How to Go from Math Anxiety to Math Excitement

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Abstract

Math anxiety has been widely considered as one of the key reasons for students weakness in mathematics. The author assumes that there is a negative correlation between math anxiety and math skills. In Negative math experiences may lead to a vicious cycle in which fear of math interferes with learning math which leads to more negative math experiences. This article provides a solution to go from math anxiety to math excitement. First of all, the student with math anxiety needs to understand the following five stages of math learning: 1) Familiarization, 2) Understanding, 3) Do-it-Yourself, 4) Creativity, and 5) Performance. The learning stages are very useful and important to describe the students math back-ground. Imagine that your brain accumulated all of the math concepts you learned before and it is able to classify them using the previous ordinal stages from 1 to 5 (Assume stage 0 for a new concept that the student is not familiar with yet). The article gives strategies and actions to complete each learning stage to overcome math anxiety.

1. Introduction.

In my life, I had difficulty learning mathematics initially. My lack of under-standing mathematical concepts can be explained as math anxiety. My fear, lack of confidence, and dislike of math translated into dismal grades. Subsequently, I created new techniques and procedures to overcome my shortcomings and became con dent and comfortable. I realized that I really liked math and that I could pursue degrees in engineering, computer science, education, and business which required excellent math abilities. I also realized that what I discovered on my own could be taught to others who also su er from math anxiety. With these new techniques and procedures, I could change the lives of young students as I had changed my own life. There are numerous descriptions of mathematics anxiety involving psychological and physiological characteristics. Psychologists Richardson and Suinn [7], who developed Mathematics Anxiety Rating Scale (MARS), the first instrument designed specifically to measure mathematics anxiety, de ned math anxiety as the feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of ordinary life and academic situations. Tobias and Weissbrod [10] de ned math anxiety as the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem. Spicer [8] stated that mathematics anxiety is an emotion that blocks a persons reasoning ability when confronted with a mathematical situation. In short, math anxiety is a serious and pervasive problem in many forms and degrees, from freezing up during a math exam, to attempting to avoid anything having to do with numbers. Also, the author explained that math anxiety may include psychological or physiological characteristics and may include any of the following symptoms:

- Physical: Nausea, shortness-of-breath, sweating, heart palpitations, in-creased blood pressure.
- Psychological: Memory loss, paralysis of thought, loss of self-confidence, negative self-talk, math avoidance, isolation (thinking you are the only one who feels this way).

In short, math anxiety has been widely considered as one of the key reasons for students weakness in mathematics. There are several statistical evidences that reveal US students anxiety in mathematics. For example, Burns [2] reported that two-thirds of adults in the USA report a fear of mathematics. In fact, for the past 20 years, studies such as TIMSS (the Trends in International Mathematics and Science Study) and PISA (the Program of International Student Assessment) have played a transformative role in how educational researchers think about K-12 math teaching and learning. Jackson and Kiersz [4] reported that Singapore and others Asian countries again topped the math rankings in 2012 and 2015, and US ranking fell to 35th in 2015 from 28th in math in 2012. In fact, the United States is currently not producing enough graduates in science, technology, engineering, and math (STEM) fields to meet the demands of a technology-dependent society. The United States is currently facing what many have deemed a STEM crisis because it is not producing enough graduates to work in STEM fields. Although many efforts are in place to improve math education in the United States, efforts that focus solely on increasing math requirements are overlooking the very important role that the social and emotional factors play in math achievement. Beilock and Maloney [1] explained that we tend to focus on addressing affective factors, such as math anxiety, that are known to affect math learning, math performance, and interest in pursuing STEM majors and careers. Freedman [3]

explained math anxiety as an emotional reaction to mathematics based on a past unpleasant experience which harms future learning.

Cycle of failure.

Preis and Biggs [5] concluded that negative math experiences may lead to a vicious cycle in which fear of math interferes with learning math which leads to more negative math experiences. This Math Anxiety Cycle of Failure may lead students to delay or stop taking math courses which often limits their educational opportunities. Pries and Biggs [5] have described a cycle of math avoidance as having the following four phases:

- Phase 1: The math-anxious person experiences negative reactions to math situations.
- Phase 2: The person avoids math situations.
- Phase 3: Poor mathematics preparation.
- Phase 4: Poor math performance.

The poor math performance generates more negative experiences with math and brings us back to phase one. This cycle can be repeated so often that the math-anxious person becomes convinced they cannot do math and the cycle is rarely broken.

The five stages of math learning.

First of all, the student with math anxiety needs to understand the following five stages of math learning:

1. ***Familiarization.*** It is the stage when the student is first introduced to a math concept.

   Strategies: Try to absolve the maximum information about the new concept.

