Learning Algebra on the Right Side of the Brain

How to make Algebra a Successful Learning Experience for Students of all Ages!

A psychologist looks at why algebra is so stressful for so many students of all ages and what can be done to make it stress-free. If you or anyone in your family struggled with algebra in school, this article is for you.

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Mathematicians are fond of saying that God must have been an algebraist (one versed in algebra). The reason: algebra impressed them as a divine code that God must have used to design the universe and all the natural events in that universe. For example, Einstein used a special algebra discovered by William Rowan Hamilton to predict the location of the planet Mercury—an extraordinary feat that made Albert an international celebrity in the world of science for an esoteric theory called relativity.

There is no quarrel that algebras are powerful languages (I used the plural because most people are not aware that there is more than one algebra). These algebras are only intellectual toys created in the minds of mathematicians. Some speculate that mathematicians have, in some clairvoyant way, been "reading" the divine mind. The algebraic models are completely independent of the external world. But, the bizarre fact is that these intellectual toys, somehow in some yet to be discovered way, give scientists permission to predict and often control natural events in chemistry, physics, and even medicine.

So why do students fail?

Why is algebra (perhaps the "language of God") such a high-stress, high-failure subject? One of every two students fails the course and walks away with the harmful conclusion, "I guess that I am no good at mathematics!" I want to present three explanations for this strange result that disables 50 percent of our student population. I will conclude with solutions that promise an exciting turn-around for students of all ages.

Explanation Number 1 for why students fail

There is an assumption that algebraic exercises, especially word problems, improves problem solving and thinking. There is no evidence that solving those word problems transfers to other intellectual skills such as problem solving, creativity, or thinking. Solving those word problems only makes one proficient at solving more word problems exactly like those in the textbook.

A closer look at word problems

Seventh-graders were asked to solve this word problem: "Orville and Wilbur owned a bicycle shop which also sold tricycles. One day, they decided to take an inventory of their stock. They each volunteered to count one item, which would have worked out just fine if one had counted bicycles and the other had counted tricycles. But Orville and Wilbur were both very independent thinkers. Orville counted the number of pedals in the shop and Wilbur counted the number of wheels.

"Orville found that they had 144 pedals in the shop, and Wilbur found that they had 186 wheels. All pedals and wheels were actually parts of either bicycles or tricycles. They were just about to start over with their inventory when their friend Kitty, who was a good problem solver, challenged them to figure out the number of bicycles and tricycles from the inventory they had already done. Can you help the Wright brothers? How many bicycles and tricycles did they have in their shop?..." (San Jose Mercury News, April 3, 1995).

Some kids perceive this as a fun puzzle and joyfully speculated about possible ways to develop an answer. Other youngsters perceive this word problem as absolute nonsense. They reason: We are talking about the Wright brothers, owners of a bicycle shop in Ohio. The brothers are famous for doing the impossible—inventing a bicycle that flies in the air. Secondly, these thoughtful students (who probably will get "F" in algebra) do not believe that the geniuses who invented the airplane would waste valuable hours counting wheels and pedals when the simple solution is to count bicycles and tricycles. Surely these intellectual giants have something better to do with their time.

Nobody cares about word problems—not even the writers of algebra textbooks

The reason we find nonsensical word problems in those textbooks is that it is impossible to find meaningful problems in real life. (I challenge anyone to e-mail me one meaningful word problem from the real life of ordinary people that can be solved with algebra. You can reach me at TPRWORLD@aol.com) Writers must invent synthetic word problems that are of no interest to anyone, including those who wrote the textbook. For example, Ellen is 7 years older than her sister, and the sum of their ages is 21 years. How old is each? First, this is a puzzle and not a problem because no one cares one way or the other about Ellen or her sister.

Secondly, not only is the answer already known, but the answer came before the question. Unless you already know the ages of both Ellen and her sister, how can you conclude (a) that Ellen is 7 years older than her sister, and (b) the sum of their ages is 21 years? The ages of Ellen and her sister had to be known in advance. So why ask the question?

Here is another example taken from a textbook used in the first algebra course. Notice that the question will be of interest to no one—not even the author of the algebra text: "In a class of 37 pupils there are five more girls than boys. How many boys and how many girls are there?" We could continue with those mind-numbing word problems about trains going in opposite directions and meeting somewhere on the journey. Why would anyone want to predict where they will cross paths and how long it will take to do this? I wonder whether professional railroad personnel have ever bothered to sort out the answers to this puzzle. Does it have a trace of relevancy to the operation of a railroad? Is it of any interest to passengers on a train? If it is of no concern to those who operate or ride trains, why should it be of concern to us?

Explanation Number 2 for why students fail

There is the assumption that algebra is absolutely positively an essential skill for boys and girls in all walks of life. Not only does everyone need algebra, but students cannot hope to pass those entrance examinations to enter college without an understanding of algebra.

I invite you to visit any shopping mall in America, stop ten people at random, and ask this question: "Once you were out of school, can you think of a time in your life when you used algebra to solve an important problem? If so, what was it?"

I predict that you will not find one person in ten who will answer in the affirmative. Even airline pilots have tables and ready-made graphs for plotting distances and estimating time of arrival. People in finance have ready-made tables for finding the answers to financial problems that they frequently encounter such as compound interest. Most people are successful in their everyday lives without using algebra.

