

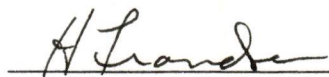
To the Graduate Council:

I am submitting herewith a thesis written by Frank Hamilton Vanzant entitled "A Study of Mathematics Anxiety Exhibited by Senior High School Students." I recommend that it be accepted in partial fulfillment of the requirements for Specialist in Education, with a major in Curriculum and Instruction.



Donald Dessart, Major Professor

We have read this thesis
and recommend its acceptance:





Accepted for the Council:



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A STUDY OF MATHEMATICS ANXIETY EXHIBITED
BY SENIOR HIGH SCHOOL STUDENTS

A Thesis
Presented for the
Specialist in Education
Degree
The University of Tennessee, Knoxville

Frank Hamilton Vanzant

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ABSTRACT

In order to assess the significance of mathematics anxiety in an educational setting, it has become important to determine the extent to which anxiety is associated with various mathematical backgrounds of students. One area of interest is the determination of the relationship between the amount of secondary level mathematics courses taken by high school seniors and the levels of mathematics anxiety as measured by the Mathematics Anxiety Rating Scale (MARS). Therefore, it was the purpose of this study to test the following hypotheses:

1. There is no significant relationship between the number of mathematics courses taken by high school seniors and their levels of mathematics anxiety.
2. The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses.

The population for this study consisted of students from the 1978 senior class at Franklin County High School, Winchester, Tennessee. All students were classified according to the number of years and types of mathematics courses studied through their senior year. Random selections from each of these categories yielded samples totaling 151 students.

To test the hypotheses, the Mathematics Anxiety Rating Scale scores were analyzed by a one-way analysis of variance ($p \leq 0.05$). The independent variable was the number of mathematics courses taken, and the score on the Mathematics Anxiety Rating Scale was the dependent variable. Duncan's Multiple Range Test was used to compare the means. A Pearson product-moment correlation coefficient was also calculated to assess the degree of relationship between mathematics anxiety and the number of years of mathematics studied in high school.

The correlation coefficient between the number of years of high school mathematics and mathematics anxiety was found to be significant at the 0.05 level ($r = -0.32$). The results of the analysis of variance and Duncan's Multiple Range Test showed a significant difference in the level of mathematics anxiety experienced by students taking four years of mathematics and those students taking General Mathematics, or Algebra I, or a combination of General Mathematics and Algebra I.

This study was significant in that it revealed a relationship between the number of mathematics courses taken by high school seniors and their levels of mathematics anxiety. A significant relationship existed in the mathematics anxiety scores between students who had taken only one year of high school mathematics (either General Mathematics or Algebra I) and those who had taken four

years of mathematics. Also, this study showed that there was an inverse relationship between mathematics anxiety scores, as measured by the MARS, and the number of years a student takes high school mathematics. Mathematics anxiety scores did decline as the number of years of mathematics enrollment increased.

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CHAPTER I

THE PROBLEM AND THE EXPERIMENTAL DESIGN

In order to understand the significance of mathematics anxiety in an educational setting, research concerned with determining the extent to which anxiety is associated with various mathematical backgrounds of students should be useful to teachers and educational researchers.

I. STATEMENT OF THE PROBLEM

Researchers have investigated the prevalence and intensity of mathematics anxiety (Betz, 1977) and the difference in the level of mathematics anxiety of mathematics and non-mathematics majors in the post-secondary school level (Mein, 1973). Only a small amount of research has been directed toward the study of mathematics anxiety of secondary school students. Therefore, the purpose of this study was to test the two hypotheses:

1. There is no significant relationship between the number of mathematics courses taken by high school seniors and their level of mathematics anxiety.

2. The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses.

II. METHOD

Description of the Subjects

Participants in the project included 151 students from the 1978 senior class at Franklin County High School, Winchester, Tennessee. Franklin County High School is a three-year high school in a rural setting with an enrollment of approximately 1,200 students. Students were classified according to the number of years and types of mathematics courses studied through their senior year. In the spring of 1978, random selections from each of these categories yielded a sample of 151 participants.

Measurement of Mathematics Anxiety

The Mathematics Anxiety Rating Scale (MARS) measured the mathematics anxiety of each student. The MARS is a ninety-eight-item scale developed by Richard Suinn at the Rocky Mountain Behavioral Science Institute. Each item on the Mathematics Anxiety Rating Scale represents a situation that might arouse different levels of mathematics anxiety. Most of the items are worded to include practical situations that involve mathematics. Some of the items depict academic test situations that concern mathematics.

Each item on the Mathematics Anxiety Rating Scale is weighted with a five-point range. The five categories for the MARS are "Not At All," "A Little," "A Fair Amount," "Much," and "Very Much." The participants are asked to rate themselves on each of the ninety-eight items.

Summation of the values of all items provides a total score in which high scores reflect high levels of mathematics anxiety. The scores on the MARS may range from 98 (illustrative of low anxiety) to 490 (illustrative of high anxiety). A copy of the Mathematics Anxiety Rating Scale is included in Appendix C.

Information concerning the normative data, reliability, and validity for the MARS can be found in Chapter II.

Procedures

Information obtained from school records assisted in categorizing each member of the senior class. Each student was classified according to the number and types of mathematics courses taken from grades nine through twelve. The classification process placed each student into exactly one of eight categories, as illustrated in Table I.

In using the established criteria, any student having failed a mathematics course was classified as having taken the course. Similarly, if a student had repeated any mathematics course, this did not constitute having taken an additional year of mathematics. Any senior enrolled in a mathematics course at the time of the study was classified as having completed the course; e.g., if a student had taken Algebra I and was taking Algebra II in the spring of 1978, then that student was classified under group 2B.

TABLE I
CLASSIFICATION OF STUDENTS ACCORDING TO THE TYPES OF
MATHEMATICS COURSES STUDIED

Category	
Name	Course Taken
1A	General Mathematics
1B	Algebra I
2A	General Mathematics and Algebra I
2B	Algebra I and Algebra II
3A	General Mathematics, Algebra I and Algebra II
3B	Algebra I, Algebra II, and Geometry
4A	General Mathematics, Algebra I and II, and Geometry
4B	Algebra I and II, Geometry, and Advanced Mathematics

Because of the small number of potential students in categories 3A and 4A, statistical treatment of the data combined 3A and 3B as one category, and 4A and 4B as one category. All students in categories 3 and 4 had completed three or four years of high school mathematics, respectively. The only difference was the final mathematics course completed. For example, 3A and 3B students had studied the same number of years of mathematics starting with grade nine. However, students in 3B terminated their mathematics study with Geometry, while Algebra II was the terminating course for group 3A.

In a general meeting, the students received an explanation of the project and of their potential roles in the study. Signed consent forms were obtained from each participant (or from the parents, if the student was under eighteen years of age). Copies of consent forms are found in Appendices A and B.

The Mathematics Anxiety Rating Scale was administered in the spring of 1978 to the 151 students. All students were placed in a non-mathematical setting and were administered the scale by the Guidance Department of Franklin County High School. Although no time limit was specified, all students had completed the MARS in approximately fifty minutes. The number of students who participated in each category is given in Table II.

TABLE II
NUMBER OF PARTICIPANTS IN EACH GROUP

Group		Number of Subjects
1A		38
1B		23
2A		19
2B		22
3A	{ 3A/B	24
3B		
4A	{ 4A/B	25
4B		

III. DEFINITIONS OF TERMS

The following definitions of terms used extensively in the study will be helpful to the reader.

