# Because Math Matters

The president has recently appointed a National Mathematics Advisory Panel. National newspapers carry lead editorials on math education. Why, and why now? For many years there has been a debate on how to best teach mathematics in our nation's schools. There are a number of reasons that this discussion has gone on so long and become so heated. The first is that there is a great deal at stake. From Sputnik on, we have worried about our ability to compete in science and industry—first with Russia, then with Japan, and now with India and China. Mathematics is at the heart of technological innovation, advances in engineering, physics, medicine, biology, and on and on. Mathematical models can forecast environmental change and monitor energy supply and demand. Without mathematics we wouldn't have MRIs or maps of the human genome.

Second, we are not doing a very good job. U.S. students are falling behind students in most industrial countries as measured on any number of international tests. Again math matters. We know that the careers of the twenty-first century will require more and more quantitative reasoning. We know that in this global economy, companies can and will outsource jobs to countries with more mathematically skilled work forces. To quote CBS news great Fred Friendly, we don't want to become a country "in which we take in each other's laundry".

The third reason the debate is so heated is that it has become political. We hear terms like "back to basics" and "fuzzy math". But what's lost in all of this is the kids. Education debates need at their heart to be about education. We want our children to learn, to understand and be able to use mathematics as they go through school and work. Not all students will go on to be mathematicians, but they will all be called upon to use the mathematics they know.

I can't emphasize this point strongly enough. The half-life of students in mathematics courses remains one year from 10th grade on. In other words, the number of students taking math in 11th grade is half those taking math in 10th and so on for every year up until the Ph.D. What happens to the other half? We simply cannot afford to throw away half of our students each year because they don't have serious prospects of becoming research mathematicians.

We can continue to ask students problems of the form "solve for $x$ in the equation $x^2-3x+1=0$". Or we can ask at what proportion of performance-enhancing drug use in the population is it cheaper to test two athletes by pooling their blood samples—which leads to the same equation. We can teach mathematics through engaging contexts kids will see as real and important or continue to insist on honing skills. Learning to hammer a nail before trying to build a house sounds right. But hammering nails for six years before even knowing that there's such a thing as a house just doesn't make sense. If mathematics is a life skill, then students need to see mathematical skills at work in their lives.

And that brings us back to the National Math Panel. This panel was formed as a part of the president's new American Competitiveness Initiative. The idea was to have a panel with expertise in mathematics education study the issues and give the president their best advice on how to train our students in the subject. This was to be a diverse panel with broad experience representing many points of view. But many panel members have little or no mathematical training. And many subscribe to the philosophy of emphasizing mechanical skills over the ability to meaningfully use the mathematics learned. It is hard not to fear a replay of the National Reading Panel that dealt with the issue of phonics vs. whole language only a few years ago.

But math matters. We cannot afford partisan politics. The National Science Foundation, staffed by independent scientists and mathematicians, has led the effort for innovation in mathematics education since the 1950s. Innovation is desperately needed. We must not go back to methods that have consistently failed us. After all, the reason that the current reform movement began in the first place was that we were unhappy with student performance. What we need are serious people who recognize the importance and difficulties in getting a quantitatively literate citizenry and who are willing to put aside any specific political agenda.

Articles in the *Wall Street Journal* and the *New York Times* have declared that the Math Wars are over and that the Back to Basics movement has won. Well, I have news. The Math Wars are not over because this is still about helping children learn, not about winning a political battle or finding common ground. We will continue to call for the introduction of new and relevant content, the appropriate use of new technologies, showing students important contemporary applications and using innovative pedagogical approaches. And we will do this, because math matters.

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# Letters to the Editor

## Teaching the Romance of Mathematics

It has been refreshing to see *Notices* include increased coverage of the public perception of mathematics, books for lay audiences, and mathematics in the media over the past few years. Sadly, I found the editorial section of the October *Notices* retrograde.

It is not a good sign when the principal math consultant of *Numb3rs* and the past president of the National Council of Teachers of Mathematics both write letters to take issue with *Notices* Opinion pieces regarding this popular show which features mathematics in prominent ways. Rightfully, this show won this year's Carl Sagan award. Do you remember Sagan? All of science and mathematics are still reaping the benefits of Sagan's tremendous achievements in popularizing astronomy, yet in his time he was snubbed by not being elected to the National Academy of Sciences.

Which brings me to my main objection, Daniel Biss' "Communicating the Romance of Mathematics" (*Notices*, October 2006). While agreeing that such communication is "absolutely essential", I found the depth of his essay to be unworthy of a *Notices*' Opinion and his complete omission of the role of teachers to be utterly insulting.

