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The Role of the Educator in Causing and Addressing Math Anxiety

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ABSTRACT

This study endeavors to determine the role of the educator both in creating or perpetuating and in solving or addressing the existence of mathematics anxiety in their students. How common societal beliefs about mathematics impact the development of this anxiety is also examined. The central purpose of this study is to develop and/or refine instructional strategies that are effective for students with an anxiety about mathematics. The research focused solely on anxieties related to the mathematics classroom and curriculum – general school related anxieties were not examined. Research was conducted by consulting several research-based studies on this topic and was supplemented by evaluating practitioner articles from teachers who have had experience in working with students with math anxiety and by clinical experiences in a local high school. The consensus of the research is that there is neither one distinct cause nor one single solution to the problem of math anxiety in students. In general, the cause and solution are unique to the individual student – though there are several common factors that may contribute to the development of math anxiety in a student and evidence has shown there are several instructional strategies that may be effective for students with math anxiety.

I. Introduction of the Issue

If we, as a society in general and as educators in particular, are to take all students and make them proficient learners and competent users of mathematics, then it is necessary to understand more about how students learn mathematics and the barriers that may hinder such learning. Understanding math anxiety is a key part of this larger process. As educators, it is critical to understand the backgrounds of our students. These backgrounds play a prominent, central role in how students learn in the present. Thus, by being mindful of both the existence and causes of mathematics anxieties, teachers will be better prepared to develop instructional strategies that are effective – for both themselves and, more importantly, for their students. Such reasons should be justification enough for research into mathematical anxieties. However, the significance of the issue is greatly increased by the current pressures placed on the American educational system.

For the past half century, the American education system has continually been moved into the forefront of national politics. During this time, the education of the country's youth has seemingly become an increasingly important societal value. The 2001 passage of the No Child Left Behind Act can be seen as a culmination of this value. Indeed, under the two most recent Administrations, the nation's education system has undergone mounting government pressure to be held accountable for student learning. In particular, the emphasis has been placed on increasing student competency and proficiency in mathematics and the sciences in order to compete in the global market. The feasibility, benefits and problems of such legislation are subjects for another time and place. In the contexts of this study, it is necessary to treat such legislation as the reality in which our educational system must operate. In this regard, the recent

legislation serves as a backdrop for understanding the immediate importance and significance of math anxiety.

II. Focus of the Study

Before proceeding any further into an analysis of math anxiety, an important distinction needs to be made. That distinction is to differentiate between math anxiety and more generalized school anxieties. Math anxiety is defined as "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Godbey, 1997, p. 2). This is distinct from other school related anxieties, such as test anxieties, anxieties due to stereotyping, anxieties in students with learning disabilities and anxieties about academic performance and/or social situations (Peters-Mayer, 2008). Such anxieties most certainly exist and would undoubtedly be present in a mathematics classroom – but they would be present across all disciplines. As such, the goal of eliminating – or at least mitigating – these more generalized school anxieties is a focus that would and should cross all disciplines. In contrast, addressing the issue of mathematics anxieties is an issue that is relegated specifically to math educators.

Accordingly, this investigation focuses upon reducing or even outright eliminating the anxieties that are unique to the mathematics curriculum. It seeks to determine how the content of said mathematics curriculum is itself – particularly at the secondary level – causing anxiety in students. Further, this study endeavors to identify the role (if any) that the teacher plays in both causing and mitigating such anxieties. The information that follows is based on evidence found in research-based studies and in articles published by teachers with experience working with

students who have math anxiety. In limited places where it is appropriate, personal observations are discussed to supplement the information found in the research. These observations are based on the writer's clinical experiences at an area high school.

