

Confidence in their ability to do mathematics: The need to eradicate math anxiety so our future students can successfully compete in a high-tech globally

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Abstract

This article makes the argument for the importance of having one's confidence with mathematics in order to compete globally in a high-tech world that relies very heavily on mathematics, science, and technology. This article reviews the literature on preventing and reducing math anxiety. In addition, the article is geared toward educators in hopes that they can ultimately excite children about math, encouraging students to be confident in their ability to solve problems, understand mathematical concepts, and see math as a human endeavor. The authors believe that there is a connection between math anxiety and student performance in mathematics. One hopes that as students feel less anxious about, and more confident in, their abilities to do math, their performance on standardized tests will improve, as test scores are often a concern for principals, teachers, and society as a whole. The ideas shared in the article, based on current research on math anxiety, have been applied and shared with teachers and students. Math anxiety has become a growing concern in the United States as well as many other countries around the world. A young person's ability and confidence to do mathematics is critical for their future success in our high-tech globally competitive world.

Introduction

Often students who are anxious, bored, fearful, or who simply believe that mathematics is unimportant, are likely to avoid the study of mathematics. Mathematics is truly the gateway to engineering and all scientific and technology fields. The shortage of workers in many technical fields is a matter of national concern (Dawson, Internet). Due to the shortage, the U.S. government has given increasing permission to the number of individuals who may enter the country with work visas in technological fields, although the immigration laws have been more stringent since the September 11, 2001 tragedy. Much has been written about the decline of mathematics scores on the Third International Mathematics and Science Study (TIMSS) and Scholastic Aptitude Test (SAT) and a general weakness in mathematics instruction, the practice of setting higher standards, as well as other reform measures, has not had an appreciable effect. Research about attitudes toward mathematics is important in determining the connection between achievement and math anxiety. It would be beneficial for PreK-16 teachers to develop a better understanding of current issues related to assessment and intervention strategies in order to promote better attitudes toward mathematics among students at all levels. This paper focuses on such issues as math confidence, attitudes, anxiety, assessment, intervention, and best practices/pedagogy.

In today's high-tech world, it is important that our young children grow to become confident in their ability to do mathematics in an ever-increasingly high-tech globally competitive society. This article reviews the literature on preventing and reducing math anxiety. It also shares with the reader, from an educator's perspective, approaches that could be used to ultimately excite children about math, encouraging students to become more confident in their ability to solve problems, understand mathematical concepts, and see math as a human endeavor. The authors believe that there is a connection between math anxiety and student performance in mathematics. One hopes that as students feel less anxious about and more confident in their abilities to do math, their performance on standardized tests will improve, which is often a concern for principals, teachers, and society at large.

Research on math anxiety has become more extensive as more researchers try to determine why so many people in America demonstrate a disregard toward math. The instruction of mathematics also seems to play a critical role in shaping one's attitudes toward math (Jackson & Leffingwell, 1999). Mathematics Anxiety can be defined as an "irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (Buckley and Ribordy, 1982, p. 1). NCTM (1989) recognizes math anxiety as a problem and has specifically included in its assessment practices, since a teacher's job is to assess his/her students' mathematical dispositions. NCTM (1989) has included the following in its Standards document for teaching mathematics:

"As mathematics teachers, it is our job to assess students' mathematical disposition regarding:

As mathematics teachers it is our job to assess students' mathematical disposition regarding:-confidence in using math to solve problems, communicate ideas, and reason;

-confidence in using math to solve problems, communicate ideas, and reason;-flexibility in exploring mathematical ideas and trying a variety of methods when solving problems;

-flexibility in exploring mathematical ideas and trying a variety of methods when solving problems;-willingness to persevere in mathematical tasks;

-willingness to persevere in mathematical tasks;-interests, curiosity, and inventiveness in doing math;

-interests, curiosity, and inventiveness in doing math;-student ability to reflect and monitor his/her own thinking and performance while doing math;

-student ability to reflect and monitor their own thinking and performance while doing math;-focus on value of and appreciation for math in relation to its real-life application, connections to other disciplines, existence in other cultures, use as a tool for learning, and characteristics as

Burns (1998) contends that two thirds of American adults loathe and fear mathematics. A changing, economically competitive world has necessitated reform in mathematics education. Dawson (Internet) has found that Americans often times are not qualified for many high-tech jobs and that companies seek employees outside the U.S. requiring special H1-B Visas. Since the September 11th tragedy, this process may be hampered and the U.S. has no alternative than to better prepare its students in the areas of math, science, and technology. Dawson (Internet) contends that our K-12 educational system is not preparing students for future studies in math and science. Lane (1999) emphasizes the critical importance of mathematics and science education for our young people and the contribution they will make to our nation's economy and overall well-being. Lane (1999) contends that we must support high quality mathematics and science education in every way we can so that we are ensured an adequate talent pool for our country. Lane (1999) refers to the Japanese model of math instruction where teachers pose problems students have never seen before and they make connections from what they know to solve and develop skills, the Japanese in general posses a resilience toward solving problems and not giving up, the kind of group think and problem solving that typifies the Japanese approach to learning math is also important in the advancement of technology and the sciences. Much of the research conducted by the Board of Directors of the National Council of Teachers of Mathematics (NCTM) in the mid-1980s indicated that the mathematics curricula for elementary and secondary schools in the United States could be more effective. NCTM's response to the need for change was the publication of *Curriculum and Evaluation Standards for School Mathematics* (Standards) in 1989. The NCTM suggested that standards would improve nationwide test scores in the area of mathematics. The NCTM *Standards* were established as a broad framework to guide reform in school mathematics (NCTM, 1989 and 2000), not as a specific mathematics curriculum. The NCTM's vision includes mathematics teachers encouraging students, probing for ideas, and carefully judging the maturity of a students' thoughts and expressions (NCTM, 1989). Most often, current teaching practices in mathematics classrooms do not provide sufficient critical thought needed to compete in an ever-advancing technological age. The need for implementation of the *Standards* is essential. Often, teachers tend to teach the way they were taught. Sarason (1993) maintained that any reform in education must first begin with teacher training. Practicing mathematics teachers and preservice teachers, thus, need to be trained to implement these standards. Mathematics anxiety in students has become a concern for our society. Evidence of students' poor attitudes and high levels of anxiety toward math is abundant. In the midst of a technological era, declining mathematics (math) scores on the Scholastic Aptitude Test have been widely publicized along with the poor middle school and high school scores on the Third International Mathematics and Science Study. Golberg and Harvey (1983) reported that American students ranked last when compared with students from all other industrialized countries on 19 different assessments.