1. Mathematical anxiety is the level of anxiety felt in the presence of mathematical situations.

2. General mathematics is a one-credit mathematics course taught in the ninth grade in the Franklin County School System. This course is designed to teach basic operations skills. It also contains a comprehensive treatment of informal geometry, basic consumer applications, and an introduction into algebra.

3. Algebra I is an introductory course of algebra taught in the ninth through twelfth grades in the Franklin County School System. This course is designed to include the study of mathematical symbols, algebraic sentences, number systems, operations with polynomials, relations, functions, linear equations in one and two variables, number line and graphs, and an introduction into quadratic equations.

4. Algebra II is an intermediate course of algebra taught at Franklin County High School in grades ten through twelve. This course is an extension of topics begun in Algebra I with the inclusion of some new topics: exponential functions, logarithms, quadratic functions, and the conic sections.

5. Geometry is a unified course of plane and solid geometry taught in grades ten through twelve. This course places the greatest emphasis on the development of the formal proof. Some of the topics discussed are: parallel lines, triangles, quadrilaterals, circles, area, some space geometry, and an introduction into trigonometry.

6. Advanced mathematics is a course taught in the twelfth grade to students who have successfully completed Algebra I, II, and Geometry. This course is designed to teach the following topics: linear relations, theory of equations, matrices, vectors, trigonometry, sequences and series, conic sections, and an introduction into limits and finding derivatives.

IV. LIMITATIONS OF THE STUDY

The population for this study was defined as members of the 1978 senior class of Franklin County High School, Winchester, Tennessee. Therefore, the conclusions are applicable only to that population or a similar population. Since the study used the Mathematics Anxiety Rating Scale (MARS) as the measurement of mathematics anxiety, other results might have been possible by using other measures.

V. SOURCES OF ERROR

When dealing with questionnaires, the main sources of error are lying, the tendency to mark answers in a pattern, and the tendency to agree with the statement (Sarason, Davidson, Lighthall, Waite, and Ruebush, 1960). Although every effort was made to insure privacy for each student while taking the MARS, the tendency for students to observe the work of others is always present. Also, the students were told that their answers would be held in strict confidence. Therefore, an assumption made for this study was that the students were truthful in their answers, and the other two sources of error had minimal effects.

Another assumption of this study was that all students possessed a vocabulary adequate to comprehend all ninety-eight statements on the MARS. Because it appears the MARS was designed for college freshmen, some students in high school may not comprehend all of the statements. This is probably true for students with very low aptitudes.

VI. STATISTICAL TREATMENT OF THE DATA

The scores obtained by using the Mathematics Anxiety Rating Scale were analyzed by a one-way analysis of variance, ($p \leq 0.05$). The independent variable was the number of mathematics courses taken, and the score on the Mathematics Anxiety Rating Scale was the dependent variable. The following null hypotheses were tested:

1. There is no significant relationship between the number of mathematics courses taken by high school seniors and their level of mathematics anxiety.

2. The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses.

If the null hypothesis was rejected, Duncan's Multiple Range Test was used to compare means. A Pearson product-moment correlation coefficient was also calculated to assess the degree of relationship between mathematics anxiety and the number of years of mathematics studied in high school.

VII. IMPORTANCE OF THE STUDY

The discovery of the relationship between students' mathematics backgrounds and anxiety levels would be a worthwhile contribution. Teachers should be made aware of the level of anxiety at each level of mathematics. Consequently, recognition and treatment of mathematics anxiety could encourage further study in mathematics rather than avoidance. Crumpton (1977, pp. 12-13) contends that mathematics anxiety can produce a passive attitude toward the study of mathematics:

Children and adults who are anxious about mathematics tend to avoid mathematics. . . . People who feel highly anxious about mathematics often rationalize that mathematics is unimportant and that the fact that they are

incompetent in various areas of mathematics is of no consequence. . . . Furthermore, such persons may have poor self images, be unpopular, and may also pass on their mathematical anxiety to their children.

In an increasingly technological society, knowledge of mathematics is critical to the pursuit of many existing and emerging occupational fields (Carnegie Commission on Higher Education, 1973). A knowledge of mathematics is increasingly important in business, the social sciences, and the humanities (Stent, 1977). However, many intellectually capable students avoid taking mathematics courses in high school and, consequently, restrict the range of careers from which they may choose. Many other students fail to perform as well in mathematics as they are capable, and do not attain the mathematics knowledge which is essential to expand the range of career options available to them.

Further information is needed concerning the effects of mathematics anxiety on mathematics avoidance, on performance in mathematics courses, on educational and vocational plans, and on its relationship between prior preparation and achievement in mathematics (Betz, 1977). Thus, it is important that the educational system determine the level in school at which mathematics anxiety tends to increase.

VIII. ORGANIZATION OF THE STUDY

Chapter I of this study includes a statement of the problem, a description of the method and procedures used in the study, a listing of the definitions pertaining to the project, a statement of the limitations of the study, sources of error, a description of the statistical treatment of the data, and a discussion of the importance of the study.

Summaries of some of the related literature are contained in Chapter II. The following areas are addressed: definitions of anxiety as it relates to an educational setting, definitions of mathematics anxiety, measurements of anxiety, measurements of mathematics anxiety, the relationship of attitude to achievement in mathematics, research relating anxiety levels with intelligence, information concerning the relationship of anxiety and academic performance, and research showing the correlation between mathematics anxiety, prior preparation, and achievement.

Chapter III contains the statistical analysis of the data and the presentation of the findings.

A summary of the study and a statement of the conclusions are included in Chapter IV.

CHAPTER II

SURVEY OF THE LITERATURE

Extensive research has been conducted in various areas of anxiety as related to education. One of the newer areas of interest is the anxiety that is associated with the study of mathematics, i.e., mathematics anxiety. Consequently, the survey of the literature is limited to the following areas: definitions of anxiety often measured in an educational setting, definitions of mathematics anxiety, some measurements of anxiety, the relationship of attitude to achievement in mathematics, the relationship of anxiety levels and intelligence, the relationship of anxiety and academic performance, and the relationship between mathematics anxiety, prior preparation, and achievement.

I. DEFINITIONS OF ANXIETY OFTEN MEASURED IN AN EDUCATIONAL SETTING

Sieber, O'Neil, and Tobias (1977, p. 20) defined test anxiety as the manifestation specifically related to "school-relevant evaluation situations." The focus on test anxiety was substantiated by the fact that test situations were frequently encountered by almost all members of our society. Test anxiety can interfere with task performance.

Gaudry and Spielberger (1971, p. 13) explained the effect of test anxiety in the educational setting:

The test-anxious child often pays more attention to his own anxiety responses in test situations than to the task. Consequently, his performance may be impaired if situations contain areas which tell the child he is being evaluated and therefore in a danger situation. The resulting anxiety interferes with adequate perception of external events and with task performance.

Spielberger, Gorsuch, and Lushene (1970, p. 2) defined state anxiety (A-State) and trait anxiety (A-Trait) as follows:

State anxiety (A-State) is conceptualized as a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feelings of tension and apprehension and heightened autonomic nervous system activity. A-States may vary in intensity and fluctuate over time.

Trait anxiety (A-Trait) refers to relatively stable individual differences in anxiety proneness, that is, to differences between people in the tendency to respond to situations perceived as threatening with elevations in A-State intensity.

In general, it would be expected that those who are high in A-Trait will exhibit A-State elevations more frequently than low A-Trait individuals because they tend to perceive a wider range of situations as dangerous or threatening. High A-Trait persons are also more likely to respond to stressful situations with increased A-State intensity.

