# MATHEMATICS ANXIETY--REMOVING THE ROADBLOCK TO THE NEW CAREERS

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Mathematical illiteracy, and thus technological illiteracy, presents a very real threat to national defense, the growth of our complex industrial-technological economy, and the opportunity for large numbers of our population to be employable in both the near and distant future.

Even today, millions of people are unemployed or underemployed, while at the same time many "help wanted" signs are displayed begging for technically trained workers in the fields of aerospace, electronics, computer science, electrical and mechanical engineering, energy, and the many exotic high-technology fields, such as robotics, fiber optics, and laser technology. These fields obviously all require varying levels of competency in mathematics.

Part of the problem lies in the fact that at least half of all high school graduates today have had only the minimum of one course in algebra and many have not reached that level of competence. Seven states do not even require mathematics at the high school level. Mathematics scores on the Scholastic Aptitude Test have fallen each year since 1962.

Most girls don't take advanced mathematics in school because they do not see mathematics as being relevant to the traditional female jobs. Their lack of mathematics is a major reason that a larger number of females are not in the emerging high-technology career fields.

The solution is not simple. Qualified mathematics teachers are in short supply. Recent graduates of mathematics teacher education programs can often double or triple their salary by entering industry. Unqualified mathematics teachers are often forced to fill the gap and, unfortunately, may "turn off" students to further advanced study.

Without proper instruction, the study of mathematics can produce stress and embarrassment in students who have difficulty with numbers. Working with mathematics simply frightens many students. This fear of mathematics is what we call mathematics anxiety.

Mathematics anxiety can be identified and often treated by the trained and observant classroom teacher. The psychological traits and specific symptoms relating to mathematics anxiety are presented below to aid in identification.

1. Cautiousness

   Cautiousness can be valuable when doing mathematical work. Obviously some mathematical problems require careful work, but when extreme caution is observed, this may indicate a symptom of mathematics anxiety.

2. Dependency, direction seeking, conforming tendencies

   A student who continuously asks for help when doing mathematics may be indicating another symptom of mathematical anxiety. The "is this right" syndrome may be indicating a lack of confidence with mathematics.

3. Reduced responsiveness to the environment

   Not paying attention may have a purpose. By avoiding the mathematical topic, the student can then explain failure in a more rational way. Paying attention and then failing requires realistic assessment by the student. By not paying attention, we can avoid a realistic assessment of the consequences of our behavior. Culturally, we also avoid saying that taboo phrase "I don't know."

4. Deterioration in complex intellectual and problem solving processes

   Sometimes students will perform calculations well, but they will have difficulty with mathematical problem solving. It may be that the anxiety and perceived loss of self-esteem operate to reduce problem solving effectiveness.

5. Extreme fear of failure

Students who are unwilling to take a moderate risk or make a guess when solving mathematical problems may be very concerned with failure. Avoidance of this fear of failure may be observed in some of the very quiet students.

6. Inadequate congruence between expectations and realistic talents

Realistic goals are important. A student needs to develop self-diagnostic tools to appraise, refine and further develop his true mathematical ability.

7. Hostility

Hostility may be the result of anxiety. Perhaps some students who are loud or abusive during mathematics class are really very frightened about their mathematical abilities.

8. Physiological symptoms, such as hair pulling and twisting, eye tics, dilated pupils, headaches, stomachaches, loss of sleep, increased respiration and nightmares

Physiological symptoms observed during mathematics work may reflect a high degree of anxiety about mathematics learning.

9. Compulsive behaviors

Some compulsive behavior can get in the way of performance. For example, a mathematics student was once observed to compulsively play with his glasses during a mathematics test. After asking the student why his performance on the test was low, the student replied, "My glasses don't fit." Compulsively thinking about his glasses was a non-task-related behavior and it tended to decrease the student's mathematical performance.

10. Avoidance behaviors

Avoidance behavior may be observed when assignments are not turned in.

11. Low self-esteem

Low self-esteem manifests itself with remarks such as, "I am just not any good at mathematics." Some students will consistently depreciate their mathematical performance.

12. Female Sterotyping

Female students often allow teachers and counselors to steer them away from mathematics and toward more feminine-related classes like home economics and art.

## Teacher Behaviors and Mathematics Anxiety

After observing that several of the symptoms of mathematical anxiety are exhibited by a student, therapeutic strategies need to be developed to lessen the impact of mathematical anxiety. In this section, we will provide an overview of the relationship between teacher behaviors and mathematical anxiety.

A reasonable starting point for a teacher is an examination of his/her own mathematical anxieties. In this way, a teacher may discover that mathematical anxiety is being modeled or taught to the student. An initial question to ask is, "What mathematical topics are most frightening? Why are these topics frightening to the teacher? Is there a resource person who might be able to offer assistance?"

Teachers can also analyze the degree to which they equate adequacy of performance with adequacy as a person. Seymour Sarason's major study of anxiety yielded this statement:

> From our observations we have concluded that one of the most important dimensions on which teachers vary is the degree to which they establish an atmosphere in which a child's sense of security and level of self-esteem are very much determined by the adequacy of his performance (Sarason, 1960, p. 272).

We may, at times, convey to the student who has trouble with mathematics that he also has been a failure as a person. Some reinforcing statements to build the student's self-esteem are important statements even if the student has not performed well on one of our mathematics assignments.

Another strategy that mathematics teachers can use is to accept, at times, "I don't know" statements from students. Socrates once said, "I know nothing except the fact of my own ignorance." Certainly if a classical philosopher like Socrates could accept his own lack of understanding, we as mathematics teachers should be able to occasionally say that we don't know the answer. Likewise, we should be willing to accept this from our students at times.