According to Callahan, Tomlinson, Reis, and Kaplan (2000), "U.S. 12th-graders who were taking Advanced Placement calculus, when compared with *all* advanced mathematics students in other nations, performed only at the international average and significantly higher than students in just five other countries." Steen (1999) points out "national and international studies show that most U.S. students leave high school with far below even minimum expectations for mathematical and quantitative literacy." Neunzert (2000) believes we have to understand ourselves as MINT-professionals, where MINT is M=mathematics, I=informatics, N=natural sciences, T=technology. Neunzert (2000) feels that mathematics is critical for people living in the 21st Century for them to be successful. Neunzert believes we need to encourage our students in all countries to study more mathematics and to see it as a tool for success in life.

Gallup (1983) found that the American public rated math first in importance when compared with the other academic fields. Educators, parents, politicians, and others are trying to assess the cause for the apparent academic weakness in mathematics, and solutions to the problem are being sought.

NCTM (2000) recently published a revised version of standards for teaching mathematics. Included are a list of the following six principles:

1. Equity----high expectations for ALL students;
2. Curriculum-----coherent and articulated for grades Kindergarten through 12;
3. Teaching----using effective pedagogy that takes into consideration what students know and what they need to learn;
4. Learning for understanding and incorporating prior knowledge;
5. Assessment----designed to support learning and give information to teachers and learners;
6. Technology----consideration of what is taught and how it can enhance learning

In addition, NCTM (2000) recommends the following 10 standards for grades Pre-Kindergarten through 12:

Content Standards:

- Numbers and Operations
- Algebra
- Geometry
- Measurement
- Data Analysis and Probability

Process Standards (all of which highlight ways of acquiring and using content knowledge):

- Problem Solving
- Reasoning and Proof
- Communication

- Connections
- Representations

According to Zemelman (1998), the role of the principal and/or other school administration are extremely important in helping to implement best practices for teaching mathematics. Zemelman suggests that principals do the following in order to overcome math anxiety among students:

1. Play the leading role in promoting best practices by setting the tone for the school with teachers, students, and parents;
2. Distribute copies of the NCTM standards and any other pertinent local, state or regional standards documents in order to educate the principal and his/her staff;
3. Hold Family Math Nights to educate parents;
4. Include in the budget monies for professional development;
5. Encourage the use of math manipulatives and supplies;
6. Encourage teachers to use a variety of assessment methods;
7. Encourage teachers to share and network with each other regarding ideas that work for them, as well as provide in-service workshops for colleagues.

One principal states, *"My job as a principal is to see that every child gets the best education possible. I feel it is safe to say that reading and mathematics achievement are two of the primary academic concerns a principal has. It is then important that teachers and parents are equipped with the tools for successful performance of their students. One issue that impedes success in mathematics is the level of students' math anxiety. If teachers can help to reduce and prevent math anxiety then students will more likely find more success and develop more confidence in their ability to do math."*

One task a principal has is getting teachers to work more effectively when teaching math and to ensuring that faculty members are on the "same page" as far as what "best practice" is in mathematics instruction. Teachers need to know about the NCTM *Standards* and current research in mathematics education. It is important that teachers recognize the distinction between preventing math anxiety and reducing math anxiety. Ideally, if teachers can prevent math anxiety from the onset, then the need of educators to deal with the task of reducing math anxiety will decrease. Teachers need to prevent math anxiety from ever happening. However, teachers still need to get a feel for their students' dispositions toward mathematics. If math anxiety exists, then it is the teacher's obligation to help his/her students overcome such anxiety toward math. NCTM Standard #10

Marzano 's (1992) Dimensions Of Learning Model is based on the premise that before real learning can occur, students must have good attitudes and perceptions toward learning. In the same respect, then, students must have good attitudes about learning math before they both truly understand and develop confidence in their ability to do math.

Mathematics anxiety has been a prevalent concern among educators and others in our society for decades. Now, with the advent of computer technology, the need for the understanding of mathematics is critical. Teachers can play an important role in reducing the level of mathematics anxiety among their students. McLeod (1991) claims that affective factors play a central role in mathematics learning and instruction. There are many components of mathematics anxiety, such as math test anxiety, number anxiety, and math course anxiety.

One of the authors was the secondary principal of Colegio Interamericano, a bilingual school, in Guatemala City, Guatemala. She found math anxiety to be a rampant problem at the school. She and the Head of the Math Department translated the NCTM Standards into Spanish, and distributed them to the members of the math department. The principal requested budgetary allowances for professional development, but, unfortunately, monies were not available. Instead, she tapped the resources of her staff, inviting them to provide workshops for their colleagues. In addition, she sent teachers to local workshops that were provided on occasion for no fee. She even enticed a Mathematics Education professor, on vacation in Guatemala, to come to the school to offer a workshop on Math Anxiety. The professor was provided with lunch, a complimentary letter of appreciation, and the experience of sharing his knowledge with teachers who were willing to learn.

The aforementioned author, in a second position as the Pre- K-12 principal of Colegio Maya, an international school in Guatemala City, Guatemala, encountered as one of her first responsibilities the task of hiring a new secondary math teacher. It is essential to hire an individual who is committed to adhering to the NCTM Standards, incorporates writing into the math curriculum, encourages students to think critically, utilizes alternative forms of assessment, and is willing to work with math teachers in the elementary and middle school programs to work toward articulating the curriculum. In this way, math anxiety can be alleviated.

Causes of Math Anxiety

Causes of math anxiety, according to Hackett (1985), varied from socioeconomic status and parental background to the influence of teachers and the school system. Kutner (1992) asserted that teachers and parents who were afraid of math could pass on math anxiety to the next generation, not genetically, but by modeling behaviors of their own discomfort with the subject. Oberlin (1982) discussed the following teaching techniques as causes of math anxiety: (a) assigning the same work for everyone, (b) covering the book problem by problem, (c) giving written work everyday, (d) insisting on only one correct way to complete a problem, and (e) assigning math problems as punishment for

misbehavior. Brush (1981) contended that the development of math anxiety carried some symptoms that included the following: (a) mathematics became difficult during early years of school, (b) students spent excessive amounts of time relearning what they had been previously taught, and (c) students were not exposed to the everyday applications of the material covered.

