Running Head: MATH ANXIETY

Math Anxiety: Causes, Effects, and Preventative Measures

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Abstract

Math anxiety is a real problem facing students and teachers today. The mathematics teacher especially needs to understand the causes and effects of math anxiety as well as ways to help students overcome it. There are many symptoms of math anxiety including an unwillingness to attempt mathematics problems, a fear of taking advanced mathematics classes, and being unusually nervous when in mathematics class. Math anxiety hinders students' working memory (Perina, 2002). It occurs at different ages in different people for different reasons. The main cause of math anxiety is the teacher himself. It has been shown that students tend to internalize their instructor's interest in and enthusiasm for teaching math (Jackson and Leffingwell, 1999). If the teacher has a bad attitude about mathematics, his students most likely will as well. However, the teacher can take many steps to reduce math anxiety including reviewing basic mathematics skills, by making sure students understand the mathematical language, and by providing a support system for their students (Schwartz, 2000). The more a teacher understands math anxiety the more he will be able to prevent it and help students overcome it.

The present study further investigates the role that teachers play in their students' math anxiety. Two different classes with different teachers were assessed, using the Mathematics Attitude Inventory, which measures students' attitudes towards mathematics. A version of the test was also given to the teachers of the two classes, in order to assess their attitudes towards mathematics. The results were then compared, and it was found that teachers' attitudes towards mathematics do have an impact on their students' attitudes towards mathematics.

Math Anxiety: Causes, Effects, and Preventative Measures

The mathematics teacher at any level faces serious obstacles to teaching his students the mathematics they need. One of the biggest obstacles for the teacher is trying to teach students who experience math anxiety. Math anxiety has been defined as "an inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (Buckley & Ribordy, 1982, p. 1). Some students would even go so far to say that they panic about mathematics. Panic can be seen as a turbulence in the mind, a kind of mental frenzy. The mind may also freeze and the student may experience physical tension and rigidity. (Buxton, 1981). It has been estimated that two-thirds of adults loathe and fear mathematics (Furner & Duffy, 2002). These negative feelings toward mathematics greatly affect the student's ability to perform well, and his even desire to continue learning mathematics. This makes the mathematics teacher's job of teaching his students to succeed in and appreciate mathematics extremely difficult, if not impossible. Knowing some of the causes, effects, and preventative measures of math anxiety would be of great use to the secondary mathematics teacher.

The National Council of Teachers of Mathematics developed standards in 1989 for the curriculum and evaluation of mathematics at all grade levels. These standards express five general goals for all students: that they learn to value mathematics, that they "become confident in their ability to do [it,] . . . become mathematical problem-solvers[,] . . . learn to communicate mathematically[, and] learn to reason mathematically" (National Council of Teachers of Mathematics, 1989, p. 5). Math anxiety in students would specifically hinder the value they place on mathematics and their confidence that

they can do mathematics.

Some students do not like mathematics simply for the reason that they are scared of it and do not feel like they are able to understand the concepts. The same students who have this fear of mathematics do not try as hard to understand and finish their homework as students who do not have this fear. The students who have a fear of mathematics assume that if they do not understand the homework the first time, they will never understand it. They set themselves up for failure before they even attempt to succeed. Knowing this, teachers face many questions: At what age does math anxiety begin? What causes math anxiety? How can I, as the mathematics teacher, help the students overcome their math anxiety? How can I prevent students from ever experiencing math anxiety?

Symptoms

Before any of these questions can be answered the mathematics teacher has to know the symptoms of math anxiety. Math anxiety can be manifested in many different ways. A student may believe he or she is incapable of doing mathematics problems before attempting the problem or even before the teacher explains the problem. A student may have a bad attitude about mathematics. When he in mathematics class, he may be nervous and unable to sit still or focus on the lecture. Math anxious students may dread even going to mathematics class. There is a greater fear of answering a teacher's question incorrectly in mathematics class than other classes. They also tend to compare their grades to their peers' more and worry more about how their peers will react to them if they give a wrong answer in mathematics class. They fear taking more advanced mathematics classes (Hsiu-Zu, 2000). Students with math anxiety may also feel embarrassed, irritated, frustrated, and fearful (Buxton, 1981). Not all of these symptoms

are external, so the teacher should try to know his students as best he can so he can tell if any of the students have these negative feelings about mathematics. The teacher does this by being aware of the students' facial expressions and body language, among other indicators.

Students may experience math anxiety because they have never experienced success in their mathematics classes. This can be due to poor instruction. If the teacher does not teach well, the average student will most likely not do well in his class. Also, the student may have taken an insufficient number of mathematics classes, causing him to be unprepared for the class he is in. This could especially be a problem in schools where teachers are very strongly discouraged from failing their students. It is possible for students to be in a mathematics class that they should not be in because they did not pass the previous class. The textbooks could be unintelligible, and somewhere during their education they could have received misinformation about mathematics and about who should do well in mathematics (Furner & Duffy, 2002). This includes the false assumption that mathematical aptitude is innate and that only certain people will ever be able to succeed in mathematics (Perina, 2002). The teacher needs to battle these false assumptions as he sees that his students believe them.