The concepts of state and trait anxiety have significance for the learning situation. Some students may be anxious in many different situations and circumstances while others will rarely experience anxiety states. Also, a high A-Trait student may show high levels of A-State in

some school subjects, such as mathematics, but not in others.

According to Sarason, Mandler, and Craighill (1952), anxiety does not necessarily lead to poor performance. In 1960, Alpert and Haber (1960) constructed the achievement-anxiety scale to identify individuals whose academic performance is facilitated by the stress of the test situation, as well as those whose performance is impaired (debilitated).

II. DEFINITIONS OF MATHEMATICS ANXIETY

Mathematical anxiety, according to Stent (1977, p. 41) is a "fact of American life, whatever its cause." Tobias (1976, p. 57) defined mathematics anxiety as an "I can't syndrome. . . . Once a person has become frightened of math, she or he begins to fear all manner of computation." At the Wesleyan Clinic, a clinic which studies the causes and treatment of mathematics anxiety, Donady and Tobias (1977, p. 71) call "Math anxiety--a non-rational distaste for and avoidance of math and math related subjects." "An irrational and impeditive dread of mathematics" is the definition used by Lazarus (1974, p. 16). Richardson and Suinn (1972, p. 551) contend that mathematics anxiety "involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations."

To make the term mathematics anxiety seem more concrete, Gough (1954, p. 290) made an analogy between this type of anxiety and the common cold:

. . . let us take a look at what we already know about this disease which is almost as common as the common cold. Its symptoms are hard to recognize when the disease is in its incipient stages. In fact, it has usually reached the chronic stage long before the pupil-patient recognizes it or the teacher-physician even suspects its presence. All too often the disease has proved fatal before its presence is detected.

Mathematics anxiety is both an emotional and cognitive disease (Tobias, 1976). Lazarus (1974, p. 16) believed that the emotional and intellectual block that develops due to a fear of mathematics can make "further progress in mathematics and closely related fields very difficult." Also, mathematics anxiety does appear to be a separate factor from all other anxieties (Dreger and Aiken, 1957; and Richardson and Suinn, 1972).

The fear of mathematics is not isolated to the college population. Even though most research has been performed at the post-secondary level, Lazarus (1974, p. 18) revealed that mathematics anxiety "has its roots in earlier education, in the secondary and grade school classrooms." There are two distinct respects in which mathematics anxiety can be serious (Lazarus, 1974, p. 17):

If it arises early in school, it constitutes a problem because the child will find almost all of mathematics a mystery and will be handicapped thereby. And if it turns up in sufficient strength at any level, it constitutes a problem because it makes all of mathematics repugnant.

The exact sources of mathematics anxiety are very difficult to identify. Mathematics anxiety could be a result of mathematics itself, its conventions of notations and terminology, methods of learning by the student, the curriculum, and probably the teachers (Lazarus, 1974). In contrast with most other school subjects, mathematics tends to build on itself cumulatively. Gough (1954, p. 291) claimed that "in mathematics the student must, as a rule, master each successive stage of development before he can satisfactorily perform the next one." Consequently, a student who has a bad year in mathematics could be severely handicapped for the rest of his school career.

III. SOME MEASUREMENTS OF ANXIETY

Anxiety has been measured by several different scales. Five measures of anxiety are described in this chapter. Because some studies pertaining to mathematics have relied upon the measure of general, test, and mathematics anxiety, scales that measure these areas are defined. No attempt has been made to cover the total range of anxiety scales used to measure the mentioned areas of anxiety. Only scales discussed in this study are presented.

General Anxiety Scales

Much of the early work on anxiety followed the development of the Manifest Anxiety Scale (MAS) by Taylor.

This fifty-question scale is a measure of the general trait to experience anxiety (Taylor, 1953).

Spielberger, Gorsuch, and Lushene (1970) developed the State-Trait Anxiety Inventory (STAI). The STAI measures two distinct anxiety concepts: state anxiety (A-State) and trait anxiety (A-Trait). The A-State scale contains twenty items which require the subject to indicate how he feels at a particular moment. The subject rates each item on a four-point scale. The A-Trait contains twenty statements that ask the subject to describe how he generally feels. As with the A-State scale, each item is rated on a four-point scale.

Test Anxiety Scales

Several researchers have developed scales to measure test anxiety. The possible reason for the focus on test anxiety was determined, in part, by the fact that test situations are encountered by almost all members of our society. The Test Anxiety Scale for Children (TASC) developed by Sarason and his colleagues (Sarason, Davidson, Lighthall, Waite, and Ruebush, 1960) is a measure of the anxiety aroused in children by tests or test-like situations. The TASC contains thirty questions about test situations to which the subject responds "yes" or "no."

In 1952 the Test Anxiety Questionnaire (TAQ) was constructed by Mandler and Sarason (cited in Gaudry and Spielberger, 1971) to measure the anxiety reaction of

adults taking course examinations or intelligence tests. The Test Anxiety Scale (TAS) is also used to measure one's performance in an evaluative setting (Sarason, 1972). The TAQ and TAS scales focus on the debilitating effects of anxiety (Gaudry and Spielberger, 1971). In contrast, Alpert and Haber constructed the Achievement Anxiety Test (AAT) to identify individuals whose academic performance is facilitated by the stress of the test situation, as well as those whose performance is impaired. The AAT, developed by Alpert and Haber (1960, pp. 207-15), consists of two scales--a nine-item facilitating scale and a ten-item debilitating scale. The facilitating-anxiety subscale consists of items such as "Before a test, I become excited and alert, and this helps me to organize what I know." The debilitating-anxiety subscale consists of items such as "When I am about to take a test I get upset and forget a lot of things I have studied."

IV. MEASUREMENTS OF MATHEMATICS ANXIETY

One of the nine scales of the Fennema-Sherman Mathematics Attitudes Scales (1976) is the Mathematics Anxiety Scale. This scale is intended to assess "feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics" (Fennema and Sherman, 1976, p. 4). The twelve items used on the Fennema-Sherman scale are designed for administration to high school students.

The Mathematics Anxiety Rating Scale (MARS) measures anxiety associated with number manipulation or mathematics concepts (Suinn, Edie, Nicoletti, and Spinelli, 1972). The MARS is a ninety-eight-item scale composed of brief descriptions of situations that might arouse different levels of mathematics anxiety. To permit application to a diverse group of subjects, the Mathematics Anxiety Rating Scale contains a wide variety of situations. Several of the items are worded to describe situations that involve mathematics, e.g., "determining the amount of change," or "figuring the sales tax on a purchase that costs more than \$1.00." Other items depict academic situations that concern mathematics, e.g., "being asked to add $976 + 777$ in your head," "looking through the pages of a math test," or "listening to a lecture in a math class."

Values ranging from one to five are assigned to the level of anxiety checked ("one" represents "not at all" anxious, and "five" means "very much" anxious). The summation of all the values provides a total score which reflects the amount of mathematics anxiety present (high scores are indicative of high levels of anxiety).