Crawford (1980) found that a student's lack of success with math might be caused by any one of several factors: a poor math instructor at some point; an insufficient number of math courses in high school; unintelligible textbooks; or misinformation about what math was and what it was not, as well as who should do well in math. Crawford also found that many people often blamed their failures on their lack of a mathematical mind, the notion that men were better than women at math, or that they had poor memories or learning disabilities rather than any of the other aforementioned obstacles. Tobias (1987) contended that there were two myths about mathematics that needed to be eliminated. One is that higher level math is too difficult for otherwise intelligent students to master, and another is that without mathematics you can live a productive intellectual and professional life. Students must overcome any fears of mathematics and be challenged to take higher-level math courses. One reason is that fear of mathematics may reflect on students' career choices in the future if they do not challenge themselves to take higher level math courses. Many researchers have found distinct connections between math anxiety and test anxiety. Hendel and Davis (1978) suggest that current conceptions of test anxiety may be useful in clarifying the nature of math anxiety. Anton and Klisch (1995) have found that a large part of math anxiety is test anxiety. Sarason (1987) contends that math anxiety, like test anxiety, may be composed of two major components: cognitive concerns about performance (worry) and emotionality (autonomic reactions that are evoked by stress). Arem (1993) believes that test anxiety is threefold: poor test preparation and test-taking strategies; psychological pressures; and poor health habits.

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It appears that there has been a great deal of research conducted related to gender issues and mathematics. Reilly (1992) found that females did not have higher levels of math anxiety than males until the late junior high/early high school period. Bernstein (1992) found that at age 12, males felt slightly more math anxiety than females; however, by the age of 14, females were more anxious about math than males were. Tobias (1993) feels that the differences between males and females in terms of math anxiety cannot be attributed to differences in innate ability.

Saxe (1991) and Scribner (1984) support the idea that an individual's mathematics ability is significantly influenced by his or her participation in everyday applications such as:

Saxe (1991) and Scribner (1984) support that an individual's mathematics ability is significantly influenced by his or her participation in encompassing cultural practices such as:

-Selling lemonade in the street

selling lemonade in the street -Packing crates in a dairy

packing crates in a dairy -Completing worksheets in class

-Sequencing pages when creating a webpage or Powerpoint presentation

Teachers need to help kids see math as a human endeavor so that they learn to value and see application for learning math inside and outside the classroom. Making such

connections may help students realize that it is not something from which they can escape, but a tool they need to learn how to use. In the book, *Descartes' Dream: The World According to Mathematics* (Davis & Hersch, 1990), the authors discuss how computers have made mathematics the most important discipline to study. They take an incisive look at how math is applied in the real world today, particularly the influence of computers on mathematics, science, and society. Davis & Hersch (1990) believe all humans are drowning in digits and depend constantly on math for our high-tech lifestyle. They contend that math is everywhere, in business, in warfare, and a propaganda tool in social sciences. Dawson (Internet) cites that fewer Americans are studying math, science, and technology fields, yet the demand for these fields with technology skills is growing. It is estimated that by 2008 the top three areas of employment growth will be in technology fields: computer engineering 108%, computer support specialist 102%, and systems analysts by 94%. If the U.S. cannot produce and attract sufficient workers from the U.S. in the areas of math, science, and technology fields they are left with the alternative to seek outside the U.S. for qualified workers. The U.S. has lead the world in the Information Age. This success can only continue if we can solve some of the technology labor shortages and start better preparing our children for the digital world by allowing them to see math as a human endeavor and a large part of their future.

Confidence Instead of Anxiety: Preventing Math Anxiety

The NCTM Standards call for: (a) The NCTM Standards call for:the teaching of how to think for oneself; (b) working in groups at all levels of math; (c) efficiently using technology; (d) the teaching of estimation; (e) including more statistics and probability in early grades; (f) incorporating fewer computational drills and practices; (g) using manipulatives; and (h) focusing on more realistic problem-solving.

Research by Sheila Tobias (1993), a leading researcher on the topic of math anxiety, has found that the NCTM Standards: (a) present mathematics as a thinking and decision making tool; (b) direct teachers to teach with concrete materials (c) directs teachers to teach with concrete materials allow students to see that math makes sense in their everyday experiences; and (d) convey that math is first and foremost a language used to organize and communicate valuable information.

Best Practice: Helping to Prevent the Occurrence of Math Anxiety

Schools can help prevent math anxiety from occurring in students. Math anxiety really is a complicated matter and may involve what happens to kids inside and outside of the classroom. Teachers and parents can play a critical role in helping to develop positive attitudes toward math. NCTM (1995a & 1989) has made the following suggestions for preventing math anxiety:

-Recommendations for Preventing Math Anxiety According to the NCTM (1995)Accommodate for different learning styles;

-Create a variety of testing environments;

-Design positive experiences in math classes;

-Refrain from tying self-esteem to success with math;

-Emphasize that everyone makes mistakes in mathematics;

-Make math relevant;

-Let students have some input into their own evaluations;

-Allow for different social approaches to learning mathematics;

-Emphasize the importance of original, quality thinking rather than rote manipulation of formulas; and

emphasize the importance of original, quality thinking rather than rote manipulation of formulas -Characterize math as a human endeavor,

Teachers must employ best practices for teaching mathematics in their classrooms. Zemelman, Daniels, and Hyde (1998), based on a culmination of research, have put together a list of what are considered to be the "best practices" for teaching math, which include: (a) the use of manipulatives (make learning math concrete); (b) the use of cooperative group work; (c) the use of discussion when teaching math; (d) the use of questioning and making conjectures as a part of math; (e) the use of justification of thinking; (f) the use of writing in math for: thinking, feelings, and problem solving; (g) the use of the problem-solving

approach to instruction, making content integration a part of instruction; (h) the use of calculators, computers, and all technology; (i) the role of the teacher of being a facilitator of learning; and (j) the assessment of learning as a part of instruction (See Appendix A for a summary).

Confidence Instead of Anxiety: Reducing Math Anxiety

To reduce math anxiety, educators must use a different approach from that which is suggested for preventing math anxiety. Teachers almost have to take on the role of a counselor to help lower or overcome such anxiety toward math. Treatments effective in alleviating math anxiety include systematic desensitization and relaxation, according to Trent (1985), Hembree (1990), and Schneider and Nevid (1993). Davidson and Levitov (1993) advocate the use of relaxation in conjunction with repeated positive messages and visualizations.

