MATHEMATICS ANXIETY: WHAT A TEACHER CAN DO TO HELP STUDENTS WITH THIS PROBLEM

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INTRODUCTION

Chris stared at the paper on the desk in front of him. He thought to himself, "Why did I take this mathematics class in the first place? It was stupid of me to think I could even make it through this first test. What kind of a jerk am I anyway? I could never do this stuff even if I understood half of it."

Meanwhile, Chris's teacher watched the class and noticed his nervousness. "What is bothering Chris?" she thought. "It seems as though he understands some of the material and then draws a total blank. What can I do to get through to this student? He seems so scared and frightened of anything to do with mathematics."

Scenes like this occur each day in mathematics classrooms across the nation. Students who appear to understand what is presented in class fail to perform up to expected levels. In some cases, students who are capable of understanding mathematical concepts fight within themselves the fears and frustrations of past experiences. Both of the above situations describe students who are plagued by what is called mathematics anxiety. What can a

teacher do to help these students overcome their fears? The first step in this process is to know something about this mathematics anxiety. Exactly what is it and what causes it?

Mathematics anxiety has been defined in various ways over the years. Richardson and Suinn (1972) defined it as "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" (cited in Betz, 1978, p. 441). Another definition is "an irrational and impeditive dread of mathematics" (Fulkerson, J. P. Galassi, & M. D. Galassi, 1984, p. 377). In Steinmann's 1984 article, mathematics anxiety is described as "an habitual, counterproductive, emotional response to anything mathematical" (p. 20). Other definitions refer to mathematics anxiety as a "fear of mathematics or an intense, negative emotional reaction to mathematics" (Sherard, 1981, p. 106) or an "emotional and cognitive dread of mathematics" (Williams, 1988, p. 96).

As these definitions point out, mathematics anxiety is an emotional response to anything mathematical from the everyday task of balancing a checkbook to the more technical task of finding the area under a curve. Such emotional responses might include a fear of or a feeling of inadequacy when dealing with mathematics. Sheila Tobias

(Rounds & Hendel, 1980b). Mathematics Test Anxiety is, of course, an anxiety about mathematics tests while Numerical Anxiety can be defined as an anxiety of anything that deals with the daily encounters with mathematics. Both can be extremely painful. A different study of 1106 students identified three factors of mathematics anxiety: Evaluation Anxiety (Mathematics Test Anxiety), Social Responsibility Anxiety, and Arithmetic Computation Anxiety (Numerical Anxiety) (Resnick, Viehe, & Segal, 1982). The definition of Social Responsibility Anxiety is an anxiety over the responsibilities which come from social events such as being the treasurer of a club. So far, three factors of mathematics anxiety have been mentioned. They are Mathematics Test Anxiety, Numerical Anxiety, and Social Responsibility Anxiety. Another factor, called Abstraction Anxiety, is found exclusively through an exposure to more abstract mathematics. Abstraction Anxiety is an "anxiety concerning mathematical topics that are first introduced in the middle grades" (Ferguson, 1986, p. 149).

The anxieties mentioned above are the currently known factors that make up mathematics anxiety. However, some research has found that certain emotional responses are also common in mathematics anxiety. "Math Anxiety, like test anxiety, may be composed of two major components:

(a) cognitive concern about performance (worry) and (b) emotionality" (Hendel & Davis, 1978, p. 430). Worry and high emotions can be characteristics of mathematics anxiety. Three other emotions or areas were highly correlated to attitudes toward mathematics in J. Shaughnessy, Haladyna, and J. M. Shaughnessy's 1983 study. These areas are fatalism (my inability to affect school success), self-confidence, and perceived importance of mathematics. However, Frary and Ling (1983) found in their study of 491 students that mathematics anxiety is "a unidimensional and, unfortunately, rather global construct independent of the other personality variables" (p.992). In other words, some investigators see mathematics anxiety as composed of certain emotions or personality traits while others see mathematics anxiety as a trait in and of itself.

FACTORS AFFECTING MATHEMATICS ANXIETY

However it is viewed, mathematics anxiety hinders many mathematics students in today's classrooms and also hinders many people in their everyday interactions with mathematics. But exactly what causes these hindrances to mathematics success? A partial answer may be based on a consideration of what research and popular opinion suggest about the origins of mathematics anxiety.

EXTERNAL FACTORS

There have been many theories formed as to how mathematics anxiety is actually caused. Most of the research in this area agrees that it is influenced by external forces. The first external influence is, of course, the teacher. Researchers have recently studied elementary teachers and speculated about how their attitudes toward mathematics might be transmitted to their students. Most of the elementary education majors in one study were humanities oriented (Bulmahn & Young, 1982). They tended to like English and social studies and to avoid mathematics and science courses. Battista (1986) found in his study of 38 preservice elementary education majors that many had negative attitudes toward mathematics and low levels of mathematical knowledge. Another study by Hembree (1990) also found that the highest levels of mathematics anxiety appeared in elementary education majors. Low levels of mathematical knowledge in elementary education majors significantly reduced their ability to learn mathematics pedagogy in Battista's study, but anxiety toward mathematics can be reduced by a good methods course. The methods course used in this study helped show why mathematics is useful and also developed the elementary education majors' self-confidence in mathematics (Battista). It would be helpful to note that one author

felt that mathematics was not learned well at the elementary level because it was not reinforced in other subjects (Steen, 1990). This does not dismiss the fact that elementary teachers need to confront their fears of mathematics, but it does place an increased emphasis on relating different subjects to one other.

