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ABSTRACT

Research has shown that elementary teachers are mathematics anxious, and that this anxiousness can be transmitted to their students. Therefore, many students are not afforded the opportunity to participate in a comfortable mathematics environment. Preservice elementary teachers (n=63) reported their pre- and posttest mathematics anxiety using the Mathematic Anxiety Rating Scale. They completed an experienced-based mathematics methods course in which their enrollment was required. Results from t-tests and ANOVAs revealed significantly lower mathematics anxiety levels for students of all ages (20-41 years old) with levels of high school mathematics ranging from algebra I to calculus. Teacher educators should be aware that an experience-based mathematics methods course not only prepares teachers to teach mathematics, but it prepares them to teach mathematics with less anxiety. (Contains 21 references.) (Author)

Lowering Preservice Teachers' Mathematics Anxiety Through An Experience-Based Mathematics Methods Course

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Abstract

Research has shown that elementary teachers are mathematics anxious, and that this anxiousness can be transmitted to their students. Therefore, many students are not afforded the opportunity to participate in a comfortable mathematics environment. Preservice elementary teachers (N=63) reported their pre- and posttest mathematics anxiety using the Mathematics Anxiety Rating Scale. They completed an experienced-based mathematics methods course in which their enrollment was required. Results from t-tests and ANOVAs revealed significantly lower mathematics anxiety levels for students of all ages (20-41 years old) with levels of high school mathematics ranging from algebra I to calculus. Teacher educators should be aware that an experience-based mathematics methods course not only prepares teachers to teach mathematics, but it prepares them to teach mathematics with less anxiety.

Lowering Preservice Teachers' Mathematics Anxiety Through An Experience-Based Mathematics Methods Course

A plethora of research has shown that elementary teachers are mathematics anxious (Lazarus, 1974; Wood, 1988), and that this anxiousness can be transmitted to their students (Bulmahn and Young, 1982; Kelly and Tomhave, 1985; Larson, 1983; Wood, 1988). "Elementary teachers are charged with an extremely important role, and that role is to engender an excitement for learning in all subject matter, including mathematics" (Mihalko, 1978, p. 36, in Wood, 1988). Every student must be afforded the opportunity to participate in a comfortable mathematics environment (National Council of Teachers of Mathematics, 1989).

Definition of Mathematics Anxiety

The term mathematics anxiety has been defined in several ways. Hunt (1985) and Tobias (1976) define mathematics anxiety as the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem. Richardson and Suinn (1972) believe that mathematics anxiety "involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 552).

For many people, doing calculations or solving problems generally produces little anxiety, but they become anxious when their mathematics work is being watched or evaluated by other people (Brush, 1981). Donady and Tobias (1977, p. 71) define mathematics anxiety as "a non-rational distaste for and avoidance of mathematics and mathematics-related subjects."

In this study, mathematics anxiety is defined as a lack of comfort that someone might experience when required to perform mathematically, both on tests and in everyday life.

Development of Mathematics Anxiety

Teachers' Influence

Literature (Greenwood, 1984; Lazarus, 1974) implies that mathematics learning is largely a function of mathematics teaching. It follows that mathematics anxiety may be, in part, a function of mathematics teaching. Elementary teachers' indifferent attitudes toward mathematics are subtly passed on to students, decreasing student performance (Larson, 1983). Trice and Ogden (1987) found that elementary teachers who were mathematics anxious scheduled less time for mathematics than those who were comfortable with mathematics. Mathematics anxious elementary teachers tend to use conventional explain-practice-memorize methods for teaching mathematics (Greenwood, 1984). These methods do not encourage investigation, problem solving, or group discussion as advocated in the Standards (NCTM, 1989 and 1991) because the teachers may feel uncomfortable being challenged by students' questions (Greenwood, 1984; Williams, 1988). If teachers fail to present mathematics as a high priority subject, many of their students may show the same indifference toward mathematics.