How is math anxiety reduced? Teachers must help students understand how their math anxiety was created. According to Hackworth (1992), the following activities will assist in reducing math anxiety: (a) discussing and writing about math feelings; (b) becoming acquainted with good math instruction as well as study techniques; (c) quality studying that enables students to recognize different types of information learning; (d) being an active learner and creating problem solving techniques; (e) evaluating one's own learning; (f) developing calming, positive ways to deal with fear of math and doing math: visualization, positive messages, relaxation techniques, and frustration breaks; and lastly (g) building confidence in math through gradual, repeated success. Tobias (1987) suggests that one way for students to reduce math anxiety is to recognize when panic starts, to identify the inactiveness in their analytic and retrieval systems, and to clear up the static without ceasing to work on the problem (See Appendix A for a summary).

Best Practice: Practical Ideas for Teachers

Sandra Davis, of the University of Minnesota, has developed the Math Anxiety Bill of Rights:

1. I have the right to learn at my own pace and not feel put down or stupid if I'm slower than someone else;
2. I have the right to ask whatever question I have;
3. I have the right to need extra help;
4. I have the right to ask a teacher for help;
5. I have the right to say I don't understand;
6. I have the right to feel good about myself regardless of my abilities;
7. I have the right not to base my self-worth on my math skills;
8. I have the right to view myself as capable of learning math;
9. I have the right to evaluate my math instructors and how they teach;
10. I have the right to relax;
11. I have the right to be treated as a competent person;
12. I have the right to dislike math;
13. I have the right to define success in my own terms

A practical idea for teachers and students is for teachers to assess their students attitudes toward math at the beginning of a school year by having them complete the following mathitude survey:

Become acquainted with good math instruction as well as study techniques [Mathitude](#)

1. When I hear the word math I.....

1. When I hear the word math I..... 2. My favorite thing in math is.....

2. My favorite thing in math is..... 3. My least favorite thing in math is.....

3. My least favorite thing in math is..... 4. If I could ask for one thing in math it would be.....

5. Please don't 5. My favorite teacher for math is.....

Davidson and Levitov (1993) advocate the use of relaxation in conjunction with repeated positive messages and visualizations.

Journal writing in math classrooms has become an everyday event for many students. Students use journals to express their understanding of mathematical concepts. Journals can also be used to allow students to share their feelings about and experiences with math. Students are rarely asked how they feel about learning different concepts and branches of mathematics. Teachers can really have a better understanding and feel for any frustration students are feeling. The following sample list of journal/discussion questions may be used for students to write about alone or to discuss and share with each other as a class. Teachers must realize that for students to overcome or reduce their math anxiety, they must first initiate the journal writing form of therapy by allowing students to express their true feeling about math and how they arrived at such a disposition.

Examples of Journal/Discussion Questions for Students

1. Pretend that you have to describe mathematics to someone. List all the words or phrases you can think of that you could use.

1. Pretend that you have to describe mathematics to someone. List all the words or phrases you can think of that you could use. 2. Imagine doing or using math either in or out of school. What does doing or using math feel like? Describe.

2. Imagine yourself doing or using math either in or out of school. What does doing or using math feel like? Describe. 3. If math were a color, an animal, a piece of music, or type of food what would it be?

4. For me math is most like . Why? 4. Describe how you feel in a math class.

5. Describe how you feel in a math class. 6. Are you the type to do well in math class? Why or why not? *Math Curse*, a book by Scieszka & Smith (1995)

addressing the issue of math anxiety, is an excellent example of how educators have come to terms with the fact that not all people feel confident in their ability to do math. When Mrs. Fibonacci, an elementary school teacher, tells her class that they can think of almost everything as a math problem, one student becomes overwhelmed by the scope of math. This math anxiety becomes a real curse. However, the student eventually realizes that math is everywhere and there is no way of escaping it in daily life; therefore, the math anxious youngster recognizes math as a means of making one's life easier.

Math Curse suggests several ideas, such as: math surrounds us, everything in life is a problem (many involve math), we cannot escape math, there is real value in and real-life applications for math, it is important to become confident in one's ability to do math, math has beauty, math has patterns, math is a tool, math is a language, and, lastly, math has many uses. Teachers may want to use *Math Curse* to conduct a bibliotherapy session with students so that they can relate to the character. This activity can serve as a lead-in to prompt students to discuss their own feelings about math.

Another practical idea for teachers is to actually teach test taking and study skills. Teachers can easily incorporate and often have include in their teaching some of the following tips:

Test-Taking/Study Skills

Teach note-taking skills

Teach note-taking skills Teach test-taking skills

Teach test-taking skills Teach relaxation techniques

Teach relaxation techniques Teach the importance of homework/studying

Teach importance of homework/studying Teach how to read and use the textbook

Teach how to read and use the textbook Teach positive “I” messages

Teach positive I messages Teach visualization of success in math

Teach visualization of success in math Encourage peer or tutor practice/study

Martinez and Martinez (1996) have developed the characteristics of Fearless Math Learning. These include:

- Learning by concept;
- Flexible conditions;
- Multimethod problem solving;
- Emphasis on problem solving;
- Many theory testing;
- Positive motivation;
- High expectations;
- Negotiation of goals;
- "Something is better than nothing" thinking;
- Maximum involvement and active learning;
- Shared ownership of information;
- Learning of content; and
- Creativity

Kathy Acker developed the Math Anxiety Code of Responsibilities, which include:

1. I have the responsibility to attend all classes and do all homework as assigned;
2. I have the responsibility to recognize the rights of others to learn at their own pace;
3. I have the responsibility to seek extra help when necessary;
4. I have the responsibility to see the teacher during office hours or to schedule an appointment for assistance;
5. I have the responsibility to come to class prepared, with my homework finished and/or questions to ask;
6. I have the responsibility to speak when I don't understand;
7. I have the responsibility to give math at least the same effort I give to other subjects;
8. I have the responsibility to begin my math study at my current skill level;
9. I have the responsibility for my attitudes about my abilities;
10. I have the responsibility to learn about instructors prior to registering for class;
11. I have the responsibility for learning and practicing relaxation skills;
12. I have the responsibility to act as a competent adult;
13. I have the responsibility to approach math with an open mind rather than fighting it; and
14. I have the responsibility to be realistic about my goals and expectations.