Understanding the consequences of being anxious about mathematics helps the mathematics teacher see the urgency in helping his students overcome their anxiety. Math anxiety severely hinders students' working memory (Perina, 2002). A student with math anxiety has added difficulty working a problem such as long-division that requires one to continually keep track of the different calculations being performed. This happens because he is unable to focus solely on performing the calculations, and also has to deal

with negative thoughts and feelings toward mathematics. If a student has math anxiety, it is also more likely that he has test and social anxiety as well (Perina, 2002). Again, students who are anxious about mathematics are less likely to continue working on problems if they fail to understand it the first time.

Math anxiety begins at different ages for different people. Some students may experience it as early as third or fourth grade (Jackson & Leffingwell, 1999). The way students handle the difficult material they learn can either hasten or prevent math anxiety. This has a lot to do with how they go about trying to understand the problem. Do they review the textbook or their notes from class, or do they just give up the instant they do not know what to do? The crux of math anxiety is thought to occur in middle school when students experience increasing social pressures (Perina, 2002). Students desire to be accepted by their peers. They could see their ability in mathematics as having an effect on their social status. The freshmen year of college can also be an instigator of math anxiety, especially for those students who did not take four full years of mathematics in high school or for the students who took time off from school before attending college. These students can be especially nervous about mathematics because they have not taken a mathematics class for so long that they feel like they have forgotten what they had previously learned.

Causes

Math anxiety is caused by poor test grades, inability (or unwillingness) to complete difficult assignments, negative predispositions of parents, and even the mathematics teacher. Teachers and parents that are afraid of mathematics pass that on to their students and children (Furner & Duffy, 2002). It could be very difficult for students

to like mathematics when their parents did not do well in mathematics themselves, and thus do not understand it or do not think it is important. Students could see their parents as having a job and doing well without a great love for mathematics and think that they will be successful without an appreciation of mathematics as well. If the teacher does not value mathematics, his students certainly cannot be expected to value mathematics either.

There are many things the mathematics teacher can do that will provoke his students to dislike mathematics. The teacher may be perceived as not caring about students because he is unwilling to give extra help to students who need it. The students need to know that their teacher is able and willing to help them. The teacher may become angry or frustrated when his class does not understand the problems. The teacher may also have unrealistic expectations of his students. Covering the textbook problem by problem can turn students off from learning mathematics. Also, giving written work every day, insisting there is only one correct way to complete a problem, and assigning mathematics problems as punishment for misbehavior can cause students to dislike mathematics (Furner & Duffy, 2002). No one enjoys discipline. Making students do mathematics as a form of discipline could very likely cause students to dislike mathematics.

Another major source of math anxiety is the teaching approach of "explain-practice-memorize" (Steele & Alfred, 1998, p. 18). The mathematics teacher needs to be creative in his teaching methods, so students do not lose interest. This idea is supported by a study conducted by Pyne, Bates, and Turner (1995). They taught elementary mathematics to college students who did not reach the minimum requirements to be enrolled in a course they needed. The researchers determined that these students would be

prone to having negative feelings of mathematics. In order to combat these feelings, they decided to concentrate on using different teaching styles, methods of assessment, and support sessions. They encouraged an investigative approach to mathematics. They wanted their students to be doing mathematics instead of listening to or watching the teachers do it. The teachers prompted the students to make their own decisions about what mathematics they needed. They encouraged thinking mathematically, and they used a variety of visual aids. Instead of the usual paper and pencil test, they used continuous assessment. The students were relieved when told that there would be no written exams. The class had a total of twelve teachers for only eleven students, so there were plenty of people to assist the students when they were having trouble understanding. This was especially useful when the students were performing open ended tasks. Overall, the students enjoyed the relaxed environment. They left the class feeling more confident about their own mathematical ability and their use of mathematics. This example demonstrates the effects that differing teaching styles can have on students' attitudes towards mathematics.

One factor that showed up consistently in a study of math anxiety in different grade levels was gender bias. Many teachers promote the false idea that females cannot perform as well as males in mathematics (Jackson & Leffingwell, 1999). They do not believe that girls are as capable of succeeding in mathematics as boys. Teachers who promote this idea cause girls to give up without even trying. Sometimes teachers are more willing to help males than females, and sometimes teachers even tell students that girls do not need to learn mathematics. The mathematics teacher needs to give equal opportunity to both males and females to succeed in his mathematics classes. The teacher

should encourage, instead of discourage, females to take mathematics courses.

Also, certain circumstances tend to bring out math anxiety; knowing these circumstances allows the teacher to try to reduce them. The first circumstance that brings about this negative feeling is the presence of an authority figure (Buxton, 1981). The teacher is seen as making judgments about right and wrong; this places a lot of pressure on the student. Although it is not plausible for the teacher to leave their students alone during mathematics class, the teacher can find ways to make their presence less threatening. Many students also have a misconception that they should be able to do mathematics quickly; this emphasis on speed causes nervousness as well. This view of mathematics could stem from so called speed drills that occur frequently in elementary schools. Teachers should emphasize the reasons behind speed drills and differentiate their purpose from the purpose of homework and test questions. Students need to be shown that mathematics requires concentrated and uninterrupted attention and many times mathematics takes a good amount of time to do correctly.

