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Recognizing characteristics of mathematics anxiety: Origins, symptoms, and teaching methodologies

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Abstract

Mathematics competence ls becoming Increasingly important in a technological world. Decisions concerning how many and which courses to take after elementary school can be influenced by affective characteristics over a period of many years

Recognizing Characteristics of Mathematics Anxiety: Origins, Symptoms, and Teaching Methodologies

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The Problem

Introduction

Mathematics competence is becoming increasingly important in a technological world. Decisions concerning how many and which courses to take after elementary school can be influenced by affective characteristics over a period of many years (Reyes, 1984). This, in turn, can affect career choice and options (Burton, 1979; Fennema, 1980; Tobias & Weissbrod, 1980). A student's ability to perform mathematics is not strictly intellectual, but may be socially conditioned, resulting in what is sometimes referred to as mathematics anxiety. The mathematics teacher needs to recognize such conditions and lessen their effects on students (Burton, 1979; Pedersen, Bleyer, & Elmore, 1985).

Mathematics anxiety has been shown to begin during the elementary school years (Burton, 1979; Kogelman & Warren, 1978; Morris, 1981; Tobias, 1978). Teachers' attitudes, classroom activities, and sex role stereotyping in materials have been contributing factors (Chapline, 1981). Teachers need to become

aware of the problems faced by anxious students and focus on the causes, effects, and remedies (Reyes, 1984).

Statement of the Problem

Very little research on mathematics anxiety has focused on the middle school years. Most research has concentrated on high school and college students, although it has been shown that the characteristics defining mathematics anxiety develop primarily in grades 4 through 8 (Callahan, 1971; Kulm, 1980). Consequently, efforts aimed at developing positive mathematics attitudes during these grades may be more beneficial to students and prevent the need for later remediation efforts. Thus, the questions are: What can elementary and middle school teachers do to help students who have mathematics anxiety, and what can elementary and middle school teachers do to prevent mathematics anxiety from developing?

Procedures in Obtaining Research Literature

To obtain the related literature, the researcher made extensive use of both the Educational Resources Information Center (ERIC), Education Index, and the Microcomputer Information Services databases. This involved use of the Iowa Network for Obtaining

Resource Materials for Schools (INFORMS), undertaken through the facilities of Area Education Agency Seven, and ERIC and Education Index computer searches, undertaken through the facilities of the Hawkeye Institute of Technology Library. The printed counterparts of these computer databases are Current Index to Journals in Education (CIJE), Resources in Education (RIE), and Education Index. The materials were obtained at the Drake University Library, the Englebrecht Library at Wartburg College, the University of Northern Iowa Library, and the Area Education Agency Seven Media Center.

After obtaining many of the materials and reviewing the literature, a further search for related information was conducted from bibliographies of previous reports.

This information was then organized for further investigation into the following major areas related to the problem: Mathematics Anxiety: Definition, Characteristics, and Symptoms; Causes of Mathematics Anxiety and How It Is Reinforced: Causes and Accentuating Factors; Alleviating Mathematics Anxiety.

Review of Related Literature

Mathematics Anxiety: Definition, Characteristics, and Symptoms

Students' feelings about mathematics, the classroom environment, and about themselves as learners of mathematics are important affective characteristics (Carpenter, Corbitt, Kopner, Lindquist, & Reys, 1980; Reyes, 1984). These feelings can manifest themselves in what is often referred to as mathematics anxiety. There is a variety of definitions of mathematics anxiety. The most common is from Richardson and Suinn (1972):

> 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. (p. 551)

The discomfort of mathematics anxiety varies in intensity depending on the person. Most people feel comfortable with mathematics up to a certain point or on a certain topic. Then they have a "sudden death" experience after which they are sure they can calculate no more (Tobias, 1978). They feel they will never be competent in this area. Mathematics

anxiety may arise from feelings of helplessness in problem solving, lack of out-of-classroom opportunity to practice mathematics, role conflict, or unfortunate experiences with a particular teacher (Tobias, 1978; Tobias & Wiessbrod, 1980).