While the elementary grades are important to developing a beginning of mathematical knowledge, most research indicates a decrease in mathematical attitudes and an increase in mathematics anxiety in the middle grades (Brush, 1981; Ferguson, 1986; Hembree, 1990; Shaughnessy et al., 1983). One explanation for this is provided by Brush. He found that students were not made anxious by doing calculations or solving problems but by being evaluated by others. While anxiety toward mathematics increased with age, anxiety toward English decreased. Brush hypothesized that this occurred because mathematics becomes more evaluation oriented while English becomes more idea oriented. Tobias (1987) stated that "students complain that there is little opportunity for debate or discussion" in a mathematics class (p. 5). There is too much pressure to find one correct answer and not enough emphasis on ideas. Thus, if mathematics were taught with less emphasis on tests and evaluations, then the level of mathematics anxiety might decrease. More suggestions on

implementing this style of teaching will be delineated below.

High school teachers also play an important role in the development of their students' attitudes towards mathematics. Peterson and Mays (1981) stated one aspect of this relationship:

> Students who enjoy early agreement between what they expect from an ideal teacher and what they actually see are more likely to begin learning tasks confidently and easily. Conversely, pupils who see divergence from their ideal may be distracted by personal reactions, conflict and resistance. (p. 315)

Students need to observe a consistency in their teachers. If a teacher does not fulfill most of his or her students' expectations, then the students will not respect that teacher and will not learn to their full potential.

Another aspect of a teacher's role in the development of student attitudes towards mathematics is in the teacher's perception of his or her students. Students know how their teacher perceives them and this creates in them a self-fulfilling prophecy (Brassell, Petry, & Brooks, 1980; Rounds & Hendel, 1980a). If a teacher believes a student will not do well with a certain topic, the student is likely to prove that teacher correct. However, if a teacher keeps an open mind toward a student's ability,

then the student will have a much better chance of learning mathematics and enjoying it.

Other people may contribute to a student's developing mathematics anxiety. Parents may convey their negative feelings toward mathematics to their children (Steinmann, 1984). Mathematics instructors may fail to present material clearly thus confusing their students (Shodahl & Diers, 1984). Emphasis may be placed on timed tests and quizzes and on competitiveness rather than on learning and understanding mathematics (Tobias, 1980). Bad or negative experiences with a mathematics teacher may also cause the student to have a bad attitude towards all mathematics (Hackworth, 1985; Williams, 1988).

The external influence of a teacher is very powerful in the possible development of mathematics anxiety. From the elementary grades through high school, teachers can either make or break their students' attitudes towards the whole subject of mathematics. But there are also other external forces at work relative to the student.

One such force is a student's prior mathematics background and achievements. For some students, these are inadequate (Shodahl & Diers, 1984; Tobias, 1980). Students are not prepared for the mathematics they are being taught. This possible cause of mathematics anxiety may be due to previous teachers not having taught the students

what they need to know. Along with this lack of prior knowledge is the devastating fact that some schools promote students without the knowledge they will need in subsequent classes. Tradition dictates that all must learn in the same time and those who do not may be promoted without the prerequisite knowledge for future use. (Steinmann, 1984). Williams (1988) indicated that the lack of understanding of mathematics which many students possess leads to failure in later classes, and this in turn leads to feelings of helplessness. These feelings of helplessness soon develop into mathematics anxiety.

Mathematics texts are another possible external influence on the development of mathematics anxiety. Shodahl and Diers (1984) suggested that current mathematics texts offer too little explanation of the process involved in many mathematics problems. Students need to know the "why" of mathematics and not just the "how." Another problem with mathematics texts mentioned by Steinmann (1984) is that texts today are too long and do not emphasize understanding. The language of mathematics may also cause difficulties for some students. Students are confused because some mathematical terms have different meanings in English (Tobias, 1980). These differences need to be expressed and explained, so that students will not be confused.

Myths about mathematics are another way in which students may be influenced to be math-anxious. Some of these myths include the faulty perceptions that there is only one way to do a problem, that one must be quick and know how he got the answer, that mathematics requires logic not intuition, and that men are naturally better in mathematics (Shodahl & Diers, 1984). Some other mysteries and myths about mathematics are that mathematics ability is a gift and not a set of skills and those who do mathematics know instantly how to do it (Tobias, 1980). Mathematics instructors may skip steps when doing problems and contribute to the myth that some people are natural mathematicians (Shodahl & Diers). Lucky and unlucky numbers and numerology also attribute a mysteriousness to mathematics (Steinmann, 1984).