Another way time affects the student is when a student knows he will be having a test or be given homework in the future. This delay causes fear to set in. There is a gradual approach of an undesirable event which one knows he cannot avoid, so he starts to panic. As soon as a mathematics test is mentioned, students start to dread it. This prolonged dread breeds fear and nervousness. The student combines the fear of not succeeding on the test, the uncertainty of being able to do the problems, and the urgency to get it done on time -- all of which cause anxiety. The fact that the classroom is a public place also has an effect on math anxiety. People do not like to admit their fears or supposed inadequacies to other people, so they dread going to class where they may be

asked to do a problem on the board in front of other students (Buxton, 1981).

Sometimes the teacher can discourage students from doing well in mathematics and cause math anxiety without realizing it. The teacher needs to be aware of the effect his words have on his students and think before speaking. It can be frustrating for the teacher when he feels like he has gone over a certain concept many times but the students are not understanding or grasping the concept. The teacher needs to maintain a positive attitude and encourage the students that they can do it. The teacher should never comment on how stupid or slow the students are. He should not get frustrated when students ask questions. Questions are a sign of the desire to learn. Again, the teacher needs to be aware of his words, sighs, and overall body language (Jackson & Leffingwell, 1999).

Teacher's Role in Reducing Math Anxiety

The teacher can help his students overcome math anxiety. The mathematics teacher needs to be excited about teaching mathematics and he must believe that there is a reason for his students to learn the mathematics. If the teacher is not motivated to teach the subject, then one cannot expect his students to be motivated to learn it. It has been shown that students tend to internalize their instructor's interest in and enthusiasm for teaching mathematics (Jackson & Leffingwell, 1999). If the teacher is not happy about teaching mathematics or does not enjoy being with students in the classroom, then students are less likely to be motivated to learn the material.

The teacher needs to be able to put himself in his students' shoes and remember what it was like to struggle with understanding new concepts (Schwartz, 2000). He needs to understand that it takes time for students to master concepts. Therefore, the teacher

must have patience. He also should never give up trying to help his students succeed. He needs to give specific examples and applications of mathematics.

The teacher should review basic mathematics skills with his students. Students need to be able to do the basics before they can move on to more complicated problems. Learning mathematics is a building block process. Each step builds on another one. It is imperative when teaching mathematics that the teacher progresses from simple problems to complex ones (Schwartz, 2000). Mathematics is a language all its own. It is full of definitions, vocabulary, symbols and notations that students must know in order to succeed in mathematics. Therefore, the teacher needs to make sure that his students can read and speak the language.

The students also need to have support systems in mathematics, whether this comes from their parents at home or with other students at school (Schwartz, 2000). They need to have people they can go to when they are having difficulty who will help them look at the problem through a different view point and encourage them not to give up on the problem. Cooperative learning is one way students can get this support. Sometimes other students can explain concepts in a manner that their peers will understand and be able to relate to, especially if there is a student who had trouble understanding it. In this case, the teacher needs to be sure that the students are explaining the concepts correctly.

The teacher should also try to reduce test anxiety by helping students develop their test-taking skills. Along with this, the teacher needs to be aware of some of the warning signs that panic about mathematics is about to set in. Many times when students are given a test, noticeable physical manifestations of math anxiety can be seen. Examples of this would be slightly glazed eyes, rigidity of posture, and just an overall

look of nervousness (Buxton, 1981). The teacher should try to make the testing situation as unthreatening as possible.

Other ideas the teacher can use to help reduce math anxiety, and even stop it before it starts, is to incorporate writing in the mathematics curriculum (Furner & Duffy, 2002). This can be accomplished through having the students keep a journal where they can talk about their frustrations and successes with mathematics. Instead of actually doing a mathematics problem, students could explain in words how to do it. This also tests the students' ability to translate the mathematical symbols into words.

Another idea is to utilize alternate forms of assessment (Furner & Duffy, 2002). The teacher should teach students to read and study mathematics like they would in any other subject. Doing mathematics in groups can also be a successful way of reducing math anxiety. Having students make up their own questions and problems can teach them a lot as well and help them see how much they really know (Prescott, 2001). The teacher should teach his students how to use constructive self-talk so the students can encourage themselves that they can succeed in mathematics and learn not to allow themselves to say that they cannot do it (Tobias, 1978). There should also be mutual respect between the teachers and students (Jackson & Leffingwell, 1999).

The mathematics teacher also needs to encourage his students to think critically, share their thinking process, and justify their answers out loud or in writing (Furner & Duffy, 2002). It is important that teachers emphasize the process, not right or wrong answers. Although correct answers are important, getting the students to think critically is even more important (Schwartz, 2000). Students of mathematics also need to realize that it is more than just computations (Prescott, 2001). Flexibility in mathematics classes can

help facilitate cooperation, reduce stress, and create positive attitudes (Steele & Alfred, 1998).