Mathematics anxiety is not necessarily related to general anxiety, nor is it related to general intelligence (Morris, 1981). It often affects persons, to some degree, who are highly successful in other areas. They are convinced that they cannot calculate correctly. It has been found that if a person has confidence in his or her own ability, within a specified area, then that person is more motivated to achieve (Fennema & Sherman, 1977). Reyes (1984) reported that mathematically confident students tend to learn more, feel better about themselves, and are more interested in pursuing mathematical ideas than students who lack confidence. Calculation requires confidence and concentration. Mathematics anxiety makes this impossible and can easily control an individual's approach to problem solving (Kogelman & Warren, 1978).

Causes of Mathematics Anxiety and How It Is Reinforced: Causes and Accentuating Factors

Mathematics anxiety does not arise from a single cause. Some common myths contribute to the condition (Kogelman & Warren, 1978; Tobias, 1978). Sometimes teachers inadvertently contribute to these myths. Students are given the impression that solutions to problems are quickly derived and that false starts are uncommon. Parents often expect their children to be nonmathematical (Tobias, 1978). Some have mathematics anxiety themselves and convey the fear to their children. Conversely, if mathematics was easy for the parents, they may not understand what their child is experiencing and often cause further anxiety.

Not only does mathematics anxiety inhibit students from achieving, it may cause them to avoid calculating. By avoiding math experiences, students seriously handicap themselves in their daily lives and limit career opportunities. This, in effect, will disenfranchise those who are mathematics avoiders from full participation in an increasingly technological society (Morris, 1981).

Although mathematics is traditionally one of the

most objective school subjects, it is recognized as the most stressful content area in the middle school years (Georgia State Department of Education, 1982). Therefore, in order to successfully teach the subject, teachers must deal with the affective attitudes of their students.

Among the most damaging values that students bring to the classroom, are those of parents and society as a whole (Brush, 1981). Mathematics has traditionally been associated with sex role stereotyping that can be damaging to both sexes. It is often seen as being within a male domain. Parents play a major role in developing or hindering progress in their children (Burton, 1979). They have been found to perceive mathematics as more appropriate for boys than for girls. They offer more encouragement to boys than to girls (Fennema & Sherman, 1977). They even tend to buy more mathematical games for their sons than their daughters. Not only do girls suffer from this role bias, but boys who are not naturally quantitatively inclined may feel pressured to perform well.

Parents may communicate expectations of success or failure in mathematics. Children usually accept

the attitudes of their parents. Such attitudes can be equally stressful whether the parent is talented in mathematics or uncomfortable with the subject (Steinmann, 1984). If they excelled in mathematics, they may push the child before he or she is ready or interested. Parental expectations seem to have a greater impact on the self-image of females toward mathematics than on males (Junghans, 1980). Parents who seem receptive to working with their children in reading are often reluctant to give the same amount of help in mathematics (Goldberg, 1986).

Teacher attitudes may exert an even greater influence than parents. This influence also extends to sex role standards, which include definitions of acceptable achievement in the various subject areas (Reyes, 1979). This was noted by Fennema (1980).

> Students' feelings about themselves as learners of mathematics, their perception of the usefulness of mathematics, and their willingness to continue the study of mathematics beyond minimum requirements are all directly influenced by teachers. (p. 169)

It has been found that teachers have different expectations of students based on the sex of those

students. Teachers, as members of society, come to class with expectations that closely reflect commonly held stereotypical views (Becker, 1981). They tend to treat students differently in ways consistent with their expectations. This differential treatment occurs most often in directions that benefit male students, both in their expectations in mathematics and in their future course choices (Becker, 1981; Fennema, 1980; Fennema & Sherman, 1977).

The middle school years are critical because sex role identification becomes more prominent at the same time crucial educational choices are made (Pedersen, Bleyer, & Elmore, 1985). During adolescence, when the gap in boys' and girls' mathematical performance becomes increasingly evident, they are establishing an appropriate sexual identity. There are indications that mathematics performance is linked to developing sexual identity. The motivation to learn is likely to be strongest in academic areas that represent culturally defined sex-appropriate activities (Fennema & Sherman, 1977). There is evidence that mathematics anxiety is increased with the perception that it is a male dominated field. This sociocultural phenomenon

usually appears during early adolescence (Sherard, 1981). For girls of middle school age who are under pressure to adopt "appropriate" sex roles, this perception can cause females to avoid mathematics. The fear of excelling in mathematics for some girls is just as paralyzing as the fear of being dumb. Those who do stay in elective mathematics classes often try to remain as invisible as possible (Tobias, 1980). Since many people perceive ability in mathematics as unfeminine, fear of success may interfere with the ability to learn mathematics (Tobias, 1978). As recently as 1975, a pen advertisement read "You might as well give her a gorgeous pen to keep her checkbook unbalanced... and make her feel prettier" (Burton, 1979, p.268). The corollary to this is that males are under pressure to perform well in mathematics.