   - Read the books introduction about the new concept or research it on the Internet.
   - Be comfortable with the notations and symbols.

- Focus on the definitions and properties.

Actions: Know the Rules of the Game.

- Memorize formulas and properties.
- Create a trivial example to test the formulas and properties (Optional).

2. Understanding. Try to understand how to use the new concept.

Strategies: Try to absolve the maximum information about the new concept.

- Read the examples.
- Use properties.
- Create a list of questions.
- Discuss your questions with a professor or peer.
- Create procedures and techniques to solve problems.

Actions: Know how to play the game.

- First, try to solve the examples and learn from your mistakes.
- Improve your techniques and procedures to solve problems.

3. Do-it-Yourself. It is the stage when the student is able to demonstrate their ability to solve basic problems.

Strategies: Try to test your procedures.

- Start by copying all the given information from the problem.
- Draw graphs or pictures to help visualize the situation.
- Apply your procedures on the class and homework exercises.
- Be critical and persistent.
- Create procedures and techniques to solve problems.

Actions: Test your Procedures.

- Do exercises from class. Complete the homework.
- Use the answer section in the end of the textbook to check if your responses are correct.
- Look at the solution section to see how to solve the problems.

4. Creativity. It is the stage when the student is able to demonstrate their ability to explore unusual or unexpected solutions beyond the common procedures or usual techniques.

Strategies: Try to explore new ideas and innovative solutions.

- Identify shortcuts to solve complex problems faster.
- Solve difficult problems by using a simple solution.

Actions: Develop your math creativity.

- Try to solve the final problems in your textbook.
- Improve your creativity by learning from the previous exams.

5. Performance. It is the final stage when the student is able to demonstrate their ability to solve exams.

Strategies: Learn how to be effective in exams.

- Be Self-Confident.
- Refresh your techniques and procedures before exams.
- Review the creative solutions.
- Learn techniques to check your answers.
- Create exam strategies.

Actions: Try to test your exams strategies.

- Improve your game plan to attack the exams by learning from the previous ones.
- Imagine what could be on your exam and be prepared to solve it.

The math background.

The learning stages are very useful and important to describe the students math background. Imagine that your brain accumulated all of the math concepts you learned before and it is able to classify them using the previous ordinal stages from 1 to 5 (Assume stage 0 for a new concept that the student is not familiar with yet). Fig. 1 shows a students background where the majority of the concepts are in the first learning stages. This weak math background could represent a student with low levels of learning in the past with little interest in math and/or a high level of math anxiety. This student has a high probability to have negative math experiences because math is accumulative. Assume that this student is attending a math class that the professor is teaching a new concept. Normally, students with weak backgrounds require more time in each learning stage. For example, the student tries to be familiar with the new notations and symbols when the professor is defining the new concept or explaining its properties. When the professor starts to show some examples, the student tries to understand the definitions and properties to know what the professor is talking about. When the professor asks the class to solve a problem, the student freezes and he/she cannot solve it. Even if the student is able to be completely successful with the two-first learning stages of the new concept (Familiarization and Understanding) on time, sometimes the student needs to face another concept, which is assumed by the professor that the student should know, but he/she does not. The student starts to feel math anxiety, reacting by thinking: This professor is horrible, this concept is not important, I hate this

professor, I hate this class, or even I hate math. Unfortunately, this would just be another negative math experience. On the other hand, Fig. 2 shows a students background where the majority of the stages are in the more advanced learning stages. This strong math background could represent a student with high levels of learning in the past. This student has a low probability to have negative math experiences because his/her math background is strong, and he/she has all minimum conditions to succeed in the class.

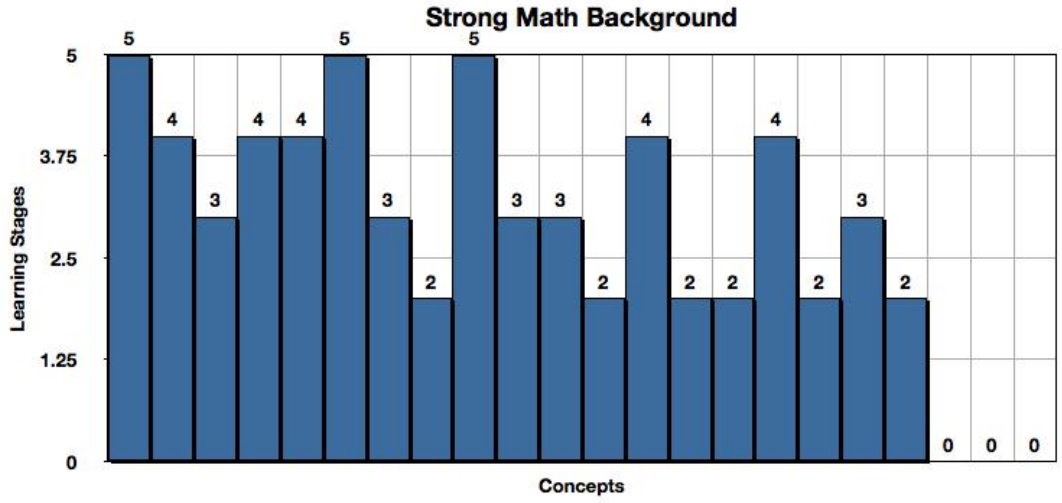

Figure 1. Learning stages of Concepts in a strong math background.