III. Origins of Math Anxiety and the Role of Educators in Perpetuating It

Anxiety about mathematics begins at an early age. Yet it is not accurate to say that children are born anxious or indifferent about math. Rather, quite the opposite is true. McGrath characterizes children as "born mathematicians" – indeed, they are naturally curious about the world around them (2010, p. 18). So, the question remains: why do some students develop an anxiety and consequently a negative disposition toward something that under different circumstances they may have viewed as pleasurable or interesting? It may seem tempting to lay the blame for this change on the abstraction of the mathematics over the course of the curriculum. True, as students age and move through the mathematics curriculum, the content becomes more and more abstract. However, citing this abstraction as the source of mathematics anxiety is a fallacy. Math anxiety typically develops at younger ages and can be observed in students studying a wide range of mathematical topics. It cannot be attributed to one specific component of the larger curriculum. Students do not just reach the threshold of Algebra and suddenly develop an anxiety due to the introduction of variables. By this time, the anxiety is already present and the introduction of variables and other abstractions (from the perspective of the student) merely take a bad situation and complicate it even further.

Therefore, according to Jameson, it seems logical that something must happen during the progression of their education that creates this math anxiety (2010, p. 45). Godbey and

Zaslavsky's arguments both support such an analysis. Further, the authors all agree that there is not one single root cause to math anxiety. As is the case with many topics in education, the development of such an anxiety is unique to each individual student (Godbey, 1997, p. 3). Nevertheless, while there is not one root cause present in all cases of students with math anxiety, there are several common factors that can help to explain how math anxiety develops. Jameson describes several factors that can lead to this development – particularly in younger students. These factors can be grouped into two categories: personal factors and environmental factors.

Personal factors focus on an individual student's beliefs about their own abilities. In turn, these beliefs are greatly influenced by a student's previous performance and by the messages that they *perceive* from others (Jameson, 2010, p. 50-51). The author states that the most important of the personal factors are the students' past experiences. From this perspective, it is clear that students' experiences have the potential to create a snowball effect – essentially learned helplessness. The student believes that they will perform poorly on a math assignment. This belief then leads to a build-up of tension and anxiety that eventually results in the student performing poorly on said assignment. This poor performance then serves as reinforcement to the student's belief that they cannot do math and the process then repeats itself. Eventually, the process may result in the student giving up altogether. In observing an honors pre-calculus course this semester, such feelings were clearly seen in the students. Over two-thirds of the class identified math as one of their weaknesses during icebreaker activities the first week of school. Subsequently, through the progression of the semester, several students have made proclamations of the form described above.

Another component of personal factors is the messages students perceive from those around them. These messages both shape and help to reinforce the beliefs an individual student has about their own abilities. The hazard here is that perception and reality are not always aligned. For example, if some students are quick to solve a problem, other students may interpret this as meaning that the problem should be easy and quick for everyone to solve. Thus, there must be something wrong with them if they do not understand the problem or are unable to do it instantaneously. This is the basis for the societal belief in the so called "math gene" – a topic that will be discussed in greater detail in the following section. Perception and reality also conflict with spoken messages. That is, what is said and what is heard may very well be two completely different things. Thus, a teacher may make a comment to a student that they intend to be either positive or a constructive critique. However, the student may interpret this comment as a blatant criticism and respond accordingly in their work for the class and in their belief as to their ability in the subject as a whole. This further contributes to the snowball effect mentioned previously.

The messages that students interpret come from their surroundings – both from their peers and adults. In this sense, environmental factors, as discussed by Jameson (2010), are closely related to this notion of perception. The most significant of the environmental factors are the attitudes of parents and teachers toward mathematics (ibid., p. 52). An educator has limited influence over the attitudes of their students' parents. However, the educator *does* have influence over their own attitudes – and to a small extent that of their colleagues. In order to better understand the development and progression of mathematical anxieties, it may be useful to separate the educators into two categories – elementary school teachers in one and middle and high school teachers in the other. This grouping is justified based on the different mathematical

preparation required for these two groups of teachers. Elementary teachers typically complete a basic math requirement (nine credit hours or even less) that may not even cover topics outside the range of elementary school mathematics. In contrast, secondary teachers often have an extensive background in mathematics (typically a Bachelors Degree in mathematics) that covers topics well beyond those taught in even the most advanced high school curriculums.

An unfortunate reality is that a significant population of elementary school teachers suffer from math anxiety themselves – whether it is to a small or large extent (Martinez and Martinez, 1996, p. 10). Some elementary school teachers may also lack a solid understanding of the math content that they are charged with teaching to students. These two realities send misleading messages to the students. Students may learn anxious behavior from their teacher or may simply infer that learning mathematics is unimportant (ibid., p. 11). This learned behavior and/or learned attitude is carried by the student to the next school year. Therefore, depending on when the student is first exposed to such messages and how often they are reinforced, the attitude can be well ingrained in the student by the end of the elementary school years.