Confidence Instead of Anxiety: Math Testing Anxiety

Another major concern related to math anxiety is test anxiety. Much research shows that often a large part of math anxiety is due to test anxiety. "The Need to

Win" by Chuang Tzu is a perfect example of how many students often feel about a math test. Students seem to show understanding of the math concepts when

they have little to lose, but when grades or time limits are placed on such practices; students tend to become nervous, as demonstrated by sweaty palms. Often,

the results are lack of confidence and failure at such tests.

The Need to Win by Chuang Tzu

When an archer is shooting for nothing, he has all his skill.

When an archer is shooting for nothing, he has all his skill. If he shoots for a brass buckle, he is already nervous.

If he shoots for a brass buckle, he is already nervous. If he shoots for a prize of gold, he goes blind

If he shoots for a prize of gold, he goes blind Or sees two targets--

Or sees two targets--He goes out of his mind!

He goes out of his mind His skill has not changed. But the prize divides him.

His skill has not changed. But the prize divides him. He cares.

He cares. He thinks more of winning than of shooting--

He thinks more of winning than of shooting--And the need to win

Drains him of power.

Often it appears that there is a vicious cycle of test anxiety. Many times superintendents place pressure on principals, who then may place pressure on teachers to have their students perform well on standardized tests in mathematics. Teachers in turn spend a great deal of time having their students take pretests in preparation for the standardized test. Day in and day out teachers send messages to students stressing the importance of the class as a whole doing well on the test. This leads to a great deal of pressure for students. Often the purpose or focus of why this test is important is lost or never understood by students.

Best Practice: Problem Solving

Currently in math there is more of a focus on process and problem solving as opposed to single answers and computation. Teachers can incorporate more problem solving approaches to instruction as well as rubrics that grade based on the process rather than right answers only. Reys (1998) and NCTM (1995b & 1989) suggest that teachers need to see that methods and tasks for assessing students' learning should be aligned with the curriculum's goals, math content, instructional approaches, and activities including the use of calculators and manipulatives. Reys (1998) and NCTM (1995b & 1989) feel that assessment should allow for multiple sources of information with tasks that show different kinds of math thinking as well as present the same math concept or procedure in different contexts, formats, and problem situations. Also, appropriate assessment methods and uses need to be taken into consideration based on the type of information sought, how the information will be used, and the developmental level and maturity of each student. Teachers need to employ alternative forms of assessment in math classes, as suggested by Reys (1998), such as: observations, questioning, interviews, performance tasks, self-assessments of students, work samples, portfolios, writing samples, paper and pencil tests, and standardized tests. Schools really need to shift toward assessing students' full mathematical power by giving students multiple opportunities to demonstrate their full mathematical understanding, aligning assessment with curriculum and instruction, and regarding assessment as continual and recursive (NCTM, 1995). Teachers need to emphasize more communication in the classroom through discussion, problem solving, discourse, and writing. Teachers benefit children most when they encourage them to share their thinking process and justify their answers out loud as they perform math operations. Currently in Florida, with the new Sunshine State Standards, students at the fifth, eighth, and tenth grade levels will be required to take the Florida Comprehensive Assessment Test (FCAT), which really emphasizes more thought process, with both long and short response types of questions. The FCAT focuses on problem solving; tests number sense, measurement, geometry, algebraic thinking and data analysis; includes long and short responses focusing on process; has guided responses with little room for guessing; raises standards with a focus on long-term outcomes; and offers a process which uses reports to improve schools. Teachers do students a huge favor when they encourage students to discuss, explain, and justify their thinking aloud or in writing for purposes of sharing, since more and more of the standardized tests (FCAT in Florida) are geared toward this form of responding to items (long and short-response questions). With less of an emphasis on right or wrong and more of an emphasis on process, teachers can thus help to create a population of students who no longer fear math tests and may no longer fear math.

Confidence Instead of Anxiety: A Teachers' own Math Anxiety

Teachers' own math anxiety can interfere with and often create math anxiety for their students. To paraphrase a Chinese proverb (W. V. Williams, 1988, p.103):

"Tell me mathematics, and I will forget; show me mathematics and I may remember; involve me...and I will understand mathematics. If I understand mathematics, I will be less likely to have math anxiety. And if I become a teacher of mathematics, I can thus begin a cycle that will produce less math-anxious students for generations to come."

It is important that all teachers are consistent in terms of having a knowledge base for teaching mathematics. Teachers not only need to come to terms with their own math anxiety, but also need to be familiar with best practices for teaching mathematics as well as incorporate national and state standards into their instruction. Taking refresher courses/workshops on new research-based best practices for teaching mathematics is critical in a world where technology is quickly changing what and how math is taught. It is also important that students from one teacher to the next receive consistent instruction in mathematics and all teachers prevent the occurrence of math anxiety as each student progresses from one grade to the next.

Best Practice: Getting Beyond Myths

Teachers also need to get beyond the following math education myths:

Men are better than women;

Men are better than women Math requires logic, not intuition;

Math requires logic, not intuition You must always know how you arrived at the answer;

You must always know how you got the answer Math is not creative;

There is a best way to solve a math problem;

There is a best way to do a math problem It is always important to get the answer exactly right;

It is always important to get the answer exactly right It is bad to count on your fingers;

It is bad to count on your fingers Mathematicians solve problems quickly and in their heads;

Mathematicians do problems quickly and in their heads Math requires a good memory;

Math requires a good memory Math is done by working intensely until the problem is solved;

Math is done by working intensely until the problem is solved Some people have a math “mind” and some don’t; and

Some people have a math mind and some don’t There is a magic key to doing math (Kogelman and Warren, 1978).

Teachers' own anxieties and misconceptions about math instruction must be addressed and corrected. Teachers can often damage their students' own dispositions toward and confidence in their ability to excel at math, even though this is not these educators' intention.

Confidence Instead of Anxiety: Family Math

Parental involvement and a parent's role in changing attitudes toward math are important. Parents need to take a proactive role in the education of their children. Schools can involve parents by encouraging parents to come into the classroom, be involved in the PTA, and invite families to family nights that allow teachers, children and parents to learn together. Family Math Nights (Stenmark, Thompson, Cossey, & Hill, 1986) are becoming a popular means of bringing families to school so a family can do math together. Family math nights can help parents learn about and what students are learning in mathematics as well as how teachers are teaching this subject. Parents can learn about the new math standards, math manipulatives, problem solving and active approaches to learning math. By involving parents in their children's' math education, parents can then better support and see what is valued in today's classrooms. Parent involvement in schools has drastically improved student success.