Richardson and Suinn (1972, pp. 552-3) collected normative data on a sample of 397 freshman and sophomore students at a Missouri university. Although a majority of the subjects were females, the data showed no significant difference between the mean scores or standard deviations for males and females. The mean score was 215.38, with a

standard deviation of 65.29; the test-retest reliability coefficient was 0.85; and the internal consistency reliability coefficient was 0.97. Richardson and Suinn (1972, p. 553) contended that the data "confirms that the test is highly reliable and that the test items are heavily dominated by a single homogeneous factor, presumably mathematics anxiety." A separate validity study was performed using thirty junior and senior students, equally divided between males and females, at the University of Missouri. The subjects were administered the MARS and the mathematics forms of the Differential Aptitude Test (DAT). Pearson product-moment correlation coefficients between subjects' scores on the two instruments was -0.64 , an indication that high MARS scores are associated with poor performance on the mathematics test. Richardson and Suinn (1972, p. 553) concluded that, "since high anxiety interferes with performance, and poor performance produces anxiety, this result provides evidence that the MARS does measure mathematics anxiety."

A second study (Suinn, Edie, Nicoletti, and Spinelli, 1972) conducted on 119 university students yielded the following results: A mean score of 198.3, with a standard deviation of 55.5 on the first testing, and a mean score of 179.9, with a standard deviation of 55.9 on the second testing; the test-retest reliability coefficient was 0.78 after two weeks; and a correlation of -0.35 between the MARS and the DAT for the first testing and

-0.32 for the second. These anticipated negative correlations are an indication that "high anxiety as measured by the MARS is associated with low performance on DAT tasks" (Suinn, et al., 1972, p. 374). A copy of the Mathematics Anxiety Rating Scale has been included in Appendix C.

V. RELATIONSHIP OF ATTITUDE TO ACHIEVEMENT IN MATHEMATICS

Some authors are of the opinion that there is, at most, a very small correlation between a student's attitude and achievement in mathematics. Knaupp (1973, p. 9) claimed that, "there is a question as to whether a favorable attitude actually causes more and better learning." Daniel Neale (1969) supported the idea that attitudes toward mathematics have only a slight influence on achievement.

There are, however, several authors of the opinion that there is a significant relationship between attitude and mathematics achievement. Anttonen (1969) examined the relationships between mathematical achievement and attitude in a six-year study. The conclusions drawn were that there was a positive relationship between elementary and secondary students in attitude scores and between attitude and achievement. Other research has shown that, "attitude toward mathematics is positively correlated with grades in . . . mathematics" (Aiken, 1972, p. 233). In a separate

study, Aiken (1972) supported the above statements by concluding that people with more positive attitudes towards mathematics tend to make higher marks in mathematics.

VI. RELATIONSHIP OF ANXIETY LEVELS AND INTELLIGENCE

Spielberger (1966) hypothesized that anxiety levels will be a function of intelligence. Therefore, high anxiety should facilitate the performance of high IQ subjects and hinder the performance of low IQ subjects. Studies have supported Spielberger's theory by showing that intelligence and anxiety interact on the performance of high and low IQ subjects (Denny, 1966; Gaudry and Spielberger, 1971). Using the Taylor Manifest Anxiety Scale, Denny (1966, p. 600) found that "high anxiety facilitated concept formation for high-intelligence subjects and impaired it for low-intelligence subjects."

Gaudry and Spielberger (1971) contended that there is a negative relationship between anxiety and performance and there is a moderate and consistent negative relationship between anxiety scales and various measures of intelligence. Sarason, et al. (Sarason, Davidson, Lighthall, Waite, and Ruebush, 1960) noticed that there was a decrease in measured IQ following increases in anxiety and an increase in measured IQ following a reduction in anxiety. In a study of anxiety in elementary school children, Dreger

and Aiken (1957) studied the correlation between Number Anxiety and general intelligence. However, a -0.25 correlation obtained in the study did not reach significance.

VII. THE RELATIONSHIP OF ANXIETY AND ACADEMIC PERFORMANCE

Several studies have been conducted in trying to discover a possible relationship between anxiety and performance in school. Biggs (1959, p. 18) theorized that very low and very high anxiety inhibit performance:

The relationship between anxiety and performance is curvilinear. When anxiety is very low, that is, performance tends to be poor simply because there is a level when the subject "couldn't care less" and obviously in this condition he will not perform at his optimum level of efficiency. On the other hand, under extreme conditions of anxiety, performance very often becomes utterly disorganized.

From a selected group of studies on the role of anxiety in learning, Reed (1960, pp. 152-53) concluded:

- a. Severe anxiety seems to decrease learning.
- b. A mild degree of anxiety may function in a positive manner for some forms of learning.
- c. A very low level of anxiety may depress learning.

An investigation of the effects of anxiety and intelligence on paired-associate learning (Gaudry and Spielberger, 1971) showed that high anxiety facilitated performance for high-IQ subjects and impaired performance for low-IQ subjects early in learning. In later learning, high anxiety tended to facilitate performance for both high- and low-IQ subjects.

Using the Taylor Manifest Anxiety Scale (MAS), Spielberger and Katzenmeyer (1959) discovered that there was a small inverse relationship between MAS scores and grades when administered to students in an introductory psychology course at Duke University. Tests for linear and curvilinear regression indicated that grade point averages (GPA) were unrelated to MAS scores for both the low- and high-intelligence groups. However, grades varied inversely with anxiety level for the average aptitude subjects. In a study not considering aptitude as a variable, Spence (1968, p. 288) discovered that, "school achievement and aptitude behavior tend to increase more for low-anxious subjects than for high-anxious subjects."

A study that investigated the differences between aptitude, achievement, sociometric, self-, and test-anxiety data between the sexes found a partially supported relationship between the sociometric, self-, and test-anxiety measures and the subject's academic achievement (Cotler and Palmer, 1970). Jacko (1974) considered test anxiety to consist of two parts--facilitating anxiety and debilitating anxiety. The studies surveyed by Jacko (1974, p. 11) confirmed the existence of these two types of test anxiety and that, "high facilitating anxiety correlates with . . . examination performance, while high debilitating anxiety is related to undesired . . . performance."

Sarason and Mandler (1952) administered the Mathematical Aptitude Test (MAT), the Scholastic Aptitude Test

(SAT), and the Test Anxiety Questionnaire (TAQ) to 492 Yale undergraduates. One conclusion drawn was that high-anxiety students obtained lower MAT and SAT scores and that they also obtained a higher grade average than predicted.

Gaudry and Spielberger (1971) investigated the correlation between anxiety and academic achievement. The most consistent general finding was that high anxiety is associated with relatively low performance at both the school and university level. This conclusion was based upon the negative correlations obtained in a variety of studies between different measures of anxiety and of academic aptitude and achievement.

Using the Achievement Anxiety Test, Pervin (1967) investigated the anxiety and aptitude relationship to academic performance. The verbal and mathematics scores from the SAT and the cumulative high school grades for each of the 717 freshman Princeton students were used as ability measures. The grade point average at the end of the year was the measure of academic performance. Significant correlations were found between the facilitating- and the debilitating-anxiety scales and the SAT scores. However, the anxiety scales correlated higher with aptitude than with performance.

VIII. RELATIONSHIP BETWEEN MATHEMATICS ANXIETY, PRIOR PREPARATION, AND ACHIEVEMENT

Several studies have investigated the correlation between mathematics anxiety and achievement. A few of the studies were able to show no significant relationship between anxiety and achievement in mathematics (Hyman, 1974; Mein, 1973; and Morgan, 1966).