The teacher should be careful when asking for correct answers. He should avoid singling out anyone by asking for volunteers (Steele & Alfred, 1998). He also should not call on students to work at the blackboard if they are uncomfortable doing so. Instead of pointing out what students are doing wrong, the teacher can encourage students to keep working on a problem by pointing out to them what is positive about their attempts. The teacher should discuss the difference in taking time out and giving up. Instead of saying, "This is a better way to do it" the teacher could say "This is just another way to do it." The teacher should put himself in the students' position and try to hear what the students would hear.

The mathematics teacher needs to exercise authority in control and management of the class, but he should not restrict thinking. In order for the students to retain information, it has to be made their own. The teacher should control behavior, but not thought (Buxton, 1981). One way to help students have more confidence in mathematics is to post a Math Anxiety Bill of Rights in the classroom. This would have statements such as "I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else," "I have the right to ask whatever questions I have," "I have the right to feel good about myself regardless of my abilities in math," and even "I have the right to dislike math" (Tobias, 1978, p. 236).

In regards to testing, the teacher should try to give as much time as possible to complete the test. He should also provide study guides so the students will know what type of questions to expect. Assessment should be informal at times. The teacher can

listen to students' responses in oral discussions or during cooperative learning activities (Steele & Alfred, 1998).

The greatest prevention of math anxiety is the teacher himself. As stated before, the teacher needs to have a positive attitude when in class and needs to be willing to help students. The teacher must believe in the students even when they do not believe in themselves. Students must overcome their fear of mathematics and be challenged to take higher level mathematics courses. If students become math avoiders, they limit future studies in the area of mathematics and are cut off from many occupations in society (Steele & Alfred, 1998).

Conclusion

Math anxiety is a real problem facing students, teachers, and parents. Students who have math anxiety face real and long-lasting consequences. Thankfully, there are real methods that teachers and parents can use to help students overcome their math anxiety. There are also ways of helping students realize their own math anxiety and work toward overcoming it. A better understanding of math anxiety is needed in order to help students overcome this problem. The more research is done, the more students, teachers, and parents will be able to work together to overcome this problem. As methods are found that help prevent and reduce math anxiety, the ideas and information should be shared so others can benefit from it as well. Mathematics is an extremely important subject and it is vital that students succeed in it.

Case Study

In the present study, the researcher attempted to identify the extent to which a mathematics teacher's attitude about mathematics affects his students' attitudes. This was

done by administering the Minnesota Mathematics Attitude Inventory (MAI) to two seventh grade mathematics classes, each with a different teacher. See Appendix A for the instrument. The teachers were given a version of the inventory that suited them better. This inventory was given to different classes with different teachers to see how the different teachers' attitudes related to their students. Seventh graders were chosen for this study because some researchers have found that students attitudes are more likely to be affected by their teacher's attitudes of mathematics the younger they are. In other words, the older the students are, the less effect their teachers' attitudes have on them. The MAI was designed specifically for students in grades seven through twelve. Seventh grade was chosen because it is more likely that seventh graders' attitudes about mathematics will be affected by their teachers than twelfth graders.

Assuming that the teachers would have different attitudes towards mathematics, the researcher expected the students of each class to have different attitudes as well, depending on which teacher they had. For example, if the teacher did not enjoy mathematics, the researcher did not expect the students to enjoy it either. If the teacher did not think that mathematics was important, the researcher did not expect the students to think it was important either. The researcher also expected the students' level of anxiety towards mathematics to vary depending on which teacher they had.

These results were expected because of previous studies done. Many researchers have found that teachers' attitudes play a very large role in the students' attitudes. The MAI tests measured the students' perceptions of their teacher, among other items. It was expected that the higher the students' perception of their teacher, the lower their math anxiety would be.

Method

Participants

Two seventh grade mathematics teachers at a middle school in Lynchburg, Virginia volunteered their classes to participate in the survey. Both classes were intermediate level. In class A, twenty-one students took the survey. Of the twenty-one, ten were females. Fifteen of the twenty-one were of African American descent and five were Caucasian. The teacher of Class A indicated that she had either a Master's or Bachelor's degree in mathematics and had been teaching mathematics for 31 years.

Class B consisted of nineteen total students, eight of whom were girls. Of the nineteen students, sixteen were African American and two were Caucasian. The teacher of Class B indicated that she did not have either a Master's or Bachelor's degree in mathematics. It is not known whether she earned a degree in a different area of study and what that may have been. She had been teaching mathematics for seven years. Item 20 on the teachers' survey dealt with the degrees they earned while in college. Regrettably, it was worded poorly so that it was not possible to tell whether the teachers minored in mathematics or had degrees in areas other than mathematics.

Materials

The students in each class were given the MAI. This assessment was chosen because it was designed specifically to measure the attitudes toward mathematics of secondary school students—students in grades seven through twelve.