INTERNAL FACTORS

While there are many external influences affecting mathematics anxiety, there are also several internal influences. The first set of internal influences is not easily changed. One such influence is the cognitive style of the student. "Cognitive style is defined as the individual's preferred method of perceiving, thinking, and retaining information" (Hadfield & Maddux, 1988, p. 76). In layman's terms, it might be thought of as the way each individual chooses to think. Hadfield and Maddux found

that field dependent learners who have a global visualization had significantly higher mean mathematics anxiety scores than did field independent learners who visualize analytically. However, another study of 71 students found slightly different results. The students in this study, half with high anxiety and half with low anxiety, were asked to complete two sets of problems while thinking aloud to obtain their cognitions (Fulkerson et al., 1984). It was found that cognitions did not vary as a function of mathematics anxiety or sex contrary to the research literature. Fulkerson et al. suggested that high and low mathematically anxious students may simply differ in their overall evaluation or set toward mathematics but not in their actual cognitions. Other possible internal influences on levels of mathematics anxiety are that students may not be formal operational thinkers and thus are not able to mentally handle the mathematical concepts and that some students are right-brain oriented and have trouble thinking analytically (Shodahl & Diers, 1984).

Some internal factors which might affect mathematics anxiety may be changed to provide improvement. The first of these influences is poor self-esteem (Steinmann, 1984). If a student feels unable to complete a task, then this will hinder any attempts the student may make. "Although a student may be well skilled in a mathematics task, the

anticipation of possible incompetence may block the operation of that skill" (Skiba, 1990, p. 188). Another possible influence which can be changed is poor study habits (Steinmann). Sometimes students are very capable of handling mathematics but need to be taught how to study. This can be effected through a study skills unit or course. A student's perception of his or her mathematical talent is another adaptable influence. It has been found that a student assesses himself or herself on past personal performances (Lorenz, 1982). A stable performance leads to a consistent student perception of his or her ability. However, varied performance leads students to be confused about their ability. Students need to have a sense of their own consistent behavior within the realm of mathematics. Teachers can help their students achieve this by giving them easier tasks to complete to provide a foundation of good performance. Once this is done, the student will have a better perception of his or her ability.

Hembree (1990) found that "mathematics anxiety seems to be a learned condition more behavioral than cognitive in nature" (p. 45). The cognitive influences cited above may have an effect on mathematics anxiety, but the effect is small when compared to the many behavioral influences also mentioned. A finding by Resnick et al. (1982) showed

that their subjects had low mathematics anxiety when compared to the national mean which may show mathematics anxiety to be a local problem. If mathematics anxiety is a local problem, then it may suggest that external influences are more potent than the internal ones.

MEASURES OF MATHEMATICS ANXIETY

Before a teacher can truly help a student who may have mathematics anxiety, he or she should know how this anxiety is usually measured. The primary measures usually used are the Mathematics Anxiety Rating Scale (MARS) developed by Suinn and Fennema and Sherman's Mathematics Anxiety Scale (MAS) or versions of them. The MARS is a 94 question Likert-type instrument which has the respondent rate the amount of anxiety he or she would feel in a certain situation on a scale of 1 (no anxiety) to 5 (high anxiety). The MAS contains 12 questions and is similar to the MARS (Rounds & Hendel, 1980a).

There have been several studies to determine the consistency and reliability of these measures. A study conducted by Dew, J. P. Galassi, and M. D. Galassi (1983) of 769 students compared the MAS, the MARS, and Sandman's Anxiety Toward Mathematics Scale (ATMS). They found that the MARS and MAS have better internal consistencies and test-retest reliabilities. The MARS was more internally

consistent than the other measures while ATMS had lower internal consistency and moderate test-retest reliability. In this study, the measures did not correlate with each other (Dew et al., 1983). One study of 124 women in a mathematics anxiety treatment program found the MARS and MAS to correlate to each other by -.55 which is lower than expected (Rounds & Hendel, 1980a). This may mean the MARS and MAS measure somewhat different factors of mathematics anxiety. In another study by Dew, J. P. Galassi, and M. D. Galassi (1984), it was found that the mathematics anxiety measures were more closely related to each other than to the test anxiety measure. They also discovered that the MARS tends to measure test anxiety more than the other measures, but this is not a major limitation since mathematics anxiety is related but not identical to test anxiety (Dew et al., 1984).

The MARS has become the most widely used measure over the years. A revised version called MARS-A was created specifically for high school students. It is a 98 question instrument with the same format as the original MARS (Gliner, 1987). Plake and Parker (1982) found this revised version to have a reliability of .98 and to have a correlation of .97 to the full MARS. Suinn and Edwards (1982) agreed that MARS-A is a good instrument to use to identify those students who need help with mathematics

anxiety by studying 483 students from Arizona, 1009 students from a Colorado junior high, and 288 students from a Colorado senior high school.

Research has shown that some students have a higher risk for developing mathematics anxiety than others. Knowing who these students are will help any teacher to concentrate on these students and look for warning signs of mathematics anxiety. One group already mentioned is that consisting of students with low mathematics ability. Another high-risk student who is easy to locate is the female student.

Recent studies have confirmed that, for whatever reason, female students have a higher incidence and higher levels of mathematics anxiety than male students (Betz, 1978; Dew et al., 1983; Hembree, 1990; Llabre & Suarez, 1985). Pedersen, Bleyer, and Elmore (1985) found that there is "a general decrease in the scores of females on positive attitudes toward mathematics and on mathematics achievement" (p. 46). Females have not only higher levels of mathematics anxiety but also a general dislike for mathematics altogether. It was also found that "older women reported greater math anxiety than did younger women" (Betz, p. 445). This should be significant to a college instructor who would encounter older women in his or her classroom on a regular basis. Although mathematics

anxiety is more common in females than males, Llabre and Suarez (1985) found that the women in their study received higher grades than the men. Hembree also found that the effects of mathematics anxiety seem more pronounced in males than in females. Women may have a higher incidence of mathematics anxiety but men are affected by it to a greater extent.