Finally, our test administration procedures need to be analyzed. Walking around the room may stop some cheating, but perhaps some students get anxious when the teacher is walking around or leaning over their shoulders. The mathematics test should be viewed as a learning aid, not the most vital part of a student's life. Reassurance when administering a mathematics test can go a long way toward treating mathematical anxiety.

In summary, many of our statements appear almost self-evident. Yet, haven't we been in a classroom where these common sense procedures have been lacking? Perhaps the routine of everyday life needs to be examined to insure that our classroom procedures are not unduly arousing anxiety.

## Modifying Teaching Strategies

In this section, a more detailed description of the modification of teaching strategies is presented. For example, one of the main consequences of anxiety is the rigid or extremely cautious personality trait. Certainly, it seems important to provide clear objectives to our mathematical lesson and to carefully sequence and structure our mathematical content. But teaching seems to be an art as well as a science. It is, therefore, important to vary our approach and, for the severely rigid student, we need to set up educational experiences where moderate risk taking, individual decisions, and creativity are emphasized.

Fear of failure, avoidance and low self-esteem have all been mentioned as being related to mathematical anxiety. Teaching strategies can be altered to treat these symptoms. A particular alteration that can affect the anxiety level of students is the

manner in which we treat competition and cooperation. Anxious students may get very worried about their performance in front of the whole class. They may be afraid of failing; they may avoid participating; also, they may suffer loss of self-esteem by being embarrassed in front of their peers.

The use of technology in the mathematics classroom is also a promising approach. The hand calculator, for example, can provide immediate feedback to mathematical questions and it can do so in a non-threatening manner. Calculators and microcomputers can reduce a student's excessive dependency needs, and they can help reduce the fear of failure due to peer and teacher evaluations.

Three main approaches for modifying teaching strategies in order to reduce mathematical anxiety have been presented. More emphasis on creative mathematical problems, a more balanced approach to competition and cooperation, and a planned use of hand calculators and microcomputers are three ways to modify teaching strategies.

## Coping Skills When Taking Mathematics Tests

Psychologists have developed various strategies for coping with stress. Some of these techniques may prove useful for students exhibiting symptoms of mathematical anxiety. These strategies place emphasis on the student's ability to analyze and cope with anxiety. Meichenbaum (1975) has delineated four major areas for coping with stress. These are:

1. the stage of preparing for the stressor;
2. the stage of confronting the stressor;
3. the stage of coping with the feeling of being overwhelmed;
4. reinforcing self-statements.

Let us examine these four stages and see how they might be used when taking a mathematics test.

First, the stage of preparing for the test (stressor) would involve the student by having him ask these questions: What is it I have to do? Can I develop a plan to deal with it? Can I emphasize positive, not negative self-statements? As teachers, we need

to help the student identify the key mathematical tasks that will be on the test. We need to help the student to develop a plan of attack when taking the test, such as to first work all the problems which seem easiest. Finally, we need to help the student develop an image of successfully coping with the mathematics test. Simply put, the student should verbalize a statement such as, "I can perform well on this test."

The stage of confronting the mathematics test would involve these activities by the student:

1. answering one question at a time, not being overwhelmed by the entire test;
2. solving first the questions which are easiest;
3. and taking a deep, slow breath in order to pause for a moment.

The stage of coping with the feeling of being overwhelmed involves these activities: 1) remembering the test will be over before too long; 2) pausing for a moment before a difficult question; 3) labeling fear from 0 to 10 and watching it change. Here, the emphasis is on monitoring the flood of anxiety during the test.

Reinforcing statements are vital. After the test, the student should be praised for having taken it (and surviving it!). The student should verbalize a statement such as, "I am really pleased with the progress I am making."

In short, these coping skills need to be practiced and refined. Many of the ideas seem to relate to the student developing a sense of confidence with mathematics, a positive feeling which can be extended to the studying of other mathematical concepts.

In summary, this article has tried to develop some understanding of the term "mathematical anxiety." An examination of some of the characteristics of mathematics anxiety has been explored. Also, suggestions for modifying teacher behaviors and teaching strategies have been developed. Finally, strategies for coping with mathematics tests have been developed. Hopefully, these suggestions may help some students to feel more emotionally secure with mathematics.

## References

Meichenbaum, D. A self-instructional approach to stress management: A proposal for stress innoculation training. In I.G. Sarason and C.D. Speilberger (Eds.) Stress and Anxiety - Volume I. New York: John Wiley, 1975.

Sarason, S.B. Anxiety in elementary school children. New York: John Wiley & Sons, 1960.


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## SINGLE AND DOUBLE INTEGRALS FOR AREA IN ADVANCED PLACEMENT CALCULUS


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One of the most fascinating and useful applications of elementary integral calculus is its application to area. It is at the time of applying integration to area that calculus students begin to see the power of integration. It is the area application that first destroys the myth that integration is simply antidifferentiation or reversing the derivative process. Indeed, the geometric interpretation of the integral is light years from the geometric interpretation of the derivative. This fact should be strongly emphasized in the calculus classroom.

A firm understanding of just how the area between a curve f(x) and an axis is computed can best be demonstrated using the Riemann integration technique of inscribing 'n' rectangles having equal length bases, finding the sum of their areas, and then letting the number of rectangles approach infinity as a limit. In this way exact areas can be computed and confidence in the fundamental theorem of integral calculus,

$$\lim_{\Delta x \to 0} \sum_{a}^{b} f(x) \quad \Delta x = \int_{a}^{b} f(x) \quad dx$$