The MAI was designed to measure six different areas of mathematics attitude. These include the perception of the mathematics teacher, anxiety toward mathematics, value of mathematics in society, self-concept in mathematics, enjoyment of mathematics,

and motivation in mathematics. The inventory consists of 48 questions to measure these areas. The questions were answered using a Likert type scale (1 = Strongly Agree to 4 = Strongly disagree).

The teachers of each class were given a shortened version of the MAI that the researcher prepared (See Appendix B). The researcher chose questions that measured the teacher's anxiety toward mathematics, the value of mathematics in society, enjoyment of mathematics, and motivation in mathematics. Four questions written by the researcher were then added to measure the teachers' contentment in teaching mathematics, the number of years they have taught mathematics, and their college background in mathematics.

Procedure

Testing for both classes occurred on the same day, although at different class times. The MAI was administered in the classroom where the students met for their mathematics class. The testing began at the beginning of the class period. The students and teachers were not given a time limit. They were instructed to be truthful on the inventory and read each question carefully. The students were told that how they answered would not have any effect on their grade in the class. After the researcher gave the instructions in Class A, the teacher reiterated everything that was said and emphasized the importance of taking the inventory seriously. In Class A, the teacher of the class walked around the room while the students were taking the inventory. Some of the students had questions about the meaning of particular questions, so the researcher explained to them the items they were having difficulty with. Teacher B did not move around the classroom while the students were taking the assessment. Since the researcher

gave the assessment to Class B after giving the assessment to Class A, she explained the meaning of the questions that Class A had difficulty understanding before the students began the assessment.

Scoring

To score the student's attitudes about mathematics in the aforementioned six areas, the researcher followed the directions in the MAI User's Manual. With each of the 48 statements on the survey, the participant answered using a Likert type scale (1 = Strongly Agree to 4 = Strongly Disagree). Of the 48 items on the inventory, only 38 were used to determine the various attitudes. Following are the equations used to determine the attitudes in the different areas. The "A" in front of a number represents the numerical value of the answer to that particular question, which would be 1 – 5.

Perception of the Mathematics Teacher:

$T = 25 + A5 - A17 - A21 - A27 + A31 - A40 - A44 + A46$

Anxiety toward Mathematics:

$A = 30 - A20 - A34 - A36 - A37 - A39 - A48$

Value of Mathematics in Society:

$V = 25 - A1 + A9 - A12 - A15 - A23 - A24 + A33$

Self-Concept in Mathematics:

$S = 20 + A4 - A10 - A16 + A19 - A30 - A35$

Enjoyment of Mathematics:

$E = 20 - A2 - A6 + A11 + A13 + A26 - A43 - A47$

Motivation in Mathematics:

$M = 20 - A8 - A14 - A28 - A32$

The researcher first determined each individual student's score in these six areas, then separated the students by class and found the mean, median, mode, range, minimum, and maximum values for the class in each area. In Class A, there was one student who did not answer any of the questions on the second page of the inventory, so his scores were not counted. There were a few students who did not answer a couple of the questions on their inventory or answered one question with more than one answer. To score those questions, the MAI User Manual's substitute responses for unanswered items were used.

To score the teachers' responses, the researcher used the same formulas given in the MAI for the students' responses. The formulas differed in the fact that not all the questions that were used to determine the students' scores were on the inventory for the teachers. Therefore, the actual score for the teachers is not fully comparable to those of the students. For example, to score a students' enjoyment of mathematics, seven of the items were used. One of those items was not applicable to the teachers, so only six items were used in the formula. Also, only two items were used to determine the teachers' motivation in mathematics, including one question that was written by the researcher. The two teachers' inventories were scored the same way. The teachers' scores can only be compared to each other, not to the students'. Following are the equations used to determine the teachers' scores. Again, the "A" followed by a number refers to the numerical value of the answer for that question, this time on the inventory for the teachers.

Anxiety Toward Mathematics:

$A = 30 - A10 - A16 - A17$

Value of Mathematics in Society:

$V = 25 - A1 + A5 - A7 - A9 - A11 - A12 + A15$

Enjoyment of Mathematics:

$E = 20 - A2 - A3 + A6 + A8 + A13$

Motivation in Mathematics:

$M = 20 - A4 - A18$

Results

The first important result of the study was the differences between the teachers of Class A and Class B. When asked if she was content teaching mathematics, Teacher A chose "Strongly Agree" whereas Teacher B chose "Disagree." Also, Teacher A had either a Bachelor's or Master's degree in mathematics, whereas Teacher B did not. Teacher A had been teaching mathematics for 31 years, whereas Teacher B had only been teaching for seven.

The following tables represent the results of the study. The higher the score, the higher the student measured in the particular area. For example, a high score in "Anxiety Towards Math" means that the student has a high level of math anxiety. Table 1 shows the highest and lowest scores possible for each of the six assessed areas.

Table 1

Highest and lowest scores possible for each of the 6 areas tested by the MAI

	Perception of Math Teacher	Anxiety Towards Math	Value of Math in Society	Self-Concept in Math	Enjoyment of Math	Motivation in Math
Highest possible score	32	24	28	24	28	16
Lowest possible score	8	6	7	6	7	4

Tables 2 and 3 represent the individual scores for each student in Class A and Class B respectively.