Some other groups which have been found to have a higher incidence of mathematics anxiety are slow and average students and Hispanics (Hembree, 1990). No reasons have been given for these last two groups to have a higher rate of mathematics anxiety. However, several reasons have been formulated as to why females have a greater incidence.

The difference between males and females was first found because more women were seeking help with mathematics anxiety (Hackworth, 1985). One possible explanation for women to seek help more is the general view in society that "females will be more fearful and more passive than males" (Hackworth, p. 4). This, in turn, leads to the fact that "males can be expected to be less likely to admit to their anxieties" (Hackworth, p. 4). Women are supposed to be weak and scared while men are to be strong and fearless. This societal pressure encourages the

difference that is seen between the sexes in mathematics anxiety.

Males and females do perceive mathematics in different ways which may also contribute to the difference. "Boys tend to accept mathematics as a means to college, whereas girls often see no need for mathematics" (Skiba, 1990, p. 188). To a boy, mathematics is something that is needed even if it is difficult to understand. A girl, however, may feel that mathematics can be avoided, so why go through the pressure to learn it? The priorities in males and females make this difference easier to understand. Peterson and Mays (1981) found that males thought non-personal subject matter was important in a classroom. Females, on the other hand, were interested in people and social interaction. Friends and the social structure of the classroom are more important to a girl than the actual material being presented. This should be remembered when a teacher finds that the girls in a class would rather talk than listen to a lecture. If the social interactions in a class could be implemented into the mathematics presented, then perhaps females would report less mathematics anxiety than they do now.

Another explanation that has been suggested for the difference between females and males is that mathematics is perceived as a male domain. However, two studies have

provided evidence that this might not be true. Participants in Rounds and Hendel's (1980a) study did not see mathematics as a male domain, and the females in Llabre and Suarez's (1985) study thought of mathematics as less male oriented than did the males. The myth of mathematics as a male domain does exist, but its effect on the difference between the sexes when it comes to mathematics anxiety must be small.

A major reason for the difference in mathematics anxiety incidence between the sexes can be applied to all differences in incidence. It is the difference in prior mathematics experience. Greater amounts of prior mathematics experience helps a student to be less likely to develop mathematics anxiety.

> The more prior math preparation a student had, the less likely he or she was to report high levels of math anxiety. . . . There was a general tendency for higher levels of math anxiety to be associated with lower math achievement test scores. (Betz, 1978, p. 445)

Boys usually have more mathematics experiences, such as playing chess or handling mechanical instruments, early in life while girls are not encouraged to do these technical jobs (Tobias, 1980). For this reason, males are more prepared for the technical mathematics they encounter in

school and are therefore less likely to develop mathematics anxiety.

METHODS TO ALLEVIATE MATHEMATICS ANXIETY

Why do students need mathematics? Why place students with mathematics anxiety in classes where they will feel pain and fear? Do they really need mathematics? "It is estimated that at least 50 percent of the adult American population chooses to avoid, whenever possible, activities which require mathematics computations and/or thinking" (Hackworth, 1985, p. 3). "Many people manage to organize their lives so that they make virtually no use of mathematics. By relying on others for what needs to be done or by resorting to coping strategies. . . , they successfully evade the mathematics that confronts them" (Steen, 1990, p. 215). These people seem to be getting along just fine without mathematics. Why <u>is</u> mathematics needed?

Mathematics is needed for a broader range of career options. As mentioned above, many people avoid mathematics and do not have as many options available to them as possible (Betz, 1978). Mathematics has been called a "critical filter" because failure in it keeps one from careers and lifestyles associated with it (Siegel, Galassi, & Ware, 1985). One study has found that the

> fraction of new jobs needing mathematical skills that correspond to a full four-year high school curriculum

> will be 60 percent higher in the 1990s than in the 1970s, whereas the fraction of new jobs requiring the lowest levels of mathematics skills is projected to decline by 50 percent in the next fifteen to twenty years. Already, three-fourths of all majors available at colleges and universities now require some college-level mathematics. (Steen, 1990, p. 213)

Without mathematics, a student has a much smaller list of possible college majors and careers to choose from. For this reason, every person should try to learn as much mathematics as possible to expand their career options.

It has been hypothesized that low ability leads to low performance which leads to anxiety. Anxiety then leads to avoidance which leads to low achievement (Frary & Ling, 1983). This means that students with low ability will most likely have mathematics anxiety and low achievement in mathematics. One study found that mathematics ability accounted for 30.3 to 42.3 percent of performance (Dew et al., 1984). That leaves 57.7 to 69.7 percent of performance to be caused by other factors. Stevenson (1987) found that Americans think one is either born with mathematics ability or not. Asians, on the other hand, realize mathematical success through hard work, perseverance, and hours of study (cited in Skiba, 1990). Students with low abilities in mathematics need to be encouraged to

work hard in order to understand the concepts and improve their performance and decrease their chances of developing mathematics anxiety. Doing this also improves their career options and gives them a much larger list of college majors to choose from.