Many adults, when questioned why they dislike or feel uncomfortable with mathematics, can recall specific teachers and/or events from elementary school where, as students, they were ridiculed or disciplined for not doing mathematics "the teacher's way" (Frank, 1990). Negative mathematics-related events may cause students to become "helpless." This learned helplessness is a condition that results when a person experiences constant failure and reaches a point where she/he seems to have no control over the situation (Gentile and Monaco, 1986).

When a student learns to become helpless in mathematics, she/he may avoid future mathematics courses.

Society's Sexist Influence

Differential school experiences, based on students' gender, are common. Sexism in the school is subtle; it is conveyed by administrators, custodians, secretaries, counselors, teachers and peers (Meyer and Fennema, in Post; 1988). Teachers unconsciously treat girls differently than boys in mathematics class, often ignoring girls' comments and questions and giving special attention to boys' questions and contributions (Sadker and Sadker, 1985). Until recently, males were represented in more than two thirds of textbook pictures showing mathematics and/or science activities (Donady and Tobias, 1977; Shakeshaft, 1984).

Studies have shown that girls more than boys tend to be mathematics anxious, and girls tend to avoid high school and college mathematics courses (Benbow, 1989; Eccles and Jacobs, 1982). A combination of a sexist home environment, sexist teachers and counselors, and a sexist society in general may influence differential development of mathematics anxiousness in girls and boys.

In the past, the father traditionally has been the person who helps with mathematics homework and usually makes the decisions related to finances and taxes, subtly telling girls that society recognizes these as male responsibilities. Eccles and Jacobs (1982) found that many parents of girls thought that mathematics was more important for boys.

Both boys and girls are required to attend school through age sixteen, yet women are still a minority in college mathematics courses and professions requiring a strong mathematics background (Benbow, 1989). Those girls who do plan careers requiring advanced mathematics courses when in high school seem to abandon their plans before college (Becker, 1991). Perhaps society does not deem

mathematics-related careers proper for women (Meyer and Fennema, 1988; in Post).

Management of Mathematics Anxiety

Awareness

Elementary teachers can have a great influence on the prevention of mathematics anxiety in their students. The first step in overcoming mathematics anxiety is to make teachers aware of the extent and origin of their own anxiety. Larson (1983) recommended using discussion with pre-service elementary teachers in their mathematics methods course. Martinez (1987) used small informal groups where teachers shared negative mathematics experiences that were related to their elementary school years.

Gaining Information

When teachers are aware of their own mathematics anxiety, they can monitor their actions in the classroom to avoid creating the same anxiety in their students. Because some of the anxiety arises from feeling uncomfortable when teaching mathematics at the symbolic level only, all teachers should be taught concrete and pictorial strategies. Teachers may gain a fuller understanding of mathematics content, which in turn generates self-confidence when teaching mathematics.

At School

Elementary teachers can avoid promotion of mathematics anxiety by creating a non-threatening atmosphere during mathematics class. Given the proper training, elementary teachers can teach mathematics with manipulatives, allowing students to discover mathematics instead of dictating one way of doing mathematics (NCTM, 1991). Teachers can present real-life situations when using numbers so students will value the need to learn mathematics. "Teachers must become aware of their belief systems, curriculum materials, and overt behaviors

so they can consciously work to eliminate sex-related differences in mathematics" (Meyer and Fennema, 1988; in Post).

This study will investigate possible educational factors that can reduce pre-service elementary teachers' mathematics anxiety and/or improve their attitudes toward mathematics.

The purpose of this study was to investigate the effects of an experienced-based mathematics methods course on pre-service teachers' anxiety toward mathematics as measured by the Mathematics Anxiety Rating Scale (Suinn, 1979) (MARS). Three hypotheses were tested:

1. After completing the experience-based mathematics methods course, there will be a positive significant difference in pre-service K-8 teachers' mathematics anxiety level (as measured by MARS).

2. After completing the experience-based mathematics methods course, there will be no significant difference between older and younger subjects' mathematics anxiety levels.

