, K. (1986). Building confidence by overcoming math anxiety. Adult Literacy and Basic Education, 1, 1-11.

Tishler, A. E. (1980). A study of attitudes: Treatment interaction in mathematics with pre-service elementary school teachers. Paper presented at the annual meeting of the Mid-South Educational Research Association (9th), New Orleans, LA.

Tobias, S. (1978). Overcoming Math Anxiety. New York: Norton.

Tobias, S. (1987). Succeed With Math. New York, N.Y. : College Board Publications.

Tobias, S. and Weissbrod, C. (1980, February). Anxiety and mathematics: An update. Harvard Educational Review, 50, 63-68.

Tomhave, W. P. and Kelly W. P. (1985, January). A study of math anxiety and math avoidance in pre-service elementary teachers. Arithmetic Teacher, 32, 51-53.

APPENDIXES

APPENDIX A

MATHEMATICAL LANGUAGE ATTITUDE INVENTORY

_____Male _____Female

MATHEMATICS LANGUAGE ATTITUDE INVENTORY

Read the following. These statements are to show how you feel about the language and symbols of mathematics. Check "yes" beside each statement that you already know how to solve. If you are not sure how to solve the problem, check "no".

I know what to do......	yes	no
1. When asked to round a number.	_____	_____
2. When asked to find the circumference of a circle.	_____	_____
3. When asked to identify and label the place value of a number.	_____	_____
4. When asked to write an equivalent fraction.	_____	_____
5. When asked to write an equivalent fraction using the least common denominator.	_____	_____
6. When asked to identify the numerator and denominator of a fraction.	_____	_____
7. When asked to identify the quotient of a problem.	_____	_____
8. When asked to identify prime numbers.	_____	_____
9. When asked to write numerals in standard form.	_____	_____
10. When asked to write a fraction in the simplest terms.	_____	_____

	yes	no
11. When asked to find the factors of a number.	_____	_____
12. When asked to find the mean of a group of numbers.	_____	_____

13. When asked to find the prime factorization of a number. _____ _____

14. When asked to solve and explain a problem involving a base numeral and an exponent. _____ _____

15. When asked to solve a problem using a negative integer. _____ _____

16. When asked to identify the vertex of a figure. _____ _____

17. When asked to find the perimeter of a polygon. _____ _____

18. When asked to solve a problem involving the use of ratio and proportion. _____ _____

19. When asked to construct two figures that are congruent. _____ _____

20. When asked to solve an equation using a unknown factor. _____ _____

APPENDIX B

MATHEMATICAL LANGUAGE APPLICATION

_______Male ______Female

MATHEMATICAL LANGUAGE APPLICATION TEST

1. Karen needs 5.74 yards of material to make a dress and jacket. How much does Karen need to the nearest yard?

2. The diameter of a circle is 11 meters. What is the circumference of the circle?

3. Identify the place value of each digit in the following number: 7431

4. Complete the equivalent fraction of the following:
1/6 = /18

5. Find the equivalent fraction with the least common denominator:
7/12 and 5/9

6. Identify the numerator and denominator in the following mixed number: 31 7/8

numerator _____

denominator _____

7. Identify the quotient in the following problem:

24 -- 3 = 8

quotient _____

8. Circle all prime numbers listed below:

43 91 105 55

9. Write forty-three thousand seven hundred fifty-one in standard numeral form.

10. Write 16/20 in the simplest terms.

16/20 =

11. Write the factors of 24:

12. Find the mean of the following set of numbers:

6 15 18 8 3

mean _____

13. Find the prime factorization of the following number:

55

14. Solve the following problem: 4 + 2 =

15. Solve the following problem: -15 - +3 =

16. Identify the vertex in the diagram:

Vertex _____

17. Find the perimeter of the following polygon:

p = _____

18. A factory produces 27 cars in 3 days. If the rate of production is constant, how many cars can be produced in 9 days?

19. Draw two figures that are congruent.

20. Find the unknown factor and show your work: 2n = 144

APPENDIX C

DIRECTIONS FOR ADMINISTERING INVENTORIES

DIRECTIONS FOR ADMINISTERING INVENTORIES

You will be given two inventories and asked to complete the statements or problems listed in each inventory. Please read the statements carefully and answer them honestly as these inventories are not a test of your ability.

The first inventory consists of statements regarding the vocabulary found in mathematical textbooks. After reading the statements, if you feel comfortable, confident of using the terms, or unconcerned regarding the words, check "yes" in the blank beside that statement. If the underlined word is confusing, makes you feel uncomfortable, dread using the term, or any negative reaction, check "no" beside the statement.

The second inventory consists of written mathematical problems using the vocabulary found in mathematical textbooks. In solving these problems, please assert your best effort.

Remember this is not a test but the information obtained from your responses may help other students in the future. Do not sign your name.

2

VITA

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Candidate for the Degree of

Doctor of Education

Thesis: FACTORS INFLUENCING MATH ANXIETY: AN INVESTIGATIVE STUDY AND ASSESSMENT OF STUDENTS' ATTITUDES TOWARD THE LANGUAGE OF MATHEMATICS AS IT RELATES TO MATH ANXIETY

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Poteau, Oklahoma, October 18, 1954, the daughter of Mr. and Mrs. Fred Brooks.

Education: Graduated from Bokoshe High School, Bokoshe, Oklahoma, in May, 1972; received Associate of Science degree from Eastern Oklahoma State College in May, 1974; received Bachelor of Science degree in Elementary Education from Northeastern State University in 1980; received Master of Education degree at Northeastern State University, Tahlequah, Oklahoma in 1986; completed requirements for the Doctor of Education degree at Oklahoma State University in May, 1992.

Professional Experience: Medical Secretary, Sparks Regional Medical Hospital 1974-78; Elementary Education Mathematics Instructor, Fort Smith Public Schools 1980-88; Director of Learning Resource Center, Carl Albert State College 1990-91; Coordinator/Counselor and Instructor, Southeastern Oklahoma State University 1991 to present.

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Title of Study: FACTORS INFLUENCING MATH ANXIETY: AN INVESTIGATIVE STUDY AND ASSESSMENT OF STUDENTS' ATTITUDES TOWARD THE LANGUAGE OF MATHEMATICS AS IT RELATES TO MATH ANXIETY

Pages in Study: 85

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Scope of Study: This dissertation investigates the effects of the language of mathematics as a contributing factor in math anxiety. A language attitude inventory and application inventory were developed in order to assess students' feelings toward the language of mathematics and also to assess the students' skills to solve problems involving mathematical language. Anxiety levels were considered to be high if the student scored below the mid-point on the language attitude inventory and low if the student scored above the mid-point level. Application skills were considered high if the student scored above the mid-point on the application inventory and low if they scored below the mid-point. The 202 subjects for this study included all the students in the sixth and seventh grades of a public school.

Findings and Conclusions: A significant relationship exists between anxiety toward the language of mathematics and mathematics application in both sixth and seventh grades. Lower levels of anxiety tend to be associated with higher levels of application while higher levels of anxiety tend to be associated with low scores on application. Sixth-grade females scored lower on anxiety levels and higher on application skills than the seventh-grade females. The sixth-grade females scored significantly higher on levels of application when compared to sixth-grade males; however, there was not a significance difference in the application skills of seventh-grade males and females.

ADVISER'S APPROVAL Margaret M Scott