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Explaining Mathematics Anxiety in College Students: A Research Project

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Abstract

Mathematics anxiety is an important but poorly understood reality for many students and a carelessly addressed issue by many teachers. A review of recent research literature indicates that mathematics anxiety is highly negatively correlated with mathematics achievement. However, little research has been done to explain how mathematics anxiety is related to other important attitudes toward mathematics. Using Sandman's Mathematics Attitude Inventory (MAI), the responses of forty-five college students were studied to explore these relations. The results produced statistically significant findings. A linear multiple regression analysis appeared to indicate that mathematics anxiety could be explained as a function of a one's self-conception of mathematics and of one's value of mathematics in society. The combination of highly valuing mathematics and of seeing oneself as incapable of doing mathematics well leads to high mathematics anxiety. Educators need to address mathematics anxiety in their classrooms by teaching mathematics so that it makes sense to their students.

Mathematics educators need a more in-depth understanding of mathematics anxiety in order to better facilitate the teaching and learning of mathematics. An examination of recent research literature reveals the importance of mathematics anxiety on the mathematical mental health of students. It also highlights the need to develop a better conception through empirical research of the interrelationships among the factors that are at play.

Research Literature

Mathematics anxiety has been called mathophobia, an irrational and impeditive dread of mathematics (Lazarus, 1974). Once it occurs in full force, it is not easily abated. Furthermore, it is a highly communicable condition, especially

among the young. Reyes (1984) is quick to note that mathematics anxiety is not an illness or pathological state. It is a profound negative emotion and there is a strong correlation between it and scores in other affective issues like confidence in learning mathematics. A study is needed to discover how mathematics anxiety is related to other attitudes toward mathematics. Wigfield and Meece (1988) confirm that the anxiety that students report centers on negative affective reactions to mathematics. They call for training to reduce fear and dread of mathematics, which should be implemented during elementary school years, before anxiety about mathematics becomes strongly established.

Children, in general, are not math anxious before going to school. Most math anxiety has its roots in teachers and in the teaching of mathematics (Williams, 1988). Negative attitudes toward mathematics including anxiety can be transmitted to others. The principle cause of math anxiety lies in the teaching methodologies used to convey the basic mathematics skills (Greenwood, 1984). This traditional explain-practice-memorize-teaching paradigm isolates facts from reason. An instrumental and superficial approach to learning disposes students to a negative affect and a corresponding higher level of evaluation anxiety (Bessant, 1995). This is not to say that classes shouldn't be challenging. A modicum of anxiety can coexist with positive attitudes toward mathematics.

McCoy (1984) found that a combination of fewer manipulative experiences and stronger tactile/kinesthetic learning style preference is related to higher math anxiety ($r = .23$). She reported that matching instruction to learning style preference could reduce math anxiety. Teachers should provide more positive math experiences to head off the negative emotional impact of math anxiety. Students need to enjoy doing mathematics.

Most attitudes toward arithmetic are formed in primary grades. In a study of 663 students in grades 3 through 6, Swetman (1994) obtained a Spearman Rho coefficient of rank correlation of -.03 and -.07 between teacher anxiety and student attitude in the fifth and sixth grades, respectively. Ma (1999) found that the relationship between mathematics anxiety and mathematics achievement is significant ($r = -.27$) from Grade 4 on. Stopping the downward spiral of negative students' attitudes toward mathematics is a major concern of education in this decade.

Tobias (1994) believes that most people leave school as failures at math, or at least feeling like failures. She reports that the first thing people remember about failing at math is that it felt like sudden death. If left unaddressed this feeling can develop into paranoia associated with mathematics, a mild math anxiety, or a

full-blown mathophobia. As long as people believe themselves to be disabled in mathematics, they will do nothing to take control this matter and ensure the development of good mathematics mental health.

Hembree (1990) completed a meta-analysis of 151 studies related to mathematics anxiety. He, like others (Ma, 1999; Clute, 1984), found that mathematics anxiety is directly related to poor performance on mathematics achievement tests and related inversely to positive attitudes toward mathematics. He concluded that mathematics anxiety levels increase through junior high school, peak near Grades 9-10, and level off in upper high school and college. With respect to enjoyment of mathematics, he noted an inverse relation with $r = -.75$ and $-.47$ for Grades 5-12 and college, respectively.

Math anxiety has been shown to be unrelated to age and to be unrelated to grade point average (Senfeld, 1995). Furthermore, mathematics majors are not more anxious than non-mathematics majors (Ohlson & Mein, 1977). Positive and negative attitudes toward mathematics and how they relate need to be studied and the results used to improve students' success in math class and in everyday life.

Research Hypothesis

In general, if some activity is important to a person and that person cannot do it very well, then that individual becomes nervous and tense whenever that activity is discussed or confronted. This reality holds true in the realm of mathematics and leads to the following hypothesis, which guided this study. Knowledge of how students view the usefulness of mathematics and their competence in doing mathematics provides a richer understanding of the uneasiness some students feel in situations involving mathematics. In other words, it is hypothesized that a student's mathematics anxiety is a function of the value he or she places on knowing mathematics and of the self-conception of his or her ability to perform mathematically.

Method

This research was quantitative in nature using an established questionnaire with a convenient sample of students at a Midwestern liberal arts college. However, the results were carefully compared with those found by Sandman in the early and mid 1970's.

Subjects

Forty-five college students enrolled in the same course, which was taught by the same instructor in two consecutive terms in the spring of 2000, participated in this study. There were twenty-five students (10 male and 15 female) in the class in Term 3 and twenty students (7 male and 13 female) in the class in Term 4.