Table 2

Results for individual students in Class A in the 6 areas tested by the MAI

Student	Perception of Math Teacher	Anxiety Towards Math	Value of Math in Society	Self-Concept in Math	Enjoyment of Math	Motivation in Math
1	25	13	23	20	23	9
2	24	13	19	18	13	7
3	31	10	26	22	27	12
4	27	7	22	24	24	13
5	31	12	22	19	23	7
6	32	7	23	22	27	10
7	31	9	26	14	22	5
8	23	14	18	15	11	7
9[1]						
10	32	8	23	17	21	9
11	31	6	27	24	28	10
12	28	10	22	20	23	8
13	31	7	25	19	25	9
14	30	16	16	22	17	4
15	29	8	28	16	24	10
16	29	10	25	22	16	8
17	30	14	24	21	26	9
18	26	13	19	17	18	9
19	30	10	16	15	21	10
20	30	11	24	22	23	11
21	26	14	21	18	15	6

1 This student left half of the questions unanswered, so his answers were ignored.

Table 3

Results for individual students in Class B in the 6 areas tested by the MAI

Student	Perception of Math Teacher	Anxiety Towards Math	Value of Math in Society	Self-Concept in Math	Enjoyment of Math	Motivation in Math
1	29	6	25	18	21	12
2	28	12	22	15	17	10
3	27	14	25	16	16	6
4	22	9	28	18	22	8
5	29	13	23	18	18	8
6	26	11	23	19	19	9
7	24	13	21	15	15	9
8	27	17	18	17	12	4
9	27	13	24	21	20	7
10	27	15	23	14	16	9
11	28	10	22	19	23	11
12	21	12	20	23	20	10
13	30	10	24	18	18	9
14	23	8	20	23	23	11
15	22	13	19	18	20	10
16	21	19	18	16	16	10
17	26	12	23	18	21	9
18	30	7	22	20	24	8
19	28	9	22	21	25	10

Tables 4 and 5 compare the results of Class A and Class B for the students' perception of the mathematics teacher and their self-concept in mathematics, respectively.

Table 4

Perception of Math Teacher		
	Class A	Class B
Mean	28.8	26.05263
Median	30	27
Mode	31	27
Range	9	9
Minimum	23	21
Maximum	32	30

Table 5

Self-Concept in Mathematics		
	Class A	Class B
Mean	19.35	18.26316
Median	19.5	18
Mode	22	18
Range	10	9
Minimum	14	14
Maximum	24	23

Table 6 compares the teachers' anxiety towards mathematics with their students' anxiety towards mathematics. The highest score possible for the teachers was 27 and the lowest score possible for the teachers was 18.

Table 6

Anxiety toward Mathematics				
	Teacher A	Class A	Class B	Teacher B
Mean	18	10.6	11.73684	21
Median		10	12	
Mode		10	13	
Range		10	13	
Minimum		6	6	
Maximum		16	19	

Table 7 compares the value that the teachers placed on mathematics in society vs. that of the students. The highest score possible for the teachers was 28 and the lowest possible score for the teachers was 7.

Table 7

Value of Mathematics in Society				
	Teacher A	Class A	Class B	Teacher B
Mean	27	22.45	22.21053	23
Median		23	22	
Mode		23	22	
Range		12	10	
Minimum		16	18	
Maximum		28	28	

Table 8 compares the teachers' enjoyment of mathematics with that of their students. The highest possible score for the teachers was 30 and the lowest possible score for the teachers was 15.

Table 8

Enjoyment of Mathematics				
	Teacher A	Class A	Class B	Teacher B
Mean	30	21.35	19.26316	24
Median		23	20	
Mode		23	16	
Range		17	13	
Minimum		11	12	
Maximum		28	25	

Table 9 compares the teachers' motivation in mathematics to the students' enjoyment of mathematics. The highest possible score for the teachers was 18 and the lowest possible score for the teachers was 12.

Table 9

Motivation in Mathematics				
	Teacher A	Class A	Class B	Teacher B
Mean	16	8.65	8.947368	15
Median		9	9	
Mode		9	10	
Range		9	8	
Minimum		4	4	
Maximum		13	12	

Discussion

After examining the data and the differences between the attitudes of Teacher A and Teacher B, the hypothesis stands. The fact that the teachers of the classes had such different backgrounds in mathematics and varying years of teaching experience supports the hypothesis. If the teachers had similar feelings towards mathematics and similar teaching experiences, it would have been difficult to compare the effects of the attitudes of the teachers to the attitudes of the students.

After the researcher gave the instructions to Class A, Teacher A then reiterated the instructions. This did not happen in Class B. In Class B, two students answered multiple questions with more than one answer whereas no students did that in Class A. Furthermore, more students wrote comments on the inventory in Class B than in Class A. For example, item 40 on the MAI states, "My math teacher is willing to give us individual help." Student 3 in Class B chose two answers, then wrote next to it, "matters what mood she's in." The fact that more students in Class B did not answer the questions correctly demonstrates the importance of giving clear instructions. It also shows the weight of a teacher's instruction vs. a stranger's instruction.