Researchers are divided into two different groups when it comes to the relationship between mathematics anxiety and performance. One group states that mathematics anxiety is not related or is moderately related to future performance (Dew et al., 1984; Fulkerson et al., 1984; Resnick et al., 1982) while the other group believes that mathematics anxiety depresses performance (Hembree, 1990; Patten, 1983). Hembree explained that mathematics anxiety depresses performance for two reasons. First, achievement usually accompanies low mathematics anxiety, and secondly, treatment can restore performance of former high-anxious students to levels of low-anxious students. It has also been noted that work to increase student competence failed to reduce anxiety, but performance was sometimes enhanced (Hembree). This may mean that mathematics anxiety is not curable, but its effects on student performance can be decreased.

Another relationship in question is the relationship between mathematics anxiety and test anxiety. Rounds and Hendel (1980a) found that math-anxious people are almost

as apprehensive about tests in general as about mathematics tests. Hembree (1990) also found a strong relationship between mathematics anxiety and test anxiety, while Dew et al. (1983, 1984) stated that the two are related but not identical. One way to treat test anxiety is to have the students with high test anxiety learn to relabel their anxious feelings as helpful and use them to increase and maintain task relevant responses rather than to reduce them (Sime et al., 1987). Improving a student's self-talk while taking tests also helps (Hendel & Davis, 1978). Relaxation training and study skills plus relaxation training were found to be the best techniques at reducing overall test anxiety (Bander, Russell, & Zamostny, 1982).

All teachers should "be aware of the possible negative effects that the process of testing may have on mathematics attitudes and anxiety" (Sherard, 1981, p. 109). One way to counteract these negative effects is not to rely on worksheets or on short answer tests but to find out how students think and why they make the mistakes they do (Steen, 1990). Not using only tests for grading and giving ample time for exams is another way to take away some of the negative feelings about tests as is giving partial credit for correct methods (Sherard). Sherard also suggested that giving credit for correct answers that are crossed out might also work well for the student who

is truly bothered by mathematics anxiety. Teachers can make the testing process much easier and less demanding for students if they only try.

As stated before, relaxation training is good to use for test anxiety. This treatment as well as other counseling techniques have also been tried with mathematics anxiety. However, relaxation training was found to have no relation to academic performance and not to be very effective (Hembree, 1990; Sime et al., 1987). In a study by Bander et al. (1982), study skills training and study skills plus cue-controlled relaxation training were best at helping students handle mathematics. A subsequent study showed relaxation training was better at reducing mathematics anxiety and improving mathematical performance in the long run. This, of course, contradicts Hembree's view that relaxation training does not help students with mathematics anxiety. Consequently, researchers are apparently still not sure what works best to reduce mathematics anxiety. Some other techniques that have been used as well as their results are listed below. Group discussion as well as classroom interventions were not effective (Hembree). Systematic desensitization has been found to be very effective as has cognitive modification (Hembree).

Many students feel they cannot do mathematics even if they try. This is simply untrue. "Nearly all (98 per-

cent) individuals possess the intellectual capability for understanding and handling mathematics concepts and skills" (Hackworth, 1985, p. 2). Hardly anyone is totally incapable of mathematical reasoning. Skiba (1990) stated that "despite their inability to achieve, they are often quite capable intellectually" (p. 188). Many times, they need only try. However, most people with mathematics anxiety avoid mathematics and never try to learn. If they do confront their fears, teachers need to be ready to encourage them and to offer assistance. The forms of help mentioned so far are used in counseling situations. "Teachers untrained in counseling techniques, however, need not feel helpless in dealing with the math-anxious student in the classroom" (Sherard, 1981, p. 106).

Petersen and Mays (1981) discovered that "high achievers give importance to items relating to, or reflecting, concern for learning subject matter" (p. 320). Most math-anxious students are not high achievers. "Low achievers. . . supported statements of teacher behavior that have negative connotations as well as relevance for student learning" (Peterson & Mays, 1981, p. 320). Students with mathematics anxiety feel that the teacher has a major effect on their performance in the class. For that reason alone, teacher assistance to these students is extremely important.

Tobias (1980) indicated that one of the best treatments is to teach students how to use formal thinking processes. This helps the student to study mathematics and other subjects and can be done by any teacher. Another technique that can be used by a teacher is to try to improve his or her students' self-confidence in their ability to do mathematics (Brassell et al., 1980; Sherard, 1981; Siegel et al., 1985). Some suggestions as to how to do this are to express confidence that all can do mathematics, to tell students to trust their intuition and first impressions (Sherard), and to make a list of things each student can do (Pedersen et al., 1985). Sherard also suggests that a teacher not ask the person who gave a correct answer to explain it. This gives others a chance to shine if they know the correct method and does not put the student with the correct answer on the spot. Positive reinforcement is also a way to improve students' self-confidence. Students need to feel that someone important thinks they are doing great and are capable doing good (Pedersen et al.). One way to do this is to create a problem/solution board for non-class material to be submitted. Any problem can be placed on this board where space is provided for other students to place possible solutions.