Betz (1977) investigated the factors related to the prevalence and intensity of mathematics anxiety in college students. Three groups of subjects were utilized in the study. Mathematics anxiety was measured using a version of the Taylor Manifest Anxiety Scale, where higher scores on the MAS indicate lower levels of mathematics anxiety. Results concerning the relationship between mathematics anxiety and background data indicated a strong relationship between mathematics anxiety and the number of years of high school mathematics. The relationship "suggests that high school math preparation strongly influences how a college student will feel about math" (Betz, 1977, p. 20). The correlations between mathematics anxiety and years of high school mathematics were positive and of moderate magnitude ($\underline{r} = 0.19$ to $\underline{r} = 0.43$). "Thus, the more prior math preparation a college student has had, the less likely he/she is to report high levels of anxiety" (Betz, 1977, p. 13).

Studies have shown that there appears to exist a relationship between mathematical aptitude and anxiety.

Katahn (1966) found that mathematical aptitude and anxiety had an interactive effect on performance. Katahn's (1966, p. 478) conclusions indicated that, "aptitude is a factor which should be taken into account when predictions are made on the basis of anxiety and task difficulty." A study of the interaction between anxiety and mathematical ability did indicate that there was an interaction between A-State and mathematical ability on performance (Rappaport, 1971).

A variety of research has studied the relationship between mathematical anxiety and achievement. Biggs (1955) revealed that anxiety restrained one's ability to learn mathematics. In a study by Dreger and Aiken (1957) which involved first-year college students, persons with high number anxiety made lower grades in mathematics. Betz (1977) discovered that mathematics anxiety was moderately related to mathematics achievement test scores (ACT Math subtest). Correlations were statistically significant ($r = 0.17$ to $r = 0.42$) to indicate that "higher achievement in math is related to lower reported levels of math anxiety" (Betz, 1977, p. 21). In a similar study of mathematics anxiety and achievement, Fennema and Sherman (1976) found that high school students in the upper half of the achievement distribution reported more positive attitudes toward mathematics than did students in the lower half. From a mathematics test administered to eighty college-level students, Tobias, Hedl, and Towle (1973) concluded

that high-anxious students performed more poorly on the difficult items than did the low-anxious students.

After the ACT mathematics score, Betz (1977, p. 17) concluded:

The next strongest predictor of course grades was the Math Anxiety score; while . . . it was only marginally statistically significant, lower levels of math anxiety were somewhat predictive of higher math course grades.

Using eighty-five college students enrolled in mathematics classes, Crumpton (1977, p. 87) concluded that, "as mathematical competency as measured by the Mathematical Competency Test increases, mathematical anxiety decreases."

Many studies have suggested that high anxiety is associated with low scores on arithmetic achievement tests (Feldhusen, 1965; McCandless and Castaneda, 1956; and Philips, 1962). Glennon and Callahan (1968) concluded that high anxiety does have a debilitating effect upon achievement in elementary school mathematics. In a related study involving secondary school students, Sowder (1974) discovered that mathematics anxiety negatively affected achievement in geometry.

The studies reviewed have shown that anxiety is present in achievement and academic situations. One very prominent form of anxiety in today's educational setting is mathematics anxiety. This type of anxiety has been shown to be a separate entity from other forms of anxiety and can be measured by using the Mathematics Anxiety Rating Scale (MARS). Studies have shown the significant relationships

between anxiety, attitude, aptitude, and achievement. In recent years, research has been conducted in the area of mathematics anxiety. Several studies have been cited which have shown a significant correlation between mathematics anxiety and achievement in mathematics.

CHAPTER III

PRESENTATION OF THE FINDINGS

The study was designed to investigate the extent to which a difference existed in the amount of mathematics anxiety possessed by students according to the number of years of mathematics courses taken in high school. It is the purpose of this chapter to summarize the methods of analyzing the data and to present the results of those analyses.

I. CORRELATIONAL ANALYSIS

Experimental Design and Statement of Hypothesis

The Mathematics Anxiety Rating Scale was administered to 151 high school seniors. A Pearson product-moment correlation coefficient was calculated to test the following hypothesis:

There is no significant relationship between the number of mathematics courses taken by high school seniors and their level of mathematics anxiety.

Results of the Pearson Product-Moment Correlation

Table III shows the results of such calculations. The correlation coefficient between the number of years of high school mathematics and mathematics anxiety was found

to be significant at the 0.05 level. As a result, the null hypothesis was rejected.

TABLE III

PEARSON r CORRELATION BETWEEN MATHEMATICS
ANXIETY AND NUMBER OF YEARS OF
HIGH SCHOOL MATHEMATICS

N	r
151	-0.32*

*Significant at the 0.05 level of
significance.

Discussion of the Results

In a similar study, Betz (1977) discovered that the correlation between the two variables was positive and of moderate magnitude ($\underline{r} = 0.19$ to $\underline{r} = 0.43$). Since higher scores on the Mathematics Anxiety Scale used by Betz are indicative of lower levels of mathematics anxiety, then the results indicate that there is a moderate positive correlation between an increase in the number of years of mathematics taken and a decline in mathematics anxiety. The correlation coefficient of -0.32 obtained in the present study parallels the results obtained by Betz (1977).

Based upon the results of the Pearson product-moment correlation coefficient, the following conclusion was made:

There is a moderate negative correlation between scores on the Mathematics Anxiety Rating Scale and the number of years of high school mathematics.

II. ANALYSIS OF SCORES OF THE MATHEMATICS ANXIETY RATING SCALE

Experimental Design and Statement of the Hypothesis

The scores on the Mathematics Anxiety Rating Scale were analyzed by a one-way analysis of variance, $p \leq 0.05$. The independent variable was the number of years of high school mathematics; the dependent variable was the score on the Mathematics Anxiety Rating Scale. The analysis of variance was used to test the following hypothesis:

The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses.

Results of the Analysis of Variance

The mean MARS score of each group is given in Table IV. Table V contains a summary for the analysis of variance. Results indicated that there was a significant difference between the MARS scores of each category. The F was significant at the 0.05 level. As a result, the null hypothesis was rejected.

TABLE IV
THE MEAN MARS SCORE FOR EACH GROUP OF STUDENTS
BASED UPON THE MATHEMATICS COURSES
STUDIED IN HIGH SCHOOL

Group	Mean Score
1A	219.1
1B	208.3
2A	224.1
2B	197.0
3A/B	191.3
4A/B	163.8

TABLE V
SUMMARY TABLE OF THE ANALYSIS OF VARIANCE OF
MEAN SCORES OF THE MARS OF EACH
CATEGORY OF STUDENTS

Source of Variation	Degrees of Freedom (df)	Sum of Squares (ss)	Mean Square (ms)	F
Between samples	5	60,865.2	12,173.04	4.2872416*
Error	145	411,707.8	2,839.3641	
Total	150	472,573.0		

*Significant at the 0.05 level of significance.

Comparison of the Means

Duncan's Multiple Range Test for unequal sample sizes was used to compare the means (Kramer, 1956). The least significant range and sample size and means are given in Tables VI and VII, respectively.

To avoid inflated results (Gay, 1976), a probability level of 0.01 was used on the Duncan's Multiple Range Test. The results of this test are given in Table VIII, where the means that are significantly different are not underscored by the same line. The difference in the MARS scores were not significant between the following groups:

1. 4A/B and 3A/B or 2B.
2. 3A/B and 2B, 1B, 1A, or 2A.
3. 2B and 1B, 1A, or 2A.
4. 1B and 1A or 2A.
5. 1A and 2A.

The results were significantly different for the following groups:

1. 4A/B and 1B.
2. 4A/B and 1A.
3. 4A/B and 2A.