Of course, students progress through the school system and move on to middle and then to high school. At these levels it is considerably less likely that a teacher will experience math anxiety themselves (Martinez and Martinez, 1996, p. 10). These are individuals who have majored or (at the very least) minored in mathematical sciences and completed rigorous coursework in both applied and abstract mathematics. Yet, this is not to say that teachers at this level do not share in the responsibility of perpetuating mathematical anxiety in students. Indeed, it may very well be due to such advanced study that these teachers cause math anxiety to increase rather than to decrease in their students. From the perspective of the teacher, the

material they present in their classes may well be considered comparatively easy, but from the perspective of the student, it most certainly is not. Teachers at this level may make (inaccurate) assumptions about the simplicity of the material and then grow frustrated when the students have difficulty (Godbey, 1997, p. 6). This is not to insinuate that the teacher is frustrated with the student for not understanding – any competent teacher should be trained to address these situations. Rather, they may become frustrated with themselves for their own inability to clarify or simplify the material. However, as described above, how the students perceive this frustration is not always clear. Students may interpret the frustrations as being directed at them – particularly if the student already has some level of mathematical anxiety.

Classroom factors are not all created by the individual teacher. Mathematics anxieties are also perpetuated by the structure of the school system and these too should be considered. Often, the curriculum can be seen to be working against student comprehension. There is a limited amount of time available to teachers to cover material. Conventional wisdom would argue that content can either be covered for quality or for quantity, but not usually both. Alas, the norm is currently favoring quantity over quality in an effort to meet the rising demands of the mandates set by the federal government. This has lead to increased pressure on students – so that teachers do not necessarily measure a student's understanding of some given material, but the pace (or speed) at which they were able to understand it (Zaslavsky, 1994, p. 57). Given more time – that is if quality were to be favored over quantity – students may very well be able to demonstrate solid understanding of the material. Yet, this not the reality in which our schools are currently operating.

IV: The "Math Gene" (or: The Role of the Societal Myth)

It would be grossly unfair to place the burden of creating math anxiety solely on the shoulders of teachers. In the United States, society plays a substantial role in cultivating and eventually accepting a population that is not adequately prepared or competent mathematically. For most people, mathematics is certainly not the most popular of academic subjects – any opinion poll of a cross section of average Americans will surely yield this result. This may be the case, but mathematics is not alone as an unappreciated subject. Still, in many other subjects, unpopularity is not an acceptable excuse for incompetency. This is where math is perhaps unique. For it *is* socially acceptable to declare that one cannot do it. As Zaslavsky states: "In the United States most people would be ashamed to admit that they never learned to read, yet it is perfectly respectable to confess that one [cannot] do math" (1994, p. 5). It would not be appropriate to say that this view has created math anxiety. Rather, this view presents an easy escape route for students who have difficulties with mathematics. Instead of taking the time to identify where they are having problems and working with their teachers, parents and/or tutors, some students may just give up altogether – comforted by the reality that it is socially acceptable to do so.

As reflected by the statement in the preceding paragraph and by the title of this section, mathematics, by and large, has a tendency – more than any other subject – to be viewed as an innate gift that people are either born with or without. This conviction feeds the snowball effect of learned helplessness discussed in the previous section. Society sends a message to students that if they are having difficulty doing a mathematics problem, the reason is that they were born incapable of doing it. Much more likely is that the problem itself is challenging and requires time

and effort in order to determine an appropriate solution. However, this reality is not supported or encouraged by society's faith in the existence of the math gene. As a result, some students enter a math class convinced that they are being set up to fail (Scarpello, 2007). Such a mindset can be difficult to overcome – especially if it has been (repeatedly) reinforced as a consequence of the snowball effect.