Llabre and Suarez (1985) believe that the "amount of interaction with math. . . predicts the level of mathematics anxiety of college students" (p. 283). If this is true, then students with mathematics anxiety should be exposed to as much mathematics as possible. Remediation presented in a low anxiety manner would provide a good source of interaction for these students (Dew et al., 1984; Rounds & Hendel, 1980a). Dew et al. (1984) go on to state that "interventions designed to do more than reduce anxiety will be needed in order to produce maximal increments in clients' math performance" (p. 582). These interventions might be anything from a teaching technique to a mathematics game. However, all should provide as much interaction with mathematics as possible for the students to receive the maximum benefit.

Teaching techniques are something that every teacher uses every day. Some specific techniques have been found to work especially well with math-anxious students. Direct instruction where the teacher interacts with the students is one such technique. This type of instruction with a discovery approach works best with groups having low to average mathematics anxiety (Clute, 1984). Students are led to discover mathematics concepts in this approach. Direct instruction coupled with an expository or lecture approach worked best for students with high

anxiety (Clute). A low confidence in mathematics could be the reason why high anxiety students needed more structure (Clute). "Berliner and Rosenthine (1987) have shown that `it is most effective to teach in a systematic manner, providing instructional support for the students at each stage of learning'" (cited in Skiba, 1990, p. 189). Some other suggestions on techniques to use with anxious students are to take time out when doing a difficult problem (Steinmann, 1984), to allow for various learning styles by using both visual and manipulative materials (Williams, 1988), to choose explanations that maximize understanding, and to organize lessons for easy transitions (Brush, 1981). Techniques like those cited above provide a break in the action for both teacher and students and show that the teacher is understanding of his or her students.

One area that has been given considerable attention in all academic subjects is the area of reading. Learning to read is an important way for all people to remain educated about what is happening in today's world. This education carries over to mathematics. "It appears that students who have developed good verbal skills may also have acquired the skills needed to read a mathematical problem carefully and see the relationship among information needed to solve it" (Gliner, 1987, p. 86). While the language and structure of mathematical texts are differ-

ent, it is essential for every student of mathematics to be able to read mathematics. Several authorities in the area of mathematics anxiety have stated that teachers need to teach students how to read mathematics (Sherard, 1981; Tobias, 1980). Reading mathematics requires a step-by-step process and an intensity to understand what is read. A teacher should stress careful reading and understanding of the words and symbols in mathematics problems especially (Gliner). Vocabulary should be taught and the meaning and use of symbols should be emphasized for students to learn the language of mathematics (Sherard). Tobias (1980) stated that teachers should not be afraid to give additional reading assignments for those who may want to read more about the mathematics they are learning.

Spatial visualization has been suggested to be one ability that students with mathematics anxiety are lacking. Tobias (1980) and Sherard (1981) both suggested that teachers should teach their students how to develop their spatial skills. Some practical ways to do this are to use models and manipulatives in the classroom such as an abacus or base blocks. In a geometry course, a game of charades with words would help students. In this game, students pick a geometric shape and then describe it without using their hands or paper and pencil. (Pedersen et al., 1985). This type of game forces students to

conceptualize what a shape actually is. The sight of it is internalized in their minds and this is what comprises spatial visualization.

Problem solving is another area that troubles all students, and math-anxious students are no different. "Most students who suffer from math anxiety have difficulty remembering or understanding the steps involved in problem solving and calculation problems" (Skiba, 1990, p. 189). Skiba found that having the students keep a private journal of the steps used for certain problems and of a list of terms and definitions helped her students to remember these important aspects. It provides the students with one source to use for all of their questions, and it is in their own language (Skiba). Teaching how to approach problem solving systematically (Tobias, 1980) and practicing these logical steps is another way to help students with problem solving (Hadfield & Maddux, 1988). Hadfield and Maddux also suggested that teachers use special sessions to practice extracting simple concepts from seemingly unrelated scenarios. Most problem solving experiences in a mathematics classroom involve the dreaded word problem. One way to overcome students' fears of these horrible problems is to do one or two word problems each day (Sherard, 1981). This will get them acquainted

with the problems and will provide practice with the methods used to solve them.

Word problems help students see how mathematics can be used in the everyday world. It helps to make mathematics relevant and provides another tool for teachers to use with math-anxious students. Teaching other mathematical concepts besides those in arithmetic also makes mathematics relevant. Geometry and statistics can be found in many newspapers, so these two areas would be wonderful to use to show students that mathematics is used in the real world (Steen, 1990). Of course, the mathematics class is not the only class that could do this. Mathematics teachers may want to talk to history teachers to see if they would highlight the mathematics that is mentioned during the news. Several different classes could help to reinforce the mathematics that is being taught (Steen), and the mathematics class could reinforce the other classes as well.

As was discussed earlier, it has been found that English classes gain in their popularity with age. A possible reason behind this is the fact that English classes increase their emphasis on ideas as the years pass (Brush, 1981). If this is so, then perhaps mathematics teachers should also stress ideas and the creativity that goes with them. "Including tasks and activities that

require student creativity seems a meaningful way to expand students' ideas about the nature of mathematical thought" (Brush, p. 39). Creativity is usually associated with divergent thinking. Those students, especially the math-anxious ones, who are divergent thinkers need to have the chance to think and brainstorm about the aspects of a mathematical problem (Tobias, 1980). They might find some ways that society would be influenced by the problem which could increase their interest as well as the interests of others in the class. Teachers should encourage creativity in problem solving by teaching estimation and intelligent guessing. Observing what students do to get a wrong answer and asking for student answers to student questions gives the students a chance to use their creative abilities (Sherard, 1981). It also will make for a much more interesting class for teacher and students alike.