According to Greenwood (1984), a principal cause of mathematics anxiety lies with the teaching methodologies used to convey basic mathematical skills at all levels. These skills are generally taught by a model including: explain, practice, and memorize. Because this teaching method emphasizes memorization and neglects understanding and

reasoning, it tends to perpetuate the common perception of mathematics as a subject appropriate only to those with a "math mind" (Kogelman & Warren, 1978). Mathematics is therefore regarded as incomprehensible to those who have difficulty memorizing. This particular myth seems to be peculiar to mathematics (Tobias, 1978).

Blackboard exercises, timed tests, frequent quizzes, teachers' concerns about students' cheating, and excessive competitiveness in the classroom have been shown to be sources of mathematics anxiety (Tobias, 1980). The pain and stress of these experiences translate themselves into a negative association with mathematics. These anxious individuals do not trust their intuition; rather, they worry about making mistakes. Students become convinced that there is only one right answer and only one right way to arrive at that answer (Morris, 1981). Mathematics is viewed as a rigid, authoritarian subject consisting of rules to be memorized and followed and formulas to be applied. The answer becomes more important than understanding.

Alleviating Mathematics Anxiety

Because negative experiences of mathematically anxious adults are frequently traced to the elementary school years (Burton, 1979; Kogelman & Warren, 1978; Tobias, 1978), it is essential that classroom procedures and routines be examined to determine what teachers can do to improve experiences and eliminate the fear felt by many students (Morris, 1981). A variety of intervention programs has been developed and implemented to reduce mathematics anxiety. However, most of these programs have been aimed at college students and adults (Reyes, 1984). Some studies have been done at the high school level. Very little research has been done at the elementary level. Waiting until high school or college to help students address their mathematics anxiety may be too late. These students have already made decisions about which and how many mathematics courses to take. Such students will have already screened themselves from participation and, therefore, eliminated many career options. The concept of the "mathematics filter" was found by Sells (1978) who investigated the prerequisites and course programs at the University of California at Berkely in 1974. She

found that without three-and-a-half years of high school mathematics, entering students would have three-fourths of the college majors closed to them even before they began their college study.

The teacher needs to operate the mathematics classroom "to fly in the face" (Brush, 1981, p.37) of society's sex-role stereotypes. This may be one of the few instances in which the teacher may defy broadly held values and still be serving students well. The teacher must absolutely avoid sex role stereotyping that will cause girls to avoid mathematics. This will lead to continually increasing mathematics anxiety, for the less that mathematics is studied, the higher the resulting level of anxiety (Sherard, 1981). Society cannot afford to lose the talents of one-half its citizens simply because of a misplaced perception.

Next, the teacher needs to reemphasize the everyday usefulness of mathematics and its application to career options. There is evidence that as students progress in mathematics and it becomes more abstract, they have difficulty perceiving its practical application and the level of anxiety rises (Brush, 1981). Again, it is important

to stress that mathematics is equally important in the careers of men and women, also the college bound and the non-college bound, since most technical trades require such skills (Burton, 1979). The modern teacher must assume that all students will be pursuing a full array of career options.

The teacher must express confidence daily in every child's ability to perform mathematics in order to help develop positive self-images. Teachers can help students learn to accept their own best efforts by providing a supportive atmosphere where fears and anxieties can be freely expressed. Students find support from others who understand or share their feelings (Barker, 1987). Developing a willingness to try is essential to overcoming apprehensions. Students often develop a set of defensive mechanisms to protect themselves from what they expect to be another defeat with mathematics (Morris, 1981). A climate in which taking risks is perceived as acceptable should be provided by the teacher.

The teacher should also emphasize that mathematics problems are not always solved quickly or correctly on the first attempt. One false start, or uncertainty in problem solving, does not equate with

incompetence. A teacher can reassure students that even mathematics teachers are often frustrated (Morris, 1981).