In regards to the measurement of the teachers' attitudes towards mathematics, Teacher B had a higher anxiety toward math than did Teacher A. This could be due to the fact that Teacher B did not have as good a background in mathematics as Teacher A. Also, Teacher B might have been more anxious about teaching mathematics, not just mathematics itself. Teacher A placed a higher value of mathematics in society and enjoyed mathematics more than Teacher B. Teacher A also had slightly higher motivation in mathematics than did Teacher B. Considering their backgrounds and teaching experiences, this was expected.

Class A demonstrated a more favorable perception of their teacher than did Class B. This was again expected due to the differences in the teachers. One might assume that since Teacher A had more experience teaching mathematics, she had more experience using different teaching styles. Also, the fact that she had a better background in mathematics than Teacher B could affect the way the students perceive her. Although the range in scores of the two classes was the same, the minimum and maximum of the classes differed. The mean of the scores differed only by about two points.

While giving the inventory to Class A, Teacher A was going around making sure that the students were filling out the forms correctly and did not have any questions. At one point, as she was talking to a student, she said, "Quit acting stupid, you know how to do this." This was surprising considering that she had more experience than Teacher B. If she treated her students that way all the time, that might have had a negative effect on her students' math anxiety. Surprisingly, however, the students in Class A had a higher self-concept in mathematics than did the students in Class B.

The students in Class B had a slightly higher anxiety toward mathematics than did

the students in Class A which supports the hypothesis. Class A also tended to enjoy mathematics more. Although the overall score was higher for the enjoyment of mathematics for Class A, their scores also had a larger range in that category. The range for Class A was 17 as opposed to the range of 13 for Class B. On the other hand, the median and mode score for Class A was 23, which was higher than the median of 20 and the mode of 16 for Class B.

There was not a large difference in the value that the students placed on mathematics in society nor their motivation in mathematics. In fact, Class B had a slightly higher motivation in mathematics. This could be due to the possibility that they may have had to do more outside reading in mathematics and work harder outside of the classroom in order to understand mathematics, since their teacher did not have as much experience as Teacher A.

The findings in this survey are important because they support the theory that teachers' attitudes towards mathematics affect their students' attitudes towards mathematics. Teachers need to be aware of this so they know to leave their poor attitude at home before entering the math classroom. The research conducted in this experiment supported the research done previously.

It is important to note, however, that the results from this study cannot be generalized. Neither the classes nor the students in the classes were randomly chosen. Therefore, although the results were conclusive for this study, they cannot be generalized for all classrooms, teachers, and students.

One issue that could be studied further is the effect of having unqualified teachers teaching mathematics. As was previously mentioned, one of the teachers in this study did

not have either a Master's or Bachelor's degree in mathematics. This same teacher was not content teaching mathematics. Teachers should not be forced to teach classes they are not qualified for and are not content teaching. Again, research shows that these bad attitudes towards mathematics come out in a teacher's teaching style, willingness to help students, creativity, and general attitudes in the classroom. Frustrated teachers are less likely to find creative ways of helping their students understand concepts. Since they do not enjoy teaching mathematics, they are more likely to become stagnant in their teaching style.

This study was by no means exhaustive and there is still much more research that can and should be done on the topic of math anxiety. This study has demonstrated that teachers need to be aware of the impact that they have on their students' attitudes in mathematics. There needs to be more literature to aid teachers in helping their students overcome math anxiety. Also, it would be useful for teachers to know more about how math anxiety first appears in a child and how it grows into a larger problem.

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Appendix A

MINNESOTA MATHEMATICS ATTITUDE INVENTORY

Directions

The following statements are about the study of mathematics. Please read each statement carefully and decide whether it describes the way you feel about mathematics. Then, find the number of the statement in the answer column and blacken one of the spaces according to the following directions:

If you strongly agree with the statement, blacken space 1.

If you agree with the statement, blacken space 2.

If you disagree with the statement, blacken space 3.

If you strongly disagree with the statement, blacken space 4.

Be sure to blacken only one space for each statement.

Be sure to answer every question. You will have about 20 minutes to complete the 48 statements of the inventory. Remember to answer each statement according to the way you feel at the present time.