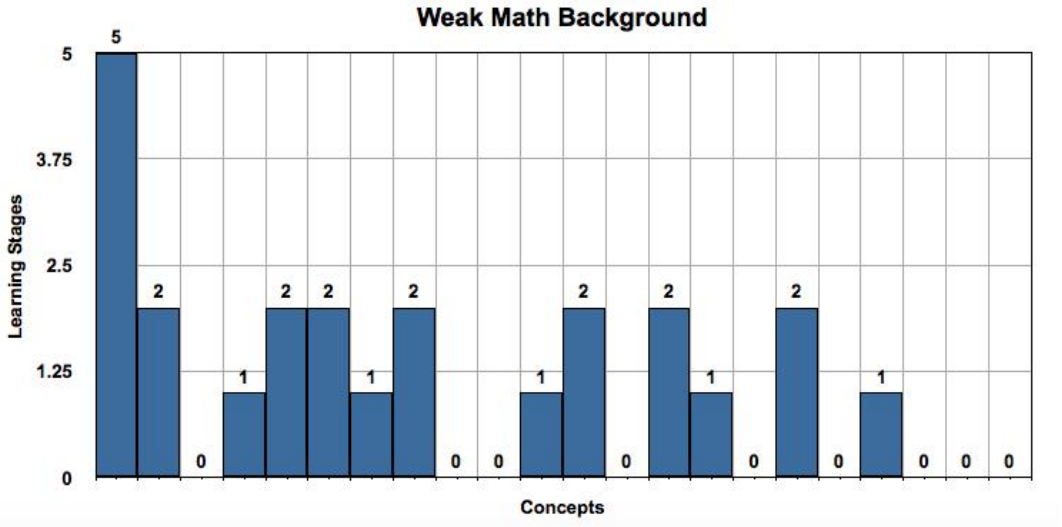

Figure 2. Learning stages of Concepts in a weak math background.

Discussions

How to go from math anxiety to math excitement.

I assume that there is a negative correlation between math anxiety and math skills. This means that math anxiety is generated by the lack of math skills. How do you obtain math skills? How can you break the circle of failure? The secret to overcoming math anxiety is to provide enough time to successfully complete each learning stage. The big secret is to study in advance. In order to have a high performance in an exam, you need to have enough time in each learning stage presented before. I used to go to a math class familiarized with the new concept. (Researching a book or researching online requires no more than 10 minutes.) It is a boost to find some interest in learning math. Some professors can show some interesting applications of math in real life. Some students see math as a challenge, and they are motivated and even proud of themselves when finding a solution to a problem. In particular, my math grades started going up after I saw every math problem as a game. You win the game when you nd its solution. The rules of this amazing game is the math definitions and properties. In fact, after more than 25 years in teaching math, believe it or not, I learned that anyone be good at this game. I remember when I found a solution and I was excited when it was correct, or curious to know where I made the mistake. I really started to be comfortable facing math because math is not a problem but a challenge or a solution. It is important to know that every time you study a math concept, you go up at least one learning stage. This means that if I offered a complete math course from basic concepts to calculus in one year, in the worst scenario, you can understand it in two years. In fact, my son Kevin learned it at only 12 years old. Now that you know my secret, it is easy to put it in practice.

Conclusions

Studying math in advance means to be at least one learning stage in front of your peers. My advice is:

1. Go prepared to the class. Try to be familiar and understand the new concepts before the class.
2. When the professor starts to explain the definitions and properties, check them with examples.
3. When the professor starts to do some examples, try to solve the class problems by yourself.
4. When your peers start to solve the class problems, you could spend some time to find a creative solution for more complex problems.
5. When the students use the homework to check the do-it-yourself stage, you use the homework as an exam to test techniques, procedures, and creative solutions.
6. When your peers start to study for the exam, go to the beach or a movie. Usually, instead of studying math during exams week, I have spent no more than one hour to review my exam strategies and creative solutions.

Studying in advance means for me to study less than the average student with better grades in a comfortable and smart way. At this point, I believe that math anxiety became math excitement, isn't it?

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