Differences in the number of male and female incidences of mathematics anxiety have already been mentioned. To help decrease this phenomena, teachers need to "avoid sex role stereotyping of mathematics as a male domain" (Sherard, 1981, p. 106). Some practical suggestions on how to do this are not to have different expectations for males and females, not to interact differently with males and females, and not to use sex-stereotyped material. Sherard also suggested that teachers use role models of

both sexes in the classroom. These suggestions could be expanded to include any specific group. No one group should ever be singled out or treated differently. This kind of teaching helps to build stereotypes and create mathematics anxiety in students rather than avoiding it.

Students with mathematics anxiety usually see little or no use for mathematics in their lives. Teachers who want to mitigate these views can make career awareness a part of their class. Teachers can talk about different careers and then show how they depend on mathematics (Pedersen et al., 1985). Such dependencies may include mathematics requirements for programs in college (Sherard, 1981) or just the use of mathematics in a job. The least that could be done for students who feel that mathematics is not needed is to relate mathematics to students' everyday lives and encourage them to take more mathematics even if it is not required (Sherard). Teachers can and should be forceful on this issue.

If nothing else works in reaching a student with mathematics anxiety, alternative activities may. Brassell et al. (1980) found that enjoyable activities may reduce mathematics anxiety. Curricular interventions such as mathematics laboratories, individualized instruction, and mathematics games may assist in developing more positive attitudes about mathematics according to Rounds & Hendel

(1980a). Even if these activities do not transform students into instant mathematicians, they will be a change of pace in the classroom and will be fun. Using games will help students to build original thinking, intuition, and confidence (Shodahl & Diers, 1984; Williams, 1988). Concepts which are presented in a hands-on, visual way are usually remembered much longer than standard presentations. Consequently, manipulatives such as geoboards, attribute blocks, cutting out factors, and tangrams could be expected to help a math-anxious student remember a specific mathematical concept (Shodahl & Diers). Teachers should not be afraid to try new and exciting activities with their classes. Some may work and others may not, but this can only be determined by trying them.

Mathematics anxiety may make some student behavior difficult to deal with. Teachers should try to understand that most of the time the student with mathematics anxiety is not trying to be difficult to work with. Many times, teachers can help the situation if they put forth the effort needed. One way to help is to accept that the student may hate mathematics (Skiba, 1990). Some students are very afraid that the teacher will find out they dislike the subject that the teacher loves. Students need to feel that they are still accepted even if they do not like mathematics. Teachers need to "provide a relaxed, suppor-

tive classroom atmosphere" where the students feel like they are being treated as fellow human beings (Sherard, 1981, p. 110).

Another way for a teacher to show students that he or she cares is to "avoid insensitive behaviors in teaching procedures" (Sherard, 1981, p. 109). Teachers should never act condescendingly, humiliate students, or withhold help when it is needed. Using mathematics to punish a student only reinforces that mathematics is to be hated, so excessive assignments should not be given (Sherard). Teachers can also help students by making mistakes and by making the classroom atmosphere less critical (Williams, 1988). Extending invitations for questions and providing ample feedback are two more ways to reinforce that students are important (Brush, 1981).

There are several miscellaneous suggestions to help decrease students' chances for developing mathematics anxiety. One is to find out what the students can do and start there. Teachers need to build on previous successes and help students believe they will succeed (Skiba, 1990) as well as provide numerous opportunities for the students to succeed (Sherard, 1981). A teacher should not ignore calculators (Steen, 1990). Students will be able to use them in the outside world, so teachers should make sure they know how to use them correctly. One last suggestion

is to teach students how to flounder constructively (Tobias, 1980). This may seem strange, but for many students with mathematics anxiety, it may help. Students need to know that it is acceptable for them to try many different ways before finding a solution. In fact, it may become a necessity later in life.

GENERAL SUMMARY

Teachers do have a big responsibility to help their students who have mathematics anxiety. However, the task of helping these students does not lie with them alone. Society also plays a major role. Changing the schools is important but society must change before there can be any kind of lasting benefit (Steen, 1990). The sports and entertainment industries can be used to change the faulty attitude that mathematics is scary and useless (Steen). Working together, society and the schools have the possibility of completely changing and improving many people's lives.

A complete solution many never be found for mathematics anxiety, and those with mathematics anxiety may never be completely fearless of mathematics (Skiba, 1990). However, "an ability to cope and survive is achievable by almost anyone willing. . . to work on the problem" (Hackworth, 1985, p. 6). Students who want to can learn to manage their anxiety, and teachers can help them to do

this. Their anxiety may not disappear, but they can learn to deal with it (Shodahl & Diers, 1984). Those students who believe they are working hard and trying their best to cope will, hopefully, succeed in overcoming their fears.

REFERENCES

Bander, R. S., Russell, R. K., & Zamostny, K. P. (1982). A comparison of cue-controlled relaxation and study skills counseling in the treatment of mathematics anxiety. Journal of Educational Psychology, 74, 96-103.

Battista, M. T. (1986). The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by preservice elementary teachers. School Science and Mathematics, 86, 10-19.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, 25, 441-448.