Further, the belief in the myth of the math gene is offensive to those who have put in a substantial amount of work, time and effort into studying mathematics. The study of mathematics – as does the study of any discipline – takes a considerable amount of time and effort and it is not guaranteed to always be easy. While we certainly do not want to make students feel inferior for having difficulty with mathematics, we also do not want them to use societal acceptance of mathematical inability as a crutch or an excuse to not put in the necessary effort. In a classroom setting, students need to know that their teachers do not believe that mathematical ability is left to chance. Everyone can learn at least some math – but it is going to take work. Students need to be held to a higher standard than the societal myth is offering.

V: The Role of Educators in Solving the Problem

From the perspective of an individual teacher, the views of society are far outside their realm of influence. Still, there are efforts that can be taken in the classroom to combat math anxiety on a smaller, more manageable scale. Indeed, dispelling the cultural myth of the math gene on a national/societal level is far outside the scope of this study. Nevertheless, a crucial step in addressing math anxiety at such a large level begins at the classroom level and with dispelling the myth there. To reiterate the point from the preceding section: students of all levels need to

know that their teachers do not accept the math gene myth as an excuse. At the same time, teachers need to make students aware that it is perfectly acceptable to be confused by the material. It will not always be easy and quick to understand. Mistakes are likely. However, they are both productive and crucial parts of the learning process.

There are several strategies that show promise in addressing mathematical anxieties in the classroom. As has been argued in previous sections, math anxiety begins at an early age and is often perpetuated and compounded during late elementary, middle and high school. Therefore, it seems most important to address the issue of math anxiety at those early stages of learning. At the early elementary level, McGrath contends that mathematics can and should be presented in a manner so that students may consider it a more pleasurable experience. This can be achieved through what she considers "play" but what can essentially be considered hands on learning and investigation (2010, p. 19 - 21). Of great importance at all levels of education – but especially at the elementary level – is the attitude of teachers (and parents). Again, teachers need to keep in mind that "the attitude we have will transfer to the [students] we teach" (p. 19). The effects of a positive outlook and attitude with students – particularly at younger ages – strongly influences the students own self-perception of their mathematical abilities.

Time is perhaps one of the greatest factors in creating anxieties; it is a major factor in most testing anxieties (Peters-Mayer, 2008). The current fast-paced nature of the curriculum – which is even more prevalent at upper level mathematics courses – works against the student with math anxiety (and in reality, all students). At younger ages especially, time and speed need to be removed – perhaps more realistically, minimized – from the equation (pardon the pun). In some cases, it may not be the content that is causing anxiety in students but the expectation that

students respond to questions with an instantaneous solution (McGrath, 2008, p. 19; Berch and Mazzocco, 2007, p. 39-40). To address this issue, some, such as Morgan (2003), go so far as to advocate a complete redesign of the curriculum (particularly at the high school level) so that teachers are not racing against the clock at the expense of student learning (p. 27-28).

In the writer's opinion, such a redesign seems rather unlikely. It is perhaps more feasible to examine ways of improving instructional strategies at the middle and high school levels. With the difficulty of the material being covered, discovery-based learning can often get overlooked. However, the value of such learning and instructional strategies is not limited to elementary school. These same strategies can be effective at all stages of mathematics education and should be explored in greater detail at the secondary level. This is not to say that every concept will (or should) be taught by the use of manipulative devices or other tactile learning strategies. This is not practical for many concepts. What is encouraged is the use of guided discovery wherein the students exchange ideas and come to conclusions more or less for themselves as opposed to simply being given a conclusion from the teacher. Martinez and Martinez (1996) advocate such an approach. They contend that the lesson should not be taught *to* students, but should be taught *with* students – the teacher serving more as a facilitator than a director (p. 56-59).

Again, such teaching strategies may not be practical or efficient for all concepts and topics. A variety of methods need to be used to reach all students. In essence, teachers need to practice what they preach. So often, students are presented with multiple approaches to solving a problem and instructed to use the method that makes the most sense to them. In similar fashion, there are multiple ways of teaching – the "best way" will be the way that gets through to our students (Brooks and Taylor, 1986, p. 3). Thus, as students change from school year to school

year, so too must our instructional methods. We cannot assume that the method that worked last year will work this year – a teacher needs to know their students to plan proper and optimal instruction and what works for one group of students may not always work for a different group.

