

August 29, 2009
Visions of mathematics

At a meeting of math teachers last week, I heard the question, “What is our vision for mathematics at High Tech High?” It is my belief that there is quite a bit of agreement on this topic. In this letter, I aim to outline the types of students we want to graduate from our schools, the math content we teach, and the methods that we use to do so.

But first, a digression on why we don't teach math the way I learned it.

Insanity: doing the same thing over and over again and expecting different results. – Albert Einstein

“Everyone” knows how to teach mathematics. First, you take the smart kids and put them together in a room, because they need to be challenged. Then, you take the dumb kids and put them in a different room, because they need more support. Then you put the average kids in another room because they don't belong in the first two rooms.

Now that the students are sorted appropriately, “everyone” knows how the class goes. First, a short lecture on section 1.1. Now, work an example problem on the board. Next, assign problems one through thirty-five odd. Students start to work in class. Any they don't finish they can do for homework. Tomorrow, go over the homework. Short lecture on section 1.2. Test on Friday.

Interestingly, how class goes is exactly the same for the smart kids, the dumb kids, and the average kids. Just more problems and faster pace for the smart kids. Fewer problems and slower pace for the dumb kids.

Since everyone knows how math is supposed to be taught, and indeed, this is how math is taught throughout the United States, what are the outcomes of our approach?

1964

*“The first systematic cross-national assessment of mathematical competencies was conducted in 1964 and included 13- and 17-year-olds from 12 industrialized nations. The results of this study indicated that American adolescents were among the most poorly educated mathematics students in the industrialized world.”*¹

2003

*“In their most recent lackluster showing on the world stage, students in the United States scored below average in mathematics literacy and problem solving in an international comparison.”*²

2009

*“Students in the United States show little distinction compared with most other countries in reading, mathematics, or science at any grade level or age – and, according to one international test, are near the bottom of the pack in math.”*³

Now, international comparisons should be taken with a grain of salt. For those interested, Harvard

1 <http://www.apa.org/ed/geary.html>

2 Sean Cavanaugh and Erik W. Robelen, “U.S. Students Fare Poorly in International Math Comparison.,” Education Week, December 7, 2004.

3 Mary Ann Zehr, “U.S. running with pack on international tests,” Education Week, August 26, 2009.

professor Daniel Koretz has a fascinating discussion of such comparisons in his book [Measuring up: what educational testing really tells us](#). Nonetheless, there seems to be a disconnect between how everyone knows that math should be taught and the results of that teaching. So I am glad that we are questioning the conventional wisdom on how math should be taught, even as we know that we don't have all the answers.

Who is the ideal High Tech High graduate?

In [The Global Achievement Gap](#), Tony Wagner, professor of education at Harvard, outlined seven survival skills for the new economy. These are:

- Critical thinking and problem solving
- Collaboration and leadership
- Agility and adaptability
- Initiative and Entrepreneurialism
- Effective oral and written communication
- Accessing and analyzing information
- Curiosity and imagination

These strike me as worthwhile goals both for our students generally as well as for our students in terms of their mathematics knowledge and skills. To read more about the seven survival skills, read Tony's piece entitled [Rigor redefined](#).

What content should we teach?

Analyzing data 1/3	College physics math 1/3	SAT prep math 1/6
		Math as Art 1/6

The diagram represents a proposed framework for the types of math taught at High Tech High. Of course, at different grade levels, students are working on different levels of math, but these represent the overall goals.

Analyzing data: As one parent, who is a UCSD economist, pointed out to me a few years ago, learning how to analyze data well is one of the most practical skills we could teach our students. Consider how a politician can misrepresent reality by manipulating data. And think about all the people who analyze data for a living. To be well prepared for citizenship in a democracy and well prepared for productive work in a career, we should probably be doing a better job of teaching students how to analyze data.

College physics math: One thing that we never want to hear is that a student has gone off to college to take freshman physics or calculus and feels like they were not well prepared by High Tech High. No matter what we do, we need to be sure that students are getting the targeted, specific math that is needed to do well in college physics (and math). This could involve dropping many things that are traditionally taught in high school math classes but are unrelated to this goal.

SAT prep math: Even though I think I am so smart, I know that the SAT is a reality for our students. More important to our students than the California standards tests, we want to prepare our students to do well on the SAT, despite whatever we may think of the value of this test. As a side note, High Tech High students are among the top scorers on the SAT for any high school in San Diego, even as a significantly higher proportion of our students take this test.

Math as Art: All the math that we learn is not only to prepare us for college, career, and citizenship. Math can be a beautiful thing just for its own sake. I know I always loved math in high school just because it had a simplicity and elegance about it, and when I got the problem right, no one could disagree with me.

"The test of a first-rate intelligence is the ability to hold two opposing ideas in mind at the same time and still function." – F. Scott Fitzgerald

When teaching the math that we think is most important, we are pulled in multiple directions. We can follow a vision such as the one outlined above. Or we can follow the state standards and attempt to prepare the students for the end of year multiple choice tests. Or somehow we have to attempt to do both as well as we can and still keep functioning.