Brassell, A., Petry, S., & Brooks, D. (1980). Ability grouping, mathematics achievement, and pupil attitudes toward mathematics. Journal for Research in Mathematics Education, 11, 22-28.

Brush, L. R. (1981). Some thoughts for teacher on mathematics anxiety. Arithmetic Teacher, 29(4), 37-39.

Bulmahn, B. J., & Young, D. M. (1982). On the transmission of mathematics anxiety. Arithmetic Teacher, 30(3), 55-56.

Clute, P. S. (1984). Mathematics anxiety, instructional method, and achievement in a survey course in college mathematics. Journal for Research in Mathematics Education, 15, 50-58.

Dew, K. M. H., Galassi, J. P., & Galassi, M. D. (1983). Mathematics anxiety: Some basic issues. Journal of Counseling Psychology, 30, 443-446.

Dew, K. M. H., Galassi, J. P., & Galassi, M. D. (1984). Math anxiety: Relation with situational test anxiety, performance, physiological arousal, and math avoidance behavior. Journal of Counseling Psychology, 31, 580-583.

Ferguson, R. D. (1986). Abstraction anxiety: A factor of mathematics anxiety. Journal for Research in Mathematics Education, 17, 145-150.

Frary, R. B., & Ling, J. L. (1983). A factor analytical study of mathematics anxiety. Educational and Psychological Measurement, 43, 985-992.

Fulkerson, K. P., Galassi, J. P., & Galassi, M. D. (1984). Relation between cognitions and performance in math anxious students: A failure of cognitive theory? Journal of Counseling Psychology, 31, 376-382.

Gliner, G. S. (1987). The relationship between mathematics anxiety and achievement variables. School Science and Mathematics, 87, 81-87.

Hackworth, R. D. (1985). Math anxiety reduction. Clearwater, FL: H & H.

Hadfield, O. D., & Maddux, C. D. (1988). Cognitive style and mathematics anxiety among high school students. Psychology in the Schools. 25, 75-83.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21, 33-46.

Hendel, D. D., & Davis, S. O. (1978). Effectiveness of an intervention strategy for reducing mathematics anxiety. Journal of Counseling Psychology, 25, 429-434.

Llabre, M. M., & Suarez, E. (1985). Predicting math anxiety and course performance in college women and men. Journal of Counseling Psychology, 32, 283-287.

Lorenz, J. H. (1982). On some psychological aspects of mathematics achievement assessment and classroom interaction. Educational Studies in Mathematics, 13, 1-19.

Patten, M. D. (1983). Relationships between self-esteem, anxiety, and achievement in young learning disabled students. Journal of Learning Disabilities, 16, 43-45.

Pedersen, K., Bleyer, D. R., & Elmore, P. B. (1985). Attitudes and career interests of junior high mathematics students: Implications for the classroom. Arithmetic Teacher, 32(7), 45-49.

Peterson, K., & Mays, B. (1981). Ideal teacher behavior perceptions of science students: Success, gender, course. School Science and Mathematics, 81, 315-321.

Plake, B. S., & Parker, C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. Educational and Psychological Measurement, 42, 551-557.

Resnick, H., Viehe, J., & Segal, S. (1982). Is math anxiety a local phenomenon? A study of prevalence and dimensionality. Journal of Counseling Psychology, 29, 39-47.

Rounds, J. B., & Hendel, D. D. (1980a). Mathematics anxiety and attitudes toward mathematics. Measurement and Evaluation in Guidance, 13(2), 83-88.

Rounds, J. B., & Hendel, D. D. (1980b). Measurement and dimensionality of math anxiety. Journal of Counseling Psychology, 27, 138-149.

Shaughnessy, J., Haladyna, T., & Shaughnessy, J. M. (1983). Relations of student, teacher, and learning environment variables to attitudes toward mathematics. School Science and Mathematics, 83, 21-37.

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

Shodahl, S. A., & Diers, C. (1984). Math anxiety in college students: Sources and solutions. Community College Review, 12(2), 32-36.

Siegel, R. G., Galassi, J. P., & Ware, W. B. (1985). A comparison of two models for predicting mathematics performance: Social learning verses math aptitude-anxiety. Journal of Counseling Psychology, 32, 531-538.

Sime, W. E., Ansorge, C. J., Olson, J., Parker, C., & Lukin, M. (1987). Coping with mathematics anxiety: Stress management and academic performance. Journal of College Student Personnel, 28, 431-437.

Skiba, A. E. (1990). Reviewing an old subject: Math anxiety. Mathematics Teacher, 83, 188-189.

Steen, L. A. (1990). Numeracy. Daedalus, 119, 211-231.

Steinmann, P. (1984, Spring). How do you teach mathematics anxiety? Delta Kappa Gamma Bulletin, pp. 19-23.

Suinn, R. M., & Edwards, R. (1982). The measurement of mathematics anxiety: The Mathematics Anxiety Rating Scale for Adolescents--MARS-A. Journal of Clinical Psychology, 38, 576-580.

Tobias, S. (1980). Math anxiety: What you can do about it. Today's Education, 69(3), 26-29.

Tobias, S. (1987). Succeed with math. New York: College Board Publications.

Williams, W. V. (1988). Answers to questions about math anxiety. School Science and Mathematics, 88, 95-103.