Minnesota Mathematics Attitude Inventory 1

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Mathematics is useful for the problems of every day life.	①	②	③	④
2. Mathematics is something which I enjoy very much.	①	②	③	④
3. I like the easy mathematics problems the best.	①	②	③	④
4. I don't do very well in mathematics.	①	②	③	④
5. My mathematics teacher shows little interest in the students.	①	②	③	④
6. Working mathematics problems is fun.	①	②	③	④
7. I feel at ease in a mathematics class.	①	②	③	④
8. I would like to do some outside reading in mathematics.	①	②	③	④
9. There is little need for mathematics in most jobs.	①	②	③	④
10. Mathematics is easy for me.	①	②	③	④
11. When I hear the word mathematics, I have a feeling of dislike.	①	②	③	④
12. Most people should study some mathematics.	①	②	③	④
13. I would like to spend less time in school doing mathematics.	①	②	③	④
14. Sometimes I read ahead in our mathematics book.	①	②	③	④
15. Mathematics is helpful in understanding today's world.	①	②	③	④
16. I usually understand what we are talking about in mathematics class.	①	②	③	④
17. My mathematics teacher makes mathematics interesting.	①	②	③	④
18. I don't like anything about mathematics.	①	②	③	④
19. No matter how hard I try, I cannot understand mathematics.	①	②	③	④
20. I feel tense when someone talks to me about mathematics.	①	②	③	④
21. My mathematics teacher presents material in a clear way.	①	②	③	④
22. I often think, "I can't do it," when a mathematics problem seems hard.	①	②	③	④
23. Mathematics is of great importance to a country's development.	①	②	③	④
24. It is important to know mathematics in order to get a good job.	①	②	③	④

	Strongly Agree	Agree	Disagree	Strongly Disagree
25. It doesn't disturb me to work mathematics problems.	①	②	③	④
26. I would like a job which doesn't use any mathematics.	①	②	③	④
27. My mathematics teacher knows when we are having trouble with our work.	①	②	③	④
28. I enjoy talking to other people about mathematics.	①	②	③	④
29. I like to play games that use numbers.	①	②	③	④
30. I am good at working mathematics problems.	①	②	③	④
31. My mathematics teacher doesn't seem to enjoy teaching mathematics.	①	②	③	④
32. Sometimes I work more mathematics problems than are assigned in class.	①	②	③	④
33. You can get along perfectly well in everyday life without mathematics.	①	②	③	④
34. Working with numbers upsets me.	①	②	③	④
35. I remember most of the things I learn in mathematics.	①	②	③	④
36. It makes me nervous to even think about doing mathematics.	①	②	③	④
37. I would rather be given the right answer to a mathematics problem than to work it out myself.	①	②	③	④
38. Most of the ideas in mathematics aren't very useful.	①	②	③	④
39. It scares me to have to take mathematics.	①	②	③	④
40. My mathematics teacher is willing to give us individual help.	①	②	③	④
41. The only reason I'm taking mathematics is because I have to.	①	②	③	④
42. It is important to me to understand the work I do in mathematics.	①	②	③	④
43. I have a good feeling toward mathematics.	①	②	③	④
44. My mathematics teacher knows a lot about mathematics.	①	②	③	④
45. Mathematics is more of a game than it is hard work.	①	②	③	④
46. My mathematics teacher doesn't like students to ask questions.	①	②	③	④
47. I have a real desire to learn mathematics.	①	②	③	④
48. If I don't see how to work a mathematics problem right away, I never get it.	①	②	③	④

Appendix B

1. Mathematics is useful for the problems of every day life.

Strongly Agree Agree Disagree Strongly Disagree

2. Mathematics is something which I enjoy very much.

Strongly Agree Agree Disagree Strongly Disagree

3. Working mathematics problems is fun.

Strongly Agree Agree Disagree Strongly Disagree

4. I would like to do some outside reading in mathematics.

Strongly Agree Agree Disagree Strongly Disagree

5. There is little need for mathematics in most jobs.

Strongly Agree Agree Disagree Strongly Disagree

6. When I hear the word mathematics, I have a feeling of dislike.

Strongly Agree Agree Disagree Strongly Disagree

7. Most people should study some mathematics.

Strongly Agree Agree Disagree Strongly Disagree

8. I would like to spend less time in school doing mathematics.

Strongly Agree Agree Disagree Strongly Disagree

9. Mathematics is helpful in understanding today's world.

Strongly Agree Agree Disagree Strongly Disagree

10. I feel tense when someone talks to me about mathematics.

Strongly Agree Agree Disagree Strongly Disagree

11. Mathematics is of great importance to a country's development.

Strongly Agree Agree Disagree Strongly Disagree

12. It is important to know mathematics in order to get a good job.

Strongly Agree Agree Disagree Strongly Disagree

13. I would like a job which doesn't use any mathematics.

Strongly Agree Agree Disagree Strongly Disagree

14. I enjoy talking to other people about mathematics.

Strongly Agree Agree Disagree Strongly Disagree

15. You can get along perfectly well in everyday life without mathematics.

Strongly Agree Agree Disagree Strongly Disagree

16. Working with numbers upsets me.

Strongly Agree Agree Disagree Strongly Disagree

17. It makes me nervous to even think about doing mathematics.

Strongly Agree Agree Disagree Strongly Disagree

18. I study mathematics outside of the classroom in order to refresh my mathematics skills.

Strongly Agree Agree Disagree Strongly Disagree

19. I am content teaching mathematics; there isn't another job I would rather have.

Strongly Agree Agree Disagree Strongly Disagree

20. Do you have a bachelor's or master's degree in mathematics?

Yes No Working towards it

21. How many years have you been teaching mathematics? _____ years