Best Practice for Parents

Stenmark, Thompson, Cossey, & Hill (1986) have made suggestions for parents who want to help their children with doing math at home. Schools may want to provide the following list as tips for parents in helping their children with mathematics at home. Parents can:

- 1.) Let your children know that you believe they can succeed at math.
- 2.) Be ready to talk to your children about math and to listen to what they are saying or feeling.
- 3.) Be more concerned with the process of doing math rather than getting the correct answer.
- 4.) Try not to tell your children how to solve problems; it may be best to ask questions and guide them to the process.
- 5.) Practice estimation with children whenever possible (i.e. in a store or on a trip)
- 6.) Provide a special place for study, allowing for the child's learning style to be used.
- 7.) Encourage group study.
- 8.) Expect that homework will be done.
- 9.) Don't expect that all homework will be easy; don't rush your child.
- 10.) Seek out positive ways to support your child's teacher and school.

Parents really play a critical role in helping to build their children's confidence in mathematics. It is important that parents work closely with their children's teachers by asking their child's math teacher for a schedule of math topics to be taught. Parents should try to follow their child's progress through his or her math book, tests, and homework.

Parents also need to encourage their child to concentrate positively, especially if their child is insecure about his or her math abilities. Parents can help to make a difference in

a child's attitude toward math.

The Internet

Professor Freedman provides math help at: <http://www.mathpower.com/>. Many math concepts can be taught in a variety of ways. On the Internet, students, teachers, and parents can access the Math Teacher's Ten Commandments, the Math Anxiety Self-Test, Ten Ways to Reduce Anxiety, Students' Math Bill of Rights, Study Skills Tips, Math Anxiety Code of Responsibilities, and many other links to math help. Many sites also can help teachers plan interactive Internet field trips (Ameis & Ebenezer, 2000; Furner, Doan-Holbein, & Scullion-Jackson, 2000) for their students like www.funbrain.com or www.funschool.com.

The Need to Improve Student Learning

Although many factors inside and outside of school influence students' level of achievement, the quality of classroom teaching is a key to improving students' learning (National Commission on Mathematics and Science Teaching for the 21st Century, 2000). Much of mathematics is taught through working on mathematics problems (TIMSS Video Mathematics Research Group, 2003). This similarity probably can be explained by a convergence of global institutional trends (LeTendre et al, 2001). The appropriate relationship of school mathematics to life outside the classroom has been discussed for some time (Stanic and Kilpatrick, 1988). As Furner (1996) has pointed out, making the relationship between mathematics and life is a way to reduce math anxiety. When anxiety is reduced, students can become more successful at math, and be better equipped to be successful in a world that is highly technologically and mathematically oriented. Many mathematics educators advocate the use of real-life contexts in mathematics classrooms (Lesh and Lamon, 1992). According to Stigler and Hiebert (1997), the U.S. had not large-scale mechanism for sustained teacher learning at the time. Although this is still the case, there is a growing sense that long-term, continuing teacher learning is a key to improving practice (Darling-Hammond and Sykes, 1999). Improved practice leads to improved situations for students to feel less anxious about math. As a result, with a decrease in math anxiety, students will be better prepared, in terms of their math scales, to experience success in a technological and mathematical world.

Summary

I am good in math at some points and not so good in others, like algebra. I've tried it. I want to go to a summer program, like Shelton to take a math class in the summer, I told my mom this.

-Jill In light of current concerns for students to achieve at a level consistent with or above national and international scores on math assessment tests such as

TIMSS, educators may need to take a more proactive role in encouraging to students to become excited about math and seeing themselves as successful,

confident mathematical problem solvers in a technological era requiring much knowledge related to mathematics and problem solving. A U.S. national curriculum

may be something for educators to ponder as we look to the future where our kids will be competing with students from around the globe for high-tech jobs.

Findings seem consistent with NCTM's philosophy on teaching mathematics.. Most research shows that until a person with math anxiety has confronted this

anxiety by some form of discussion/counseling no best practices in math will help to overcome this fear.

If we as educators do something about helping our students develop their confidence and ability to do math, we will impact their lives in a positive way forever. Our students' careers, and ultimately most of their decisions in life, could rest upon how we decide to teach math. It really is our obligation as an educational community to make the difference for the future of our students in an ever-growing competitive global environment, which depends so heavily on mathematics (Furner, 1998). If schools do more in terms of addressing student dispositions toward math, educators may see a correlation with student achievement in mathematics. Educators can play an instrumental role in fostering an environment focusing on numeracy, as well as working toward the prevention of math anxiety so that students will not face such feelings of inadequacy and lack of confidence when working with mathematical ideas. Therefore, in overcoming a major obstacle to the improvement of student mathematics performance, schools may want to begin considering how they can first begin to prevent and reduce math anxiety and address poor dispositions toward mathematics. By utilizing "best practices" in mathematics instruction and addressing math attitudes, educators can then begin to see greater gains in math achievement among their students; hence, eradicating such math anxiety. Students who feel more confident in their ability to do math will hopefully bode them well in all decisions they may make in their lives as well as help them to function and compete in our ever advancing high-tech world we live in. In the future, when asking our students how they feel about math, we will hope they will say: "I love math" or "It was my favorite subject" or "I am good at problem solving."

References

Acker, K. (n.d.). *Math Anxiety Code of Responsibilities* Retrieved February 24, 2004, from <http://www.mathpower.com/>

Ameis, J. A. & Ebenezer, J. V. (2000). *Mathematics on the internet: A resource for K-12 teachers*. Upper Saddle River, NJ: Merrill an imprint of Prentice-Hall, Inc.

Anton, W. D., & Klisch, M. C. (1995). Perspectives on mathematics anxiety and test anxiety. In C. D. Spielberger, & P. Vagg (Eds.), *Test anxiety*. Washington, DC: Taylor & Francis Publishers.

Arem, C. A. (1993). *Conquering math anxiety*. Pacific Grove, CA: Brooks/Cole.

Bernstein, J. D. (1992). Barriers to women entering the workforce: Math anxiety. *New Jersey Equity Research Bulletin* No. 3.