Biss wonders "What can be done" about society's misconceptions of mathematics. What can be done?! Lots of us are doing it—it's called teaching! Many fine mathematicians (AMS members, no less) work on this "daunting problem". We have long embraced teaching core mathematics classes for non-majors, mathematics appreciation courses, and other lower level courses as activities central to our profession. We will never be as well known as Keith Devlin, Ivars Peterson, and the *Numb3rs* producers. But our teaching, scholarship, and the passion we bring to our calling is central to the struggle to change the public's perceptions of mathematics. In this light, Biss' ideas about "communicating the romance of mathematics" are entirely superficial. He needs to get out more. He should come to one of my Mathematics for Liberal Arts classes. Or maybe one of Michael Starbird's. Or one of Annalisa Crannell's. There are thousands of mathematicians across the country successfully inspiring students and challenging their misperceptions of mathematics.

We are accustomed to being marginalized by society, our political leaders, and even our college and university administrations who often fail to see the scholarship involved in teaching. But how dare the *Notices* ignore us? In the future I hope the *Notices* encourages paradigm changes which serve to recognize, nurture and reward the work of these mathematicians. Through our teaching we add tremendous value to the society of mathematics—and not just the American one. Until then, I'll take some small solace in being in the company of Sagan and many fine disrespected colleagues who consider themselves both mathematicians and teachers.

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## What Did Turing Mean?

On page 1192 of the November 2006 issue is a photo of a piece of scrap paper, containing the following sentence (vii) written by Turing:

"A power series whose coefficients form a computable sequence is computably convergent in the of [sic] its interval of convergence".

The phrase "in the of" being ungrammatical, what did Turing mean to write?

It is true that a power series whose coefficients form a computable sequence is computably convergent in the *interior* of its interval of convergence. And indeed, in sentence (x) of the same page Turing does remember to include the word "interior".

However, a power series whose coefficients form a computable sequence is *not* necessarily computably convergent wherever it is convergent. For example, $n \geq 0$ and let $a_n = 2^{-m}$ where $m$ is such that there are exactly $n$ many positive integers $k$ such that a fixed universal Turing machine, running computations on all possible inputs in parallel ("dovetailed"), halts on input $k$ before halting on input $m$. Consider the power series $f(x) = \sum_{n=0}^{\infty} a_n x^n$.

This series is convergent, but not computably convergent, at $x = 1$. Indeed, otherwise there would be an algorithm to solve the Halting Problem for Turing machines.

The essence of this example seems perhaps at first to be the fact that the coefficients $a_n$ do not converge computably to zero. However, a minor modification of the example gives a sequence of coefficients that converge monotonically (hence computably) to zero, and nevertheless the sequence of partial sums of the power series does not converge computably.

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## Competence of American Math Graduates

Irwin Kra pointed out that the persistent mediocrity of American math education is primarily due to the shortage of knowledgeable and competent math teachers (*Notices* of AMS, December 2006, p. 1301, and *Focus* of MAA, November 2006, p. 18).

Let me pose a less-asked question: why does the American higher education system keep producing unknowledgeable and incompetent math graduates in the first place? It's my personal experience that an average American undergraduate math (or math-education) major near the completion of his degree cannot even write mathematics in a syntactically flawless fashion, let alone the accuracy of semantics. (Do music departments award degrees to pianists who consistently play wrong notes?) Since there is no standardized measure of college math graduates' competence, this widespread prob-

lem is not quantified or even publicly acknowledged.

While I don't have an easy answer, let me share some experience of comparative value. I had my secondary education in China; my high school mathematics and physics teachers were smart, knowledgeable, and competent because (I could make this inference in China but not in U.S.) they all held a college degree. One would assume that college students in the wealthiest nation, where they are only required to learn a fraction of what their third-world counter parts have to learn, will have learned that fraction very well; but perplexingly, many don't and we hand them diplomas anyway.

The Math Science Teaching Corps Act introduced in Congress is a very expensive proposition (*Focus* of MAA, Nov. 2006, p. 18). It would have been unnecessary if college diplomas were worth their face value.

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## Clay Millenium Prizes

In the January 2007 issue of the *Notices* of the American Mathematical Society, Anatoly Vershik writes in his commentary on the million dollar Clay Millenium Prizes that "this method of promoting mathematics is warped and unacceptable, it does not popularize mathematics as a science, on the contrary, it only bewilders the public and leads to unhealthy interest."

There is no question that the Clay Millenium Prize contributed to the remarkable amount of press coverage received by the resolution of the Poincaré conjecture. In the weeks which represented the apex of the media's interest in the matter, I had at least ten in-depth discussions about topology and the Poincaré conjecture with friends who are not mathematicians but whose interest was piqued by newspaper, magazine, and television reports on the subject. I do not know exactly what Vershik means by "unhealthy interest", but in my view, this represents an unqualified success on the part of the Millenium Prizes.

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### Identifications

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### Submitting Letters to the Editor

The *Notices* invites readers to submit letters and opinion pieces on topics related to mathematics. Electronic submissions are preferred (notices-letters@ams.org); see the masthead for postal mail addresses. Opinion pieces are usually one printed page in length (about 800 words). Letters are normally less than one page long, and shorter letters are preferred.