

THE CRISIS WE FACE AND HOW TO TRY TO DEAL WITH IT

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Math education in the United States is in crisis. Student performance and desire to learn is declining. Some groups feel that the cure is to drive math education back and increase rote memorization and teaching to the test. The fact is that the math taught 50 years ago will not prepare today's students for today's world.

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The Failure of Math Education in Our Schools

One crisis of American education is the dramatic drop out rate of high school students from college-intending mathematics programs. Typically a full half of a high school freshman class will drop out of the college-mathematics preparation sequence before their sophomore year. Half of the remaining students are likely to drop out by the next year; and half of those remaining students are likely out during the following year. Only about 12% of the students who started will actually complete the sequence. Math education has failed to capture the interests and imaginations of today's high school students.¹

This is a crisis for students in the schools because math permeates more of university education and life outside the university than ever before. In almost every field of study, math is strikingly more important than it was even twenty years ago. Many fields of study place demands on math that were not even thought about twenty years ago. Today's culture is both math-needy and math-hungry. But school math is failing to keep up with modern demands.

Meanwhile, a mathematical organization known as “Mathematically Correct” or “HOLD,” whose goal is to drive math education back 50 years, has risen to dangerous political power in the United States. Their message seems to be that math is a bitter pill, which must be swallowed, and that progress in math education is somehow evil. For them, standardized high-stakes tests justify the importance of their courses (and the test makers are not accountable to anyone).

The result is a continuing crisis in math education. As Sherri Fraser testified at a November 6, 2006 hearing of the American National Chicago:

This crisis in mathematics education is at least 25 years old. I remember in the 1980’s when the crisis in school mathematics became part of the national agenda with such publications as *An Agenda For Action* (NCTM, 1980), *A Nation at Risk* (National Commission of Excellence in Education, 1983), and *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (NRC, 1989). Those of you on the board who have been involved with mathematics education should remember these documents as well. Our country was in trouble. We were not preparing students for their future.

And we have yet to start. Recently William Wulf, President of the National Academy of Engineering, gave a speech called “The Urgency of Engineering Education Reform.” His main points were that academia has not kept pace with changes in the professions and is failing to educate students to be technologically literate.

About 15 years ago, Peter Lax, then president of the American Mathematics Society, complained that calculus, as taught then, was full of “inert material” and “parlor tricks” and was not paying enough attention to approximate numerical methods. Though the situation remains unchanged, Mathematically Correct seems to be happy with the state of mathematical education, but thinking citizens are not.

There is not much in American school math that captures the imagination of the students. Students seem to recognize that they are being fed very little information that they will ever need or use. As Alfred North Whitehead warned: “There can be nothing more destructive of true education than to spend long hours in the acquirement of ideas and methods that lead nowhere.” The students know that the only people in modern life who regularly use pencil-and-paper algebra and calculus are those who teach pencil-and-paper algebra and calculus. Modern American students

are turned off by math courses that seem to play no role in students' futures. This is a real shame.

Right now, thanks to the abundance of inexpensive computers, we have the opportunity to improve math instruction on a vastly broader, more interesting front, which will improve the importance of the math learned by students. For instance, with the help of the Monte Carlo method, and programs such as *Mathematica*, probability can ascend to the top of school mathematics. The stranglehold difficult combinatorics has on school probability disappears. Important measurements related to normal (Gaussian) and exponential distributions can be handled by the Monte Carlo method thereby making that portion of mathematics no more complicated than counting.

Another example is area-of-growth models coming from $y' = f[x, y]$. By simply plotting the region where $f[x, y] > 0$ and the region where $f[x, y] < 0$, the general long term behavior of solutions can be found by visually inspecting the plot. Popular media such as Jurassic Park and Numb3rs have made students crave an understanding of chaos theory. Mathematical educators can satisfy this craving by introducing discrete dynamical systems, such as predator-prey models, where extra prey are added or harvested.

In fact the course MBC (Math before calculus) is full of such examples and may be downloaded and run on Mathematica-equipped computers. See <http://calcand.math.uiuc.edu/courseware/math016/> for download and <http://mtl.math.uiuc.edu/cpm/> for a description of the lessons. The material in this courseware places students in a virtual sandbox where they can play with the ideas leading up to calculus.

References

1. Mathematical Sciences Education Board, & National Research Council (1989). Everybody counts: A report to the nation on the future of mathematics education. Washington, D. C.: National Academy Press.