- Brush, L. R. (1981). Some thoughts for teachers on mathematics anxiety. *Arithmetic Teacher*, 29(4), 37-39.
- Buckley, P. A., & Ribordy, S. C. (1982). *Mathematics anxiety and the effects of evaluative instructions on math performance*. Paper presented at the Mid-western Psychological Association, Minneapolis, MN, May 6-8, 1982.
- Burns, M. (1998). *Math: Facing an American phobia*. Sausalito, CA: Math Solutions Publications.
- Callahan, C.M., Tomlinson, C. A., Reis, S. N., & Kaplan, S. N. (2000). TIMSS and high-ability students: Message of doom or opportunity of reflection? *Phi Delta Kappan*, 81(10), 787-790.
- Crawford, C. G. (1980). *Math without fear*. New York: New Visionpoints/Vision Books.
- Darling-Hammond, L., & Sykes, G., eds. (1999). *Teaching as the learning profession: Handbook of policy and practice*. San Francisco: Jossey-Bass Publishers.
- Davis, P. J., & Hersch, R. (1990). *Descartes' dream: The world according to mathematics*. London, England: Penguin Publishing Group.
- Davis, Sandra. (n.d.). The Math Anxiety Bill of Rights. Retrieved February 24, 2004, from <http://www.mathpower.com/>
- Davidson, R., & Levitov, E. (1993). *Overcoming math anxiety*. New York: HarperCollins.
- Dawson, R. (n.d.). *Setting the record straight on H1 visa legislation*. An Opinion Piece by the Information Technology Industry Council. Retrieved February 24, http://www.itic.org/policy/h1b_000628.html
- Edge, D., & Freedman, E. (1992). Math Teacher's Ten Commandments. Retrieved February 24, 2004, from <http://www.mathpower.com/>
- Professor Freedman Math Help. (n.d.). Retrieved February 24, 2004 from <http://www.mathpower.com/>
- Furner, J. M., Doan-Holbein, M. F., & Scullion-Jackson, K. (2000). Taking an internet field trip: Promoting cultural and historical diversity through mayan mathematics. *TechTrends*, 44,(6), 18-22.
- Furner, J. M. (1998). Developing positive dispositions toward mathematics: A teacher's obligation. *Dimensions in Mathematics*, 18(1), 28-31.
- Furner, J. M. (1996). *Mathematics teachers' beliefs about using the National Council of teachers of Mathematics Standards and the relationship of these beliefs to students' anxiety toward mathematics*. Unpublished doctoral dissertation. University of Alabama.
- Gallup, G. H. (1983). The 15th annual Gallup poll of the public attitude toward the public schools. *Phi Delta Kappan*, September 1983. Report in Shultz, *Education 84/85*. Guilford, CT: Duahkin, 26-34.
- Goldberg, M., & Harvey, J. (1983). A nation at risk: The report of the national commission on excellence in Education. *Phi Delta Kappan*, September 1983. Report in Schultz, *Education 84/85*. Guilford, CT: Pushkin, 1985, 74-74.
- Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology*, 32(1), 47-56.
- Hackworth, R. D. (1992). *Math anxiety reduction*. Clearwater, FL: H & H Publishing Company.
- Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, 21,33-46.
- Hendel, D. D., & Davis, S. O. (1978). Effectiveness of an intervention strategy for reducing mathematics anxiety. *Journal of Counseling Psychology*, 25, 429-434.
- Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance. *Psych Bull*, 107, 139-155.
- Kogelman, S. & Warren, J. (1978). *Mind over math*. New York, NY: Dial Press.
- Kutner, L. (1992, August 13). Teachers and parents who are afraid of math can pass that anxiety to the next generation. *The New York Times*, pp. B4, C12.
- Jackson, C. D, & Leffingwell, R.J, (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *The Mathematics Teacher*, 92(7), 583-586.
- Lane, N. (1999). *International mathematical olympiad 2001 USA*. Paper presented at the Secretary's Conference Room of the U.S. Department of Education. September 27, 1999. Found on the Internet at: http://www.ostp.gov/html/0022_3.html
- Lesh, R., & Lamon, S., eds. (1992), *Assessment of Authentic Performance in School Mathematics*. Washington, D.C.: American Association for the Advancement of Science.
- LeTendre, G. K. et al. (2001). Teachers' work: Institutional isomorphism and cultural variation in the U.S., Germany, and Japan. *Educational Researcher*, August / September, pp. 3-15.
- Martinez & Martinez. (1996). *Math without fear: A guide for preventing math anxiety in children*. Needleham Heights, MA: Allyn and Bacon.
- Marzano, R. J. (1992). *A different kind of classroom: Teaching with dimensions of learning*. Alexandria, VA: Association for Supervision and Curriculum Development.
- McLeod, D. B. (1991). Research on learning and instruction in mathematics: The role of affect. In E. Fennema, T. Carpenter, & S. Lamon (Eds.), *Integrating research on teaching and learning mathematics* (pp. 55-82). Albany, New York: State University of New York Press.
- National Commission on Mathematics and Science Teaching for the 21st Century. (2000). *Before It's Too Late*. Washington, D.C.: U.S. Department of Education.
- National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (1995a). *Mathematics anxiety* [Supplemental Brochure]. Reston, VA: Author.
- National Council of Teachers of Mathematics. (1995b). *Professional assessment standards for teaching mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. NCTM: Reston, VA.
- National Resource Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education*. Washington, DC: National Academy Press.
- Neunzert, H. (2000). *Will Mathematics and the Mathematicians be able to contribute essentially in shaping the future?* Paper presentation at the **3ECM Conference Round Table Discussion on Shaping the 21st Century, Barcelona, Spain, July 11-14, 2000**.
- Oberlin, L. (1982). How to teach children to hate mathematics. *School Science and Mathematics*, 82, 261.
- Reys, R.E., Suydam, M. N., Lindquist, M. N., & Smith, N. L. (1998). *Helping children learn mathematics*. (Fifth Edition) Boston, MA: Allyn and Bacon.

Sarason, I. G. (1987). Test anxiety, cognitive interference, and performance. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, learning, and instruction: Volume 3: Conative and affective process analyses* (pp. 131-142). Hillsdale, NJ: Erlbaum.

Sarason, S. (1993). *The case for change*. San Francisco, CA: Jossey-Bass Publishers.