Discussion of the Results

Based upon the results of the analysis of variance and the Duncan's Multiple Range Test, the following conclusions were made:

TABLE VI

STUDENTIZED AND LEAST SIGNIFICANT RANGES FOR DUNCAN'S
 MULTIPLE RANGE TEST, WHERE $df = 145$ (SIGNIFICANT
 AT 0.01), OF EACH CATEGORY OF STUDENTS BASED
 UPON THE MATHEMATICS COURSES STUDIED
 IN HIGH SCHOOL

	P = 2	P = 3	P = 4	P = 5	P = 6
z_p	3.643	2.796	3.9	3.978	4.04
R'_p	194.135	202.289	207.831	211.988	215.292

TABLE VII

THE MEAN MARS SCORE AND SAMPLE SIZE OF EACH GROUP OF
STUDENTS (IN INCREASING ORDER OF MEANS)

	4A/B	3A/B	2B	1B	1A	2A
$\bar{\mu}$	163.8	191.3	197.0	208.3	219.1	224.1
η	25	24	22	23	38	19

TABLE VIII

COMPARISON OF THE DIFFERENCES BETWEEN MEANS* OF THE MARS
OF EACH CATEGORY OF STUDENTS AS BASED UPON THE
MATHEMATICS COURSES STUDIED IN HIGH SCHOOL

4A/B	3A/B	2B	1B	1A	2A
(163.8)	(191.3)	(197.0)	(208.3)	(219.1)	(224.1)

_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

* Any two means not underscored by the same line are significantly different; any two means underscored by the same line are not significantly different.

1. Scores on the Mathematics Anxiety Rating Scale were not significantly different between 4A/B and 3A/B or 2B; 3A/B and 2B, 1B, 1A, or 2A; 2B and 1B, 1A, or 2A; 1B and 1A or 2A; 1A and 2A. See Table I, page 4, for an explanation of the notation.

The level of mathematics anxiety does not significantly differ between those students taking mathematics every year of high school and those taking either three years of mathematics (either category A or B) or two years of mathematics (Algebra I and Algebra II, only).

There is no significant difference in mathematics anxiety between those students taking three years of mathematics (either category A or B) and those taking Algebra I and Algebra II, only Algebra I, only General Mathematics, or General Mathematics and Algebra I.

Students taking Algebra I and Algebra II experienced approximately the same level of mathematics anxiety as those taking only Algebra I, only General Mathematics, or a combination of these two.

Mathematics anxiety does not significantly differ between students taking only Algebra I and students taking General Mathematics or a combination of General Mathematics and Algebra I.

Between students taking General Mathematics only, and those taking Algebra I in addition to General Mathematics, there is no significant difference in the levels of mathematics anxiety.

2. A significant difference was noticed on the scores of the Mathematics Anxiety Rating Scale between groups 4A/B and 1B, 4A/B and 1A, and 4A/B and 2A.

There is a significant difference in the level of mathematics anxiety experienced by students taking four years of mathematics (either category A or B) and those students taking General Mathematics, or Algebra I, or a combination of General Mathematics and Algebra I.

III. SUMMARY

The results of the presentation of the correlation coefficient relation scores on the MARS and the number of years of high school mathematics have been presented in this chapter. Also, an analysis of the MARS in relation to the number of years of studying high school mathematics was presented. Discussion of the results has been included.

CHAPTER IV

SUMMARY AND CONCLUSIONS

I. SUMMARY

Research has investigated the prevalence of mathematics anxiety in post-secondary levels, with only a small emphasis toward the secondary school level. As a result, it has become important to study the occurrence of mathematics anxiety at the secondary school level. Therefore, it was the purpose of this study to test the following hypotheses:

1. There is no significant relationship between the number of mathematics courses taken by high school seniors and the level of mathematics anxiety.

2. The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses.

Method

Participants in the project were 151 students randomly selected from the 1978 senior class of Franklin County High School, Winchester, Tennessee. Students were classified according to the number of years and type of mathematics taken up through their senior year. The

Mathematics Anxiety Rating Scale was administered in the spring of 1978 to the 151 participants by the Guidance Department.

Analyses of the Data and the Results of the Analyses

The relationship between scores on the Mathematics Anxiety Rating Scale and the number of years of mathematics courses taken in high school was determined by calculating the Pearson product-moment correlation coefficient. The following null hypothesis was tested:

There is no significant relationship between the number of mathematics courses taken by high school seniors and their level of mathematics anxiety.

The null hypothesis was rejected. The coefficient (see Table III, page 32) was significant, indicating a significant negative relationship between mathematics anxiety and the number of mathematics courses taken in high school.

The Mathematics Anxiety Rating Scale was analyzed by a one-way analysis of variance ($p \leq 0.05$). The amount of mathematics courses taken and the score on the Mathematics Anxiety Rating Scale were the independent and dependent variables, respectively. The following null hypothesis was tested:

The mathematics anxiety level of students taking more mathematics courses in high school is not lower than

the mathematics anxiety level of students not taking as many mathematics courses.

The null hypothesis was rejected. Means were then compared using Duncan's Multiple Range Test for unequal sample sizes. There were no significant differences between the following groups:

1. 4A/B and 3A/B or 2B.
2. 3A/B and 2B, 1B, 1A, or 2A.
3. 2B and 1B, 1A, or 2A.
4. 1B and 1A or 2A.
5. 1A and 2A.

However, significant differences were reported for the following groups:

1. 4A/B and 1B.
2. 4A/B and 1A.
3. 4A/B and 2A.

II. CONCLUSIONS

Statement of the Conclusions

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

1. There was a negative correlation between scores on the Mathematics Anxiety Rating Scale and the number of years of high school mathematics.
2. Mathematics anxiety was not significantly different between the following groups:

- a. Students taking four years of mathematics and those taking either three years of mathematics (either category A or B) or two years of Algebra.
- b. Students taking three years of mathematics (either category A or B) and those taking either Algebra I and II, Algebra I only, General Mathematics only, or General Mathematics and Algebra I.
- c. Students taking either Algebra I, General Mathematics, or a combination of the two.
- d. Students taking Algebra I only and those taking General Mathematics, or a combination of General Mathematics and Algebra I.
- e. Students taking General Mathematics only and those taking General Mathematics and Algebra I.

3. There was a significant difference in the level of mathematics anxiety between those students taking four years of mathematics and those taking either General Mathematics, Algebra I, or a combination of General Mathematics and Algebra I.

Discussion of the Hypotheses of the Study

One of the purposes of the study was to test the following hypothesis: There is no significant relationship between the number of mathematics courses taken by high

school seniors and their level of mathematics anxiety. The rejection of this hypothesis is supported by conclusion 1.

The second hypothesis to be tested by the study was the following: The mathematics anxiety level of students taking more mathematics courses in high school is not lower than the mathematics anxiety level of students not taking as many mathematics courses. Conclusion 3 supports the rejection of this hypothesis.

Implications for Further Research

Suggestions for further research include the following:

1. Investigate the level of mathematics anxiety at each grade level (grades one through twelve) to determine if there is a particular area in mathematics that causes mathematics anxiety to drastically increase, or if it increases at a constant rate.

2. Classify all senior students into one of two categories (presently enrolled in a mathematics course or not presently enrolled). Survey these students to determine the level of mathematics anxiety of each group. One result of this study could show the significance between current enrollment in a mathematics course and mathematics anxiety.

3. Determine the factors in the educational environment that lead to the development of mathematics anxiety. Administer anxiety scales to determine the effect

of the teacher, textbook, course, prior preparation, and peer pressure upon mathematics anxiety.