As described in previous sections, many of the behaviors exhibited by teachers that can lead to math anxiety are often done inadvertently and subconsciously. Thus, it may be challenging to undo what many may not even realize they are doing. Here, simple awareness may be half the battle. Simply by recognizing that they may be sending subliminal messages that increase students' math anxiety based on their body language, tone of voice or attitude, teachers can take proactive counter measures to simultaneously combat these actions.

It should also be stated that the burden for alleviating and mitigating the effects of math anxiety do not belong solely to the teacher. Efforts also need to be taken on the part of the students and parents. Education is a partnership between teachers, parents and students – each of whom plays a vital role in the educational process. As teachers are likely to be more aware of math anxiety and the strategies that can be helpful in addressing it, it should be their responsibility to make such strategies known to students and their parents. However, following through on using those strategies is a responsibility that belongs squarely to the student. The most important strategy for the student to follow is to get assistance sooner rather than later. Students need to ask questions – either in class or outside of class – as soon as they have confusion. This process is made easier by teachers creating a classroom environment that is open-minded and where students feel free to express their thoughts. However, the ultimate responsibility lies with the student (Peskoff, 2000, p. 2).

There also exist numerous self-help books and tutoring guides that can be consulted to help students address the problem for themselves. Kitchens (1995) provides a very useful guide that helps students understand that they can often be their own worst enemy. Continual negative self-reflections leads to the snowball effect discussed earlier. Thus, just as teachers must become aware of the existence and causes of math anxiety to help them improve their instruction, students can come to understand that there are external factors influencing their performance. Then, they can see that they have created a self-fulfilling prophecy (ibid., p. 11-13) and can take steps to work against this negative mindset. A more recent guide by Davidson and Levitov (2000) is also available – it addresses many of the same issues as the guide by Kitchens.

VI: What Remains to be Done?

In the course of this study, several questions developed that remain largely unanswered by the scope of this research. The most significant of these unanswered questions, from this writer's perspective, is why the math gene myth is so prevalent and acceptable in our society. Comparing American societal values in regards to this area to that of other industrialized countries around the world should be a topic for further study. Though, it should be realized that what works in other countries may not work here. Nevertheless, the studies could be insightful as to getting American educators to perhaps think outside the box. Additionally, a comparison study within the United States is also warranted – why is it that being "bad" at math is socially acceptable but being illiterate is not? Similar studies could be conducted comparing mathematics to other disciplines as well.

Within the realm of the findings presented from this research, it is the work that remains to be done. Becoming aware of the existence of mathematical anxieties and the ways in which educators help to perpetuate them is a vital step for educators. Still, it is only the first step. From here, additional research studies can and should be done to determine and refine additional ways of helping students overcome their anxiety about mathematics. Educators need to be open to continually adjusting their instructional strategies to meet the needs of their students.

VII: Conclusion

The revamping of the American educational system is likely to continue into the foreseeable future. For better or worse, it also appears that mathematics, reading and the sciences will be receiving the bulk of this attention. Current economic conditions exacerbate the issue still further. Writing before the worst of the recession had begun, Scarpello (2007) stated that "students who suffer from math anxiety [...] tend to take the minimum number or required math courses" for graduation. This often significantly limits their potential career choices (p. 34). This should not be an acceptable reality for educators. Math anxiety needs to be recognized by educators and students alike so that it can be addressed and confronted – not so that it can be used as an excuse for poor performance. The societal notion that there is a math gene or that mathematical ability is left to chance as an innate gift to a select few is rejected as an outdated (and frankly offensive) myth.

It is such a pervasive attitude that must be fought against – one classroom and one student at a time. Simultaneously, teachers need to take care to realize that they too play a role in perpetuating math anxiety in students and they too have a role in solving this problem. To be

sure, mathematics is (at times) a difficult subject and teachers – particularly middle and high school teachers, who may consider the material comparatively easy – need to recognize this fact. The most important thing for teachers to do is to create an open, inviting classroom environment where students feel free to make mistakes, be confused and ask for help. A good teacher promises to work with students to help ease and eliminate their problems and concerns. But, no one ever promised that math would be easy or free of confusion. Few rewarding things in life are.

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