Saxe, G. B. (1991). *Culture and cognitive development: Studies in mathematical understanding*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Schmidt, W. H. (1998). *Changing mathematics in the U.S.: policy implications from the third international mathematics and science study*. Presentation at the 76th Annual meeting of the National Council of Teachers of Mathematics, Washington, D.C., April 3, 1998.

Schneider, W. J. & Nevid, J. S. (1993). Overcoming math anxiety: A comparison of stress inoculation training and systematic desensitization. *Journal of College Student Development*, 3(4), 283 - 288.

Scieszka, J., & Smith, L. (1995). *Math curse*. NY, New York: Viking.

Scribner, J. (1984). Studying working intelligence. In B. Rogoff & J. Lave (Eds.), *Everyday cognition: Its development in social context* (pp. 9-40). Cambridge, MA: Harvard University Press.

Stanic, G.M.A., & Kilpatrick, J. (1988). Historical perspectives on problem solving in the mathematics curriculum in Randall I. Charles and Edward A. Silver, eds. *The Teaching and Assessing of Mathematical Problem Solving*. Reston, Va.: National Council of Teachers of Mathematics, pp. 1-22.

Steen, L.A. (1999). Numeracy: The new literacy for a data-drenched society. *Educational Leadership*, October, 8-13.

Stenmark, J.K., Thompson, V., Cossey, R., & Hill, M. (1986). *Family Math*. Berkeley, CA: Lawrence Hall of Science, University of California.

Stigler, J. W., & Hiebert, J. (1997). Understanding and improving classroom mathematics instruction. *Phi Delta Kappan*, September, pp. 14-21.

TIMSS Video Mathematics Research Group. (2003). Understanding and improving mathematics teaching: Highlights from the TIMSS 1999 video study. *Phi Delta Kappan*, 84(10), 768-779.

Tobias, S. (1987). *Succeed with math: Every student's guide to conquering math anxiety*. New York: College Board Publications.

Tobias, S. (1993). *Overcoming math anxiety revised and expanded*. New York: Norton.

Trent, R. M. (1985). *Hypnotherapeutic restructuring and systematic desensitization as treatment for mathematics anxiety*. Paper presented at the annual convention of the Southwestern Psychological Association, Austin, Texas.

Wells, D. (1994). Anxiety, insight and appreciation. *Mathematics Teaching*, 147, 8.

Williams, W. V. (1988). Answers to questions about math anxiety. *School Science and Mathematics*, 88(2), 95-104.

Zemelman, S., Daniels, H., and Hyde, A. (1998). *Best practice: New standards for teaching and learning in America's school* (2nd Edition). Portsmouth, NH: Heinemann.

Appendix A: A Summary of Math Anxiety

What NCTM says about Mathematics Anxiety and Dispositions Toward Mathematics.....

Standard 10: Mathematical Disposition

As mathematics teachers it is our job to assess students' mathematical disposition

regarding:

-confidence in using math to solve problems, communicate ideas, and reason;

-flexibility in exploring mathematical idea and trying a variety of methods when

solving;

-willingness to persevere in mathematical tasks;

-interests, curiosity, and inventiveness in doing math;

-ability to reflect and monitor their own thinking and performance while doing

math;

-value and appreciate math for its real-life application, connections to other

disciplines and cultures and as a tool and language.

How to Reduce Math Anxiety: A Summation

1. Psychological Techniques like anxiety management, desensitization, counseling, support groups, bibliotherapy, and classroom discussions.

2. Once a student feels less fearful about math he/she may build their confidence by

taking more mathematics classes.

3. Most research shows that until a person with math anxiety has confronted this anxiety

by some form of discussion/counseling no "best practice" in math will help to

overcome this fear.

How to Prevent Math Anxiety: A Summation

1. Using "Best Practices" in mathematics such as: math manipulatives, cooperative groups, discussion of math, questioning and making conjectures, justification of content integration, technology, assessment as an integral part of instruction, etc. thinking, writing about math, problem-solving approach to instruction,
2. Incorporating the NCTM *Standards* and State Standards into curriculum and instruction.
3. Discussing feelings, attitudes, and appreciation for mathematics with students regularly is critical.

Math anxiety is contagious. As parents, you need to create that desire in your child to learn. So instead of walking around your child saying "I hate math" or "I'm not good at math", try turning everyday life experiences into learning opportunities for your child. For example, you could show your child how math is used while grocery shopping, cooking or counting change. In addition to creating a platform for mathematical conversation, making connections to everyday activities may help your child realize that math is an important skill to possess.

3. Furner J, Berman B. Confidence in their ability to do mathematics: The need to eradicate math anxiety so our future students can successfully compete in a high-tech globally competitive world. *Dimensions in Mathematics*. 2005;18(1):28-31. Math-anxious students learn less math than their low-anxious peers because they take fewer math classes and get poorer grades in the math classes they do take. Math anxiety has been studied for many years but has recently received renewed attention. Teachers with math anxiety or a negative view of math contribute to the development of math anxiety in their students (Sparks, 2011; Beilock et al., 2010; Hellum-Alexander, 2010; Furner & Berman, 2004; Brown, n.d.). Studies highlight the need for more teacher training that develops educators' math skills and positive attitudes toward math (Sparks, 2011; Beilock et al., 2010). Confidence in Their Ability to Do Mathematics: The Need to Eradicate Math Anxiety so our Future Students Can Successfully Compete in a High-Tech Globally Competitive World. *Philosophy of Mathematics Education Journal*, 18(1), 1-33. Hembree, R. (1990). The Effects of Math Anxiety on Post-Secondary Development Students as Related to Achievement, Gender, and Age. *Inquiry*, 9(1). ERIC Document Reproduction Service No. EJ876845.

Confidence in their ability to do mathematics: The need to eradicate math anxiety so our future students can successfully compete in a high-tech globally competitive world. *Philosophy of Mathematics Education Journal*, 18(1), 1-33. Hardfield, O. D., Martin, J. V., & Wooden, S. (1992). The effects of math anxiety on post-secondary development students as related to achievement, gender, and age. *Inquiry*, 9(1). ERIC Document Reproduction Service No. EJ876845. Zakaria, E., & Nordin, N. M. (2008). The effects of mathematics anxiety on matriculation students as related to motivation and achievement. *Eurasia Journal of Mathematics, Science & Technology Education*, 4(1), 27-30.