3. After completing the experience-based mathematics methods course, there will be a positive relationship between anxiety levels and subjects having high levels of high school mathematics.

Method

Subjects

Subjects (N=63) for the study were elementary education students enrolled in a required mathematics methods course at a medium-sized, suburban, midwest university. All subjects were admitted to the university's elementary education program on the basis of high grade point average, high basic skills test scores, and written essays on their desire to be teachers. Fifty-six subjects were female and seven subjects were male. The subjects were middle- to upper-middle-income Caucasians whose ages ranged from 20 years to 41 years.

Procedure

At the beginning of the first class meeting, subjects were asked to voluntarily take part in a research project. Each subject was asked to complete the MARS. There was no time limit on the MARS, and everyone finished within twenty minutes.

The subjects were enrolled in one of three mathematics methods courses for pre-service elementary teachers. One instructor taught 23 students; a second instructor taught classes of 30 and 21. Each class met for 3 1/3 hours once a week for 15 weeks.

Both instructors used a variety of methods and techniques for teaching such as lectures, demonstrations, hands-on experiences, large and small group discussions, problem solving, mastery learning, individual papers, micro and peer teaching, interviews, and critiques. Topics included mathematics anxiety, women in mathematics, sexism in the classroom, use of technology in teaching mathematics, and teaching basic mathematics skills. Subjects not only learned how to teach elementary mathematics but gained further understanding of many basic mathematics concepts. Subjects were required to complete assignments and projects of their choice outside of class. They were required to take two tests and a comprehensive examination at the end of the semester. These three tests contained questions from the textbook, outside readings and class discussions.

Subjects were required to have a weekly, half-day field experience in an elementary classroom. Here they could implement the methods for teaching mathematics they were learning in class.

At the last class meeting, subjects again rated their anxiety levels using the MARS.

Instrumentation

The Mathematics Anxiety Rating Scale (Suinn, 1972) has been used in many studies of mathematics anxiety. The MARS (Suinn, 1972) is a 98 item, self-rating scale that may be administered individually or to groups. Each item on the scale represents a situation which may arouse anxiety within a subject. The subject is to decide on the degree of anxiety aroused, using the dimensions of "not at all" (1), "a little" (2), "a fair amount" (3), "much" (4), or "very much" (5) and mark the appropriate circle rating her/his degree of anxiety. In scoring the MARS, raw scores can range from 98 to 490; 98 represents extremely low mathematics anxiety, and 490 represents extreme mathematics anxiousness.

The MARS was developed by Richard M. Suinn in 1972. An internal consistency reliability coefficient was 0.97 (N = 397) for the MARS, showing that the average intercorrelation of the items in the test to be quite high. It confirms that the test is highly reliable and indicates that the test items are heavily dominated by a single, homogeneous factor, presumably mathematics anxiety. Item-total correlations for all items were also calculated, and it was found that over half the correlations were greater than 0.50 (Richardson and Suinn, 1973).

The test-retest reliability coefficient was 0.78 after two weeks, significant at $p<.001$. This is comparable to reliabilities of other scales frequently used in clinical practice (e.g., 0.80 for the Taylor Manifest Anxiety Scale, 0.78 for the Test Anxiety Scale, 0.68 for the Social Avoidance and Distress Scale, and 0.72 for the Fear Survey Schedule) (Suinn, et al., 1973).

Personal Information Data

An information sheet was used to collect the independent variables for the study: age and level of high school mathematics.

Level of high school mathematics was determined by the subject's highest level course completed in high school. General mathematics and/or prealgebra

was rated Level 1. Algebra I and/or business mathematics was rated Level 2. Geometry and/or solid geometry was rated Level 3. Algebra II was rated Level 3.5. Trigonometry was rated Level 4. Precalculus was rated Level 4.5. Calculus and/or analysis was rated Level 5.

Results

Tables 1 and 2 show the frequency and percent of subjects' ages and levels of high school mathematics. The ages of the subjects ranged from 21 to over 40 years, with a mean of 24.1 years and the median of 22 years.