4. Survey students more than one time during their senior year to determine if their mathematics anxiety levels change. The anxiety level of students currently enrolled in a mathematics course could vary due to the material presently being covered in class. By obtaining several anxiety scores from each student, an average mathematics anxiety level could be obtained. The preceding could also be used with students not currently enrolled in a mathematics course.

5. Investigate the possibility that low, average, and high grade point averages for students with three or more years of mathematics does affect their anxiety level. This study could show if there is a relationship between the grade point average and level of mathematics anxiety of students who have taken mathematics each year during high school.

6. Use an instrument to measure mathematics anxiety which has been developed for use with senior high school students. Since the MARS was designed for use with college freshmen, a study using a different instrument could show significant differences in mathematics anxiety scores when compared to the scores obtained by using the MARS.

Final Conclusion

This study was significant in that it did reveal a relationship between the number of mathematics courses taken by high school seniors and their level of mathematics anxiety. A significant relationship did exist in the mathematics anxiety scores between students who had taken only one year of high school mathematics (either General Mathematics or Algebra I) and those who had taken four years of mathematics. Also, this study did show that there was an inverse relationship between mathematics anxiety scores, as measured by the MARS, and the number of years a student takes high school mathematics. Mathematics anxiety scores did decline as the number of years of mathematics enrollment increased.

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APPENDICES

APPENDIX A

STUDENT CONSENT FORM

Dear Student:

You have been randomly selected from the members of your senior class to participate in a project that measures mathematics anxiety. It is the purpose of this study to show, if any, the relationship between the amount of mathematics courses taken and the level of anxiety toward mathematics. As a participant in the project, you will be administered the Mathematics Anxiety Rating Scale (MARS), a ninety-eight-item scale on which you state how anxious you feel concerning various mathematical operations.

The information obtained by the MARS is in no way an indication of your mathematical or scholastic ability and shall not be recorded on your permanent record. Upon completion of the project, all information shall be destroyed by the investigator. Participation in this project will not involve any additional classwork. The MARS will be given under the direction of the Guidance Department during regular school hours. The amount of time to complete the scale will be approximately one hour.

You will not experience any emotional, physical, or academic damage by participating in the project. If you decide to participate in this study, you may withdraw at any time during the project. No recourse will be taken if you desire to not be included or discontinue participation during the study.

Feel free to contact me after this meeting or during school hours if you have any questions concerning the project.

I have read the above explanation of the mathematics anxiety project and give consent for my participation in the project.

Name: _____

Date: _____

APPENDIX B

PARENT CONSENT FORM

Dear Parent:

Your child has been randomly selected to participate in a project that measures mathematics anxiety. It is the purpose of this study to show, if any, the relationship between the amount of mathematics courses taken and the level of anxiety toward mathematics. Each student participating in the project will be administered the Mathematics Anxiety Rating Scale (MARS), a ninety-eight-item scale on which the participant states how anxious he feels concerning various mathematical operations.

The information obtained by the MARS is in no way an indicator of mathematical or scholastic ability and shall not be recorded on the permanent record of the student. Upon completion of the project all information shall be destroyed by the investigator. Participation in this project will not involve any additional classwork. The MARS will be given under the direction of the Guidance Department during regular school hours. The amount of time to complete the scale will be approximately one hour.

No emotional, physical, or academic damage can be experienced by participating in the project. Participation is not mandatory and the student may withdraw at any time during the project. No recourse will be taken if you desire that your child not be included in the study or if he decides to discontinue participation during the study.

Please feel free to contact me after school hours if you have any questions concerning this study. My home phone number is 649-5826.

Sincerely,

Frank Vanzant
Mathematics Department
Franklin County High School
Winchester, Tennessee

I have read the above explanation of the mathematics anxiety project and give consent for my child to participate in the project.

Name: _____

Date: _____

APPENDIX C

MATHEMATICS ANXIETY RATING SCALE

NAME _____

Total Score _____

MATHEMATICS ANXIETY RATING SCALE (MARS)

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

	Not at all	A little	A fair amount	Much	Very much
1. Determining the amount of change you should get back from a purchase involving several items.	☐	☐	☐	☐	☐
2. Having someone watch you as you total up a column of figures.	☐	☐	☐	☐	☐
3. Having someone watch you as you divide a five digit number by a two digit number.	☐	☐	☐	☐	☐
4. Being asked to add up $976 + 777$ in your head.	☐	☐	☐	☐	☐
5. Dividing a five digit number by a two digit number in private with pencil and paper.	☐	☐	☐	☐	☐
6. Calculating a simple percentage, e. g., the sales tax on a purchase.	☐	☐	☐	☐	☐
7. Listening to a salesman show you how you would save money by buying his higher priced product because it reduces long term expenses.	☐	☐	☐	☐	☐
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.	☐	☐	☐	☐	☐
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).	☐	☐	☐	☐	☐
10. Totaling up a dinner bill that you think overcharged you.	☐	☐	☐	☐	☐
11. Telling the cashier that you think the dinner bill was incorrect and watching the cashier total up the bill.	☐	☐	☐	☐	☐

TOTAL _____

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	Not at all	A little	A fair amount	Much	Very much
12. Being treasurer for a club.	☐	☐	☐	☐	☐
13. Totaling up the dues received and the expenses of a club you belong to.	☐	☐	☐	☐	☐
14. Adding up $976 + 777$ on paper.	☐	☐	☐	☐	☐
15. Doing a word problem in algebra.	☐	☐	☐	☐	☐
16. Solving a problem such as: If $x = 11$, and $y = 3$, then the results of x/y is equal to _____?	☐	☐	☐	☐	☐
17. Solving the problem such as: If $x = 12$, and $y = 4$, then the ratio of x to y is equal to _____?	☐	☐	☐	☐	☐
18. Determining the grade point average for your last term.	☐	☐	☐	☐	☐
19. Reading an article on the basketball team, showing what percentage of free throws each player made, the percentage of field goals made, the total number attempted, etc.	☐	☐	☐	☐	☐
20. Reading an historical novel with many dates in it.	☐	☐	☐	☐	☐
21. Counting the number of pages left in a novel you are engrossed in.	☐	☐	☐	☐	☐
22. Guessing at the number of people attending a dance you're at.	☐	☐	☐	☐	☐
23. Buying a math textbook.	☐	☐	☐	☐	☐
24. Watching someone work with a slide rule.	☐	☐	☐	☐	☐
25. Watching a teacher work an algebraic equation on the blackboard.	☐	☐	☐	☐	☐
26. Signing up for a math course.	☐	☐	☐	☐	☐
27. Listening to another student explain a math formula.	☐	☐	☐	☐	☐
28. Walking into a math class.	☐	☐	☐	☐	☐
TOTAL	_____	_____	_____	_____	_____

