Education or Lobotomy: Why Split Hairs?

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Like most people, I used to hate math. Before they go to school, children are intrigued by it, provided you don't do what our department of education insists the teachers do, which is provide you with "basic tools" like the quadratic equation and solving integrals. For some people, math really is just a toolkit. Don't go to parties with these people.

K12 teachers are smart people, and most, I believe, would lean more towards concepts and stimulating interest than cramming textbooks down students' throats. But they don't have much room to improvise. I tried it in Chicago, in a class about sensory systems. Psychophysics is complicated. Membrane potentials are complicated. Hopfield networks are complicated. But these are fundamental concepts nowadays. You may not find Hopfield nets, but look up psychophysics and membrane potential in any textbook called Sensation and Perception. Tell me if you're pulled through it, or you force your way through it.

It has forever been a problem that people, in general, assume that there is a vast body of knowledge out there, and the purpose of eduction—in school or at home—is to acquire this knowledge. Every class from kindergarten through graduate school is likely to assign grades, which are based on tests, and tests are instruments that measure knowledge. There's a fallacy that goes, "Tests that use problem-solving don't test for knowledge, they test for understanding."

Understanding is just knowledge with moving parts. I went through high school and college without attending a single class, besides chemistry, more than a handful of times. You can get a C grade in any class by stuffing moving-parts knowledge into your head the night before a test. Of course this 'understanding' dissipates quickly.

It doesn't matter. When you learn something because you have to learn it, and your mechanism of learning is to sit and listen and take notes, then go home and re-read everything and do practice problems, you're doing something more trivial than you'll ever do again. If you should find yourself, one day, in a tech company, called upon to solve problems that no one has solved, or pushing yourself to find strong, creative ideas, you can forget about the classrooms, the textbooks and the homework exercises. Let's hope you've learned how to think. And this is precisely what education takes away from you—by serving up problems like caviar at a fundraiser, and of course letting you know afterwards if you were correct. You'll be lucky if you ever get past this fixation with correct and incorrect, as if life were going to cough up that kind of feedback for free.

People vary. I'm physically unable to sit through a class or lecture; the only way to hold my attention is to let it wander, usually uncontrollably. Education was a sore spot for me. But I've been absorbing math and stats and history and biology and electronics and you get the idea every evening since the day I got out of college.

Other people may enjoy the classroom experience, and that's a good start. But one has to keep learning. Real learning begins when a curious mind shuffles through bits of information from various sources until confusion and anxiety set in. Serious learning happens when that tortured mind manages to piece it all together.

There's no obligation to keep learning all your life. And Google, Amazon, MIT and Chicago have no obligation to hire you in a serious role. People are either inclined to keep learning, or they're not. I only wish to point out that you need to at least make up for having gone to school. You must learn to think. And don't read textbooks. Go through the web, use links to follow the path of largest uncertainty. Don't learn things sequentially from chapters, and don't learn what you don't feel like learning at that moment.

> *A good way to learn math is to read the first chapter of a lot of math books.*
> Paul Erdos

> *Do not read so much, look about you and think of what you see there.*
> Richard Feynman

Pythagoras, as you know, believed that everything in the world could be represented with whole numbers. Anything in between two whole numbers, he believed, could be represented with a rational number–a fraction made of two whole numbers. To be very precise, a fraction like a/b might require a and b to be very large whole numbers. Or, if a number happened to be exactly whole, then it could be represented like $a/1$. So the idea was that everything and anything, plus all the rest, could be represented with rational numbers.

The first proof that irrational numbers must exist was like this.

Imagine a pentagon whose sides all have length x_1. If you connect the vertices of the pentagon with straight lines, the intersection points of these lines form a new pentagon, a similitude of the outer one; thus it has five sides of equal length, which we will call x_2. The ratio of the length of the sides of the inner pentagon versus the outer pentagon, x_2/x_1, is always less than one.

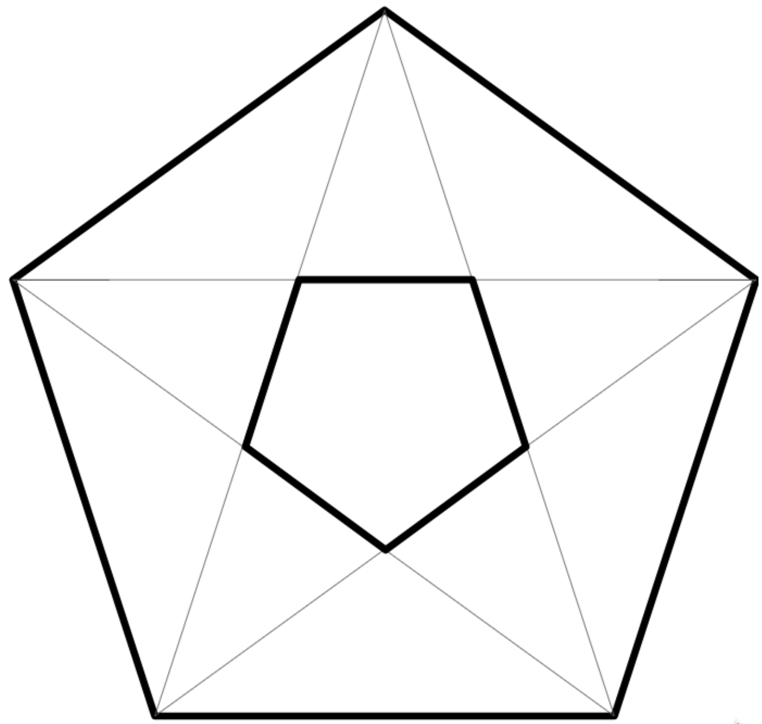

Figure 1

If you draw yet another pentagon inside the second pentagon, you create a new ratio, x_3/x_2, for the relative length of sides.

If you keep doing this, the ratio

$$\frac{x_j}{x_{(j-1)}}, \quad j = 2, 3, \ldots \tag{1}$$

will eventually become an irreducible fraction. At that moment, just draw one last pentagon inside the most recent one. Now, x_j and $x_{(j-1)}$ can't both be whole numbers. And yet, you have before you a physical reality whose measure is the ratio of those numbers.

That part of the story is true. But, in the 'history of mathematics' literature, the story usually goes on to say that the author of the proof was a student of Pythagoras, and upon learning of the proof, Pythagoras had him drowned in a barrel.

This was one of the most important proofs in the history of mathematics. Notice that there are no numbers, nothing you might have learned in class. Just careful, pristine thinking. Contrary to the lesson one swallows ten-thousand times in a classroom, the point of a theorem is not just to get there, but to see where the theorem takes you. The first time you prove, or loosely prove a theorem, and you realize something logical must follow, something previously unknown, you realize that the details and methods can all be absorbed in a day or a week, but this splendid moment finally happened because you got your brain to think freely and without reference to what is known, or what is correct. And don't worry about drowning in a barrel. I doubt that part was true. They were in Greece. It couldn't have been that far to the ocean.