Instrument

Sandman (1974, 1979) developed the Mathematics Attitude Inventory (MAI) to measure the attitudes toward mathematics of secondary school students. It was designed to measure six different constructs of mathematics attitude, namely: (1) perception of the mathematics teacher (T), (2) anxiety toward mathematics (A), (3) value of mathematics in society (V), (4) self-concept in mathematics (S), (5) enjoyment of mathematics (E), and (6) motivation in mathematics (M). This instrument was developed around a four point Likert scale rating student opinions from strongly agree to strongly disagree on each item. The construct validity and reliability of MAI were determined by analyzing data taken from 5034 eighth and eleventh-grade mathematics students in California and Indiana in 1972 and 1976. Six distinct scales were developed around these six constructs. Sandman (1980) hoped that the study of attitudes toward mathematics would help to clarify their role in mathematics learning.

Schmid (1985) concludes that the MAI may be useful for interested researchers and for teachers with some knowledge of measurement techniques. It appears to have good content validity and is easy and economical to use. However, Resnick (1985) notes that that the test should be used only cautiously and for research purposes only since the reliability and validity data are scarce. He states that more information from a broader grade and geographic sample are needed to use the normative data in any meaningful way.

Procedure

The course teacher administered Sandman's Mathematics Attitude Inventory to the participating students early in each term. It took approximately 20 minutes for the students to respond to the 48 items in the questionnaire.

The students' responses were entered into an electronic spreadsheet and

analyzed using SPSS (1999). A bivariate correlation was found for each pair of Sandman's attitude constructs. A linear multiple regression on mathematics anxiety (A) was performed by entering the data for self-concept (S) first and then those for value (V) second. This procedure was followed since prior research with high school students (Marshall, 2000) had revealed that even though anxiety and enjoyment are highly negatively correlated (r = -.71), there are better predictors for each. It was found that one's anxiety toward mathematics couldn't best be predicted from a measure of his or her degree of enjoyment of mathematics. A measure of the student's perception of his or her own mathematical abilities (S) together with the student's perception of his or her math teacher (T) provided a better guide to the student's anxiety towards mathematics than any lack of enjoyment (E) in doing mathematics.

Value (V), instead of teacher perception (T), was entered second in this multiple regression analysis since in this sample of college students the correlations with mathematics anxiety (A) were r = -.65 and r = -.55, respectively. Thus, it was theorized that the combination of one's self-conception in mathematics (S) and one's value of mathematics (V) would provide a better explanation of mathematics anxiety (A) than enjoyment alone or a combination of self-concept and teacher perception.

Results

A multiple regression analysis was performed in order to determine the relationship between mathematics anxiety and a set of two other mathematics attitude variables that contained self-concept in mathematics and value of mathematics in society. Pearson product-moment correlation coefficients were computed and tested in order to determine the linear relationship between mathematics anxiety and each mathematics attitude variable.

The statistic that pertains to the relationship between mathematics anxiety and the set of mathematics attitude variables was significant, R^2 = .76, $F(2, 42)$ = 65.77, p = .00. Seventy-six percent of the variance of mathematics anxiety was accounted for by the linear combination of the two mathematics attitude variables. The β value that pertained to the relationship between mathematics anxiety and self-concept was negative and significant, β = -.67, $t(42)$ = -7.61, p(two-tailed test) = .00. The β value that pertained to the relationship between mathematics anxiety and value of mathematics was also negative and significant, β = -.31, $t(42)$ = -3.45, p(two-tailed test) = .00.

The r value that pertained to the linear relationship between mathematics anxiety and self-concept was negative and significant, r = -.83, p(one-tailed test) = .01 and the r value that pertained to value of mathematics was positive and significant, r = .51, p(one-tailed test) = .01.

Discussion

The correlations between the statistics for the six constructs measured in this study using the Mathematics Attitude Inventory compared favorably with those found by Sandman in 1970 and 1976 and those found by Marshall earlier this year. This added some credibility to the results of this study. The multiple regression analysis produced statistically significant findings. This shed some much needed light on the difficult to understand concept of mathematics anxiety.

Conclusions

The research hypothesis was strongly supported by the results of this study. A student's mathematics anxiety is a function of the value placed on knowing mathematics and of the self-perception of ability to perform mathematically. Although there is a strong negative relationship between the enjoyment of mathematics and mathematics anxiety, the latter is better explained by giving attention to other affective issues. How one views mathematics and how one conceives of his or her ability to deal with it are paramount. If a student feels that mathematics is important and that he or she cannot do mathematics well, then that student is prone to feel uneasy in situations that require mathematical thinking.

Implications

A person's attitudes toward mathematics are important. They can help or hinder in one's personal life and professional career. Since mathematics anxiety has such a strong negative impact on mathematics achievement, it needs to be understood better, explained more carefully, and addressed more often in our classrooms.

Since educators desire for students to value mathematics, the focus for addressing mathematics anxiety should be placed on the students' self-conceptions of mathematics. Students need to believe in themselves and their abilities to

understand and do mathematics. This can best be accomplished by building on students' prior knowledge and teaching mathematics as a sense-making activity. Mathematics should be taught so that it makes sense to students (Hiebert et al, 1997). When a student understands the mathematics, he thinks to himself, "I can do it." He feels less anxious and usually performs better on mathematical assessments.

Additional educational research that informs us on how to lower math anxiety and to develop more positive attitudes in an area that has had such a large negative impact on so many members of our society is gravely needed. Similar research should be done with a greater variety of subjects and research methods that incorporate a mixture of quantitative and qualitative techniques.

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