	Not at all	A little	A fair amount	Much	Very much
29. Having to compute the miles/gallon on your car.	☐	☐	☐	☐	☐
30. Watching someone work with a calculator.	☐	☐	☐	☐	☐
31. Looking through the pages of a math text.	☐	☐	☐	☐	☐
32. Working on an income tax form.	☐	☐	☐	☐	☐
33. Reading your W-2 form (or other statement showing your annual earning and taxes).	☐	☐	☐	☐	☐
34. Studying for a math test.	☐	☐	☐	☐	☐
35. Starting a new chapter in a math book.	☐	☐	☐	☐	☐
36. Walking on campus and thinking about a math course.	☐	☐	☐	☐	☐
37. Meeting your math teacher while walking on campus.	☐	☐	☐	☐	☐
38. Reading the word "Statistics."	☐	☐	☐	☐	☐
39. Sitting in a math class and waiting for the instructor to arrive.	☐	☐	☐	☐	☐
40. Solving a square root problem.	☐	☐	☐	☐	☐
41. Signing up for a course in Statistics.	☐	☐	☐	☐	☐
42. Checking over your monthly bank statement.	☐	☐	☐	☐	☐
43. Taking the math section of a college entrance exam.	☐	☐	☐	☐	☐
44. Having someone explain bank interest rates as you decide on a savings account.	☐	☐	☐	☐	☐
45. Raising your hand in a math class to ask a question.	☐	☐	☐	☐	☐
46. Reading and interpreting graphs or charts.	☐	☐	☐	☐	☐
TOTAL	_____	_____	_____	_____	_____

	Not at all	A little	A fair amount	Much	Very much
47. Reading a cash register receipt after your purchase.	☐	☐	☐	☐	☐
48. Figuring the sales tax on a purchase that costs more than \$1.00.	☐	☐	☐	☐	☐
49. Having a person illustrate to you the best way to divide your money into a savings and a checking account.	☐	☐	☐	☐	☐
50. Figuring out which of two summer job offers is the most lucrative: where one involves a lower salary, room and board, and travel, while the other one involves a higher salary but no other benefits.	☐	☐	☐	☐	☐
51. Reading a formula in chemistry.	☐	☐	☐	☐	☐
52. Hearing a lecture in a social science class where the instructor is commenting on some figures, e. g., the percentage of each socio-economic group who voted Republican.	☐	☐	☐	☐	☐
53. Taking an examination (quiz) in a math course.	☐	☐	☐	☐	☐
54. Taking an examination (final) in a math course.	☐	☐	☐	☐	☐
55. Hearing two of your friends exchanging opinions on the best way to calculate the cost of a product.	☐	☐	☐	☐	☐
56. Having someone ask you to recheck his figures in a simple calculation, such as division, or addition.	☐	☐	☐	☐	☐
57. Being asked by a friend to answer the question: how long will it take to get to Denver if I drive at 30 miles per hour?	☐	☐	☐	☐	☐
58. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at differing speeds.	☐	☐	☐	☐	☐
59. Hearing friends make bets on a game as they quote the odds.	☐	☐	☐	☐	☐
60. Playing cards where numbers are involved, e. g., bridge or poker.	☐	☐	☐	☐	☐
TOTAL	_____	_____	_____	_____	_____

	Not at all	A little	A fair amount	Much	Very much
61. Hearing a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.	☐	☐	☐	☐	☐
62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.	☐	☐	☐	☐	☐
63. Juggling class times around at registration to determine the best schedule.	☐	☐	☐	☐	☐
64. Deciding which courses to take in order to come out with the proper number of credit hours for full time enrollment.	☐	☐	☐	☐	☐
65. Working a <u>concrete, everyday</u> application of mathematics that has meaning to me, e. g., figuring out how much I can spend on recreational purposes after paying other bills.	☐	☐	☐	☐	☐
66. Working on an abstract mathematical problem, such as: "If x = outstanding bills, and y = total income, calculate how much you have left for recreational expenditures."	☐	☐	☐	☐	☐
67. Being given a set of numerical problems involving addition to solve on paper.	☐	☐	☐	☐	☐
68. Being given a set of subtraction problems to solve.	☐	☐	☐	☐	☐
69. Being given a set of multiplication problems to solve.	☐	☐	☐	☐	☐
70. Being given a set of division problems to solve.	☐	☐	☐	☐	☐
71. Picking up the math text book to begin working on a homework assignment.	☐	☐	☐	☐	☐
72. Being given a homework assignment of many difficult problems which is due the next class meeting.	☐	☐	☐	☐	☐
73. Thinking about an upcoming math test one week before.	☐	☐	☐	☐	☐
74. Thinking about an upcoming math test one day before.	☐	☐	☐	☐	☐

TOTAL

	Not at all	A little	A fair amount	Much	Very much
75. Thinking about an upcoming math test one hour before.	☐	☐	☐	☐	☐
76. Thinking about an upcoming math test five minutes before.	☐	☐	☐	☐	☐
77. Talking to someone in your class who does well about a problem and not being able to understand what he is explaining.	☐	☐	☐	☐	☐
78. Waiting to get a math test returned in which you expected to do well.	☐	☐	☐	☐	☐
79. Waiting to get a math test returned in which you expected to do poorly.	☐	☐	☐	☐	☐
80. Walking to math class.	☐	☐	☐	☐	☐
81. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.	☐	☐	☐	☐	☐
82. Picking up a math textbook to begin a difficult reading assignment.	☐	☐	☐	☐	☐
83. Being called upon to recite in a math class when you are prepared.	☐	☐	☐	☐	☐
84. Not knowing the formula needed to solve a particular problem.	☐	☐	☐	☐	☐
85. Receiving your final math grade in the mail.	☐	☐	☐	☐	☐
86. Opening a math or stat book and seeing a page full of problems.	☐	☐	☐	☐	☐
87. Being responsible for collecting dues for an organization and keeping track of the amount.	☐	☐	☐	☐	☐
88. Getting ready to study for a math test.	☐	☐	☐	☐	☐
89. Listening to a lecture in a math class.	☐	☐	☐	☐	☐
90. Figuring out your monthly budget.	☐	☐	☐	☐	☐
TOTAL	—	—	—	—	—

	Not at all	A little	A fair amount	Much	Very much
91. Being given a "pop" quiz in a math class.	☐	☐	☐	☐	☐
92. Seeing a computer printout.	☐	☐	☐	☐	☐
93. Having to use the tables in the back of a math book.	☐	☐	☐	☐	☐
94. Being told how to interpret probability statements.	☐	☐	☐	☐	☐
95. Asking your math instructor to help you with a problem that you don't understand.	☐	☐	☐	☐	☐
96. Being asked to explain how you arrived at a particular solution for a problem.	☐	☐	☐	☐	☐
97. Tallying up the results of a survey or poll.	☐	☐	☐	☐	☐
98. Acting as secretary, keeping track of the number of people signing up for an event.	☐	☐	☐	☐	☐
TOTAL	_____	_____	_____	_____	_____
Total Score	_____				

VITA

Frank Hamilton Vanzant was born in Franklin County, Tennessee, on August 10, 1948. He attended elementary school in Estill Springs, Tennessee. In May, 1966, he graduated in the top 5 percent of his class at Franklin County High School in Winchester, Tennessee. The following September he entered The University of Tennessee and participated in the Cooperative Engineering Scholarship Program with ARO, Inc., Arnold Air Force Station, Tennessee. In August, 1971, he received a Bachelor of Science degree in Electrical Engineering. In 1972 he accepted a mathematics teaching position at Franklin County High School. A year's leave of absence was granted in the spring of 1974 in order for him to begin graduate study at The University of Tennessee, Knoxville. In June, 1975, he was awarded a Master of Mathematics degree. Part-time graduate study was continued in the summer of 1975. He received the Specialist in Education degree, with a major in Educational Curriculum and Instruction, in December, 1979.

Mr. Vanzant is a member of the Franklin County Education Association, Tennessee Education Association, National Education Association, and the National Council of Teachers of Mathematics. He is currently employed as a mathematics teacher at Franklin County High School.

His wife, the former Sylvia Sisk, is from Winchester, Tennessee, and they have been married for six years.