Children can be called upon to share the method in which a problem was solved, but need not be compelled to explain the steps used when arriving at an incorrect solution. The use of a "math-by-committee" system encourages students to collaborate. This method makes use of peer tutors and helps to eliminate the competitive emphasis of mathematics which in turn will relieve much of the stress related to learning mathematics (Tobias, 1980). Peer tutoring can also assist a student who has fallen behind or has been absent. The tutor will understand the concepts better by having to explain them. The learner gains from having an explanation in the words of another student. Peer tutoring can help both feel better about learning mathematics (Morris, 1981).

Tobias (1978) has shown that word problems may be at the heart of mathematics anxiety. Consequently, a teacher needs to concentrate attention on spatial skills, the language, and symbols of mathematics which are needed to solve

these problems. These skills will not come naturally to all children. Unfortunately, word problems are not often dissected to help students understand their parts and significance. Typically, these problems are presented at the end of the day or the end of a unit. They represent the core of that lesson, but may be assigned with little or no introduction or discussion. To students, these are sink or swim situations, and many of them sink.

Teachers need to help students work through at least one or two word problems every day. Each classroom teacher needs to provide an atmosphere in which students feel free to take chances in mathematical problem solving, to guess and risk being wrong, and to try ideas. They should accept the notion that they might not produce results. Instead of marking answers right or wrong, teachers can make comments indicating correct procedures or note good starts on problems even if the answer is wrong (Morris, 1981). A positive atmosphere can be accomplished by having students use brainstorming procedures that facilitate participation by all students. The importance of a supportive atmosphere was noted by the Georgia State Department of

Education (1982).

> Growth in mathematics for middle grade students, particularly in problem solving or thinking skills, will occur much more readily in a supportive atmosphere where students work together and not against one another. (p. 22)

Middle school students already have pressure that is self-induced.

Support and encouragement from a mathematics teacher may help students maximize career options (Burton, 1979). Teachers need to develop sex blindness (Fennema, 1980). Each person in class should be treated as an individual whose needs and abilities must be considered.

Summary and Conclusions

Mathematics anxiety has many causes and does not develop overnight. Consequently, such anxiety cannot be corrected easily. Feelings toward mathematics can be changed and the potential for achievement can be enhanced greatly if a concerted effort is made to alleviate the causes. Research has shown that there are many affective attitudes that contribute to mathematics anxiety. This condition does not appear to be intellectually based, but may be derived from

attitudes originating with parents, teachers, students themselves, and society as a whole. A parent's own success or failure in mathematics may be communicated to a child, as well as sex role prejudices that accord mathematics success to males more than females. Teachers may share these experiences and attitudes which reinforce the parents' influence on the child. As students enter the adolescent years, there is increasing pressure for them to adopt appropriate sex roles. For males, this may represent working harder to succeed in mathematics; for girls, it may mean acquiescing to the male's perceived "superiority."

The first step in preventing or treating mathematics anxiety lies in recognizing the contributing factors. Research has shown that the teacher who is aware of such anxiety can institute teaching methods to prevent or to repair the consequences. This may include establishing a classroom environment that runs counter to society's prevailing sex role expectations regarding mathematics. The teacher needs to show women as being successful in mathematics and emphasize its importance in many careers. A supportive classroom

atmosphere can reduce competition in mathematics instruction, allowing all children to participate. The supportive teacher concentrates on teaching mathematics understanding, rather than memorization. A variety of approaches to problem solving can be used and credit given for correct methods, even when there are not exactly perfect answers. This will encourage participation by students who experience anxiety.

Most research has focused on high school and college students. This has been useful in identifying the contributing factors of mathematics anxiety, but has done little to remediate or prevent the condition. One of the critical findings of this research has been the concept of the mathematics filter. This has revealed that students who avoid mathematics studies in high school will have eliminated themselves from fully three-fourths of college majors.

The paucity of research that has been done at the elementary level has shown that mathematics anxiety behavior typically manifests itself between grades 4 and 8. Prevention and treatment during these early years would eliminate or lessen the

dramatic lifelong effects that will impact such students.

Further research, particularly that targeting improved teaching methods should be encouraged at the elementary level. Mathematics anxiety has been found to be avoidable and treatable. Teachers can positively influence students' attitudes toward mathematics by recognizing symptoms, avoiding sex role stereotypes, and implementing suggested supportive teaching methodologies.

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