Results of a one-tailed t-test ($t = -4.98$, $p = .0001$) provided evidence to accept Hypothesis 1: After completing the experience-based mathematics methods course, there will be a positive significant difference in pre-service K-8 teachers' mathematics anxiety level (as measured by MARS). Comparing the MARS pretest ($\bar{X} = 192.00$, s.d. = 45.08, $N = 63$) with the MARS posttest ($\bar{X} = 171.03$, s.d. = 45.30, $N = 63$) showed that subjects' mathematics anxiety levels were significantly lower.

Table 3 displays results of a one-way ANOVA which tested Hypothesis 2: After completing the experience- based mathematics methods course, there will be no significant difference between older and younger subjects' mathematics anxiety levels. This hypothesis was not rejected; there was not a significant difference between two age groups' (Group 1 < 26 years old, MARS $\bar{X} = 174.81$, s.d. = 47.37, $N = 43$; Group 2 > 25 years old, MARS $\bar{X} = 162.90$, s.d. = 40.43, $N = 20$) mathematics anxiety levels as measured by MARS.

A Pearson correlation ($r = -.01$, $p = .47$) gave reason to reject Hypothesis 3: After completing the experience-based mathematics methods course, there will be a positive relationship between anxiety levels and subjects having high levels of high school mathematics.

Discussion

Mathematics is necessary in everyone's life and important for almost any career. Children must be encouraged at an early age to appreciate the need for mathematics. They must not develop a fear of mathematics. Elementary teachers, largely responsible for a child's early mathematics training, must encourage all children, including females and minorities, to pursue mathematical studies (NCTM, 1989 and 1991).

This study investigated the effects of a mathematics methods course on the mathematics anxiety levels of K-8 preservice teachers as measured by the Mathematics Anxiety Rating Scale. During a 15-week period of a 3 1/3 hour class per week, subjects participated in, did projects with, and practiced in an elementary classroom, the mathematics concepts and teaching methods modeled by their professor.

At the end of 15 weeks many preservice teachers showed significantly lower mathematics anxiety levels as measured by the MARS. There was no significant difference when comparing subjects' age or level of high school mathematics to the lowering of anxiety levels; a course such as this is effective for preservice teachers of traditional and non-traditional ages with many different levels of high school mathematics.

The subjects for this study were homogeneous in that they were 90% female, 95% Caucasian, middle- to upper-middle income and highly motivated to do well in university coursework. This study may be generalized to other similar populations of pre-service K-8 teachers.

All preservice elementary teachers are required to take a mathematics methods course. However, the results of this study indicate that an experience-

based mathematics methods course can prepare teachers to teach mathematics with less anxiety.

Further questions for investigation are: Will an experience-based mathematics methods course lessen mathematics anxiety and improve attitudes toward mathematics if the class size is increased? Will an experience-based mathematics methods course lessen the mathematics anxiety and improve the attitudes toward mathematics of minority subjects and/or lower socio-economic subjects? Does the gender of the instructor affect the mathematics anxiety of the subject? Does the sex-role orientation of the subject affect mathematics anxiety?

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Table 1

Frequency and Percent of Subjects' Ages

Age	Frequency	Percent
20	5	8.06
21	14	22.58
22	16	25.81
23	3	4.84
24	3	4.84
25	2	3.23
28	4	6.45
29	1	1.61
30	2	3.23
32	2	3.23
33	2	3.23
34	1	1.61
36	2	3.23
37	2	3.23
39	2	3.23
41	1	1.61

Table 2

Frequency and Percent of Subjects' Years of High School Mathematics

Years	Frequency	Percent
5	18	28.57
4	35	55.55
3	4	6.35
2	4	6.35
1	2	3.17

Table 3

One-way ANOVA: MARS Score by Age Group

Source	S.S.	df	M.S.	F	Sig.
Among	1937.63	1	1937.63		
Within	125280.31	61	2053.78		
Total	127217.94	62		0.94	.3545