Well then, how about getting into college? We need algebra for that. True, but this is an artificial gate for admittance. It is like the requirement that candidates for officer training, especially flying, be a college graduate. In an interview with an Israeli Air Force general, 60 Minutes reporter, Mike Wallace, discovered that one did not have to be a college graduate to be accepted into the Israeli flight program—a training experience that produces excellent fighter pilots. "Why then," Wallace asked, "does the U.S. Air Force insist upon a college education before a person can enter our flight training?"

"Mike," the general responded, "I don't know. It may be one of those things we assume is necessary, but have no proof one way or the other."

Algebra is a screening device for college entrance much as Latin was a hundred years ago. How can anyone consider themselves educated without Latin? Proof that precollege algebraic skill is essential for success in college is non- existant.

Explanation Number 3 for why students fail

When students ask, "Why do I have to take algebra?" The answer is quasi-religious: "Trust me! You will need algebra to be successful as a scientist, engineer or doctor. You will need algebra to take college chemistry, physics, and mathematics. Algebra is a must!"

Merely asserting that algebra is valuable is not enough. This is like a car ride with children in the back seat who keep asking their parents, "Where are we going?" "When will we get

there?" You will not quiet the children with, "We are on our way to Saint Louis. We will arrive in five days." The children will want to stop frequently before Saint Louis. Some of their favorite places are the colorful balls in the play area at MacDonalds, and the swimming pool at the motel. In other words, the teacher's goal is not necessarily the student's goal. The children do not believe there is a place called Saint Louis. The students do not believe that a long mathematical journey with no attractive places along the way is worth the effort.

Well then, what do you recommend?

I recommend three options we can try. The first is to make algebra an elective rather than a mandatory course for all students. Many students enjoy the intricate pattern- making activity of algebra. These students find the patterns fascinating apart from any synthetic attempt to make the product relevant. They will enjoy the course. Algebra should be declassified from its current status as "something everyone has to know" to "here is another interesting elective you may enjoy along with art, botany, or sports."

But, what about those who "need to know" for work in the physical sciences as chemistry and physics?

The key words here are "need to know." Our model should be the police academy where my son graduated after earning a degree from San Jose State University. Police officers "need to know" a huge chunk of law to be effective in their work. As the candidate progresses through the police academy, they internalize statute after statute on a "need to know" basis. I see a similar strategy in chemistry or physics. As we move through the course, when we "need to know," the mind opens up a window. We seem to understand information in almost one exposure.

But, don't we want our children to be math-literate?

Of course we do. But how are we going to do this? Obviously, our current attempt at "forcing" the information into young learners is not working. Evidence: We spend more on remedial mathematics in America than all other math programs put together.

Now consider this: We have successful electives that attract thousands of students. The names of these courses: Art Appreciation and Music Appreciation. It is time for a new elective called Mathematics Appreciation.

In my new book, The Super School of the 21st Century, I suggest that the content of this new elective should be the dramatic stories of mathematicians. For example, there is intrigue in the story of Bertrand Russell and Alfred North Whitehead who wrote a prize-winning volume to explain why 1 + 1 = 2. How can someone write an entire book on something as obvious as 1 + 1 = 2?

Then there is Rene Descartes, the 15th century French soldier and mathematician, who discovered the "Atlantis" of the mathematical world. For centuries, mathematicians believed there was no connection between geometry and algebra. Descartes felt that his colleagues were wrong. He began to search for the mysterious connection that he believed was there, but invisible.

In his diary, Descartes wrote, " One night when I was in a deep sleep, the Angel of Truth came to me and whispered the secret connection between geometry and algebra." Without this revelation, our world as we know it, would disappear. There would be no architecture, engineering or science. All of our technological, scientific, and medical marvels were discovered because of a visit from Descartes' Angel of Truth.

Carl Friedrich Gauss, recognized as the Prince of Mathematics, wrote his thoughts in a scientific diary that is now revered as "the most precious document in all mathematics." One of his famous discoveries was to see a hidden pattern in numbers that was invisible to mathematicians for hundreds of years.

We must include in our stories the Michelangelo of science and mathematics, Sir Isaac Newton. He discovered calculus, the composition of white light, and the laws of gravity. Sir Isaac believed that God must make some personal adjustments from time to time to keep planets in their orbit. Most people do not know that Newton conducted secret experiments in alchemy, a capital offense for which people were executed in 18th century England. He was fascinated with the occult, a subject he explored in a million words written in his private notebooks.

The history of mathematicians will intrigue young people. For example, Laura Nickel and Curt Noll were only 15 years-old when they heard the story of the Chinese mathematician Chen Jin-Run. This person dedicated his professional life to exploring the fundamental theorem of arithmetic that involves prime numbers.

All numbers seem to be composed of certain other numbers called primes. What fascinated Nickel and Noll was the notion that primes are a sort of DNA of all numbers. The two high school students were surprised that no pattern has yet been found to predict the highest prime ever discovered. They set out to find that number.

Mathematics professors warned them that their project was doomed to failure, but they vowed to prove the experts wrong. After 2,000 hours of work and 44 computer tests, they found the elusive number which was confirmed by theoretical mathematicians at the University of California's Berkeley campus.

If a student is to be wildly passionate about mathematics, the student must have the opportunity to experience the romance of mathematics. Romance comes first. Later comes the skills.

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