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Math Education: A Messy Problem

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Math education deserves support and attention (essay)

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Andrew Hacker's *The Math Myth and Other STEM Delusions* simply continues to promote the misguided path he got on several years ago, and it's difficult to see how it could lead us anywhere productive. Hacker started the business of attacking school mathematics in a *New York Times* op-ed [1] where he argued, in sync with gimmicky T-shirts claiming the same, that algebra was unnecessary, or perhaps even detrimental to our future. In a national scene where mathphobia is rampant and most people's memories of school mathematics remain unpleasant at best, he struck a chord. Then, of course, come book contracts and even more adulation.

Thoughtful people have already responded authoritatively [2] to the various errors in Hacker's argument -- see here for another scathing review [3]. A short and quick reply is here [4]. For this audience of college and university educators, some of whom might be tempted by Hacker's bravado and wonder about implications for higher education, I'd like to also point out that Hacker seems to forget why we educate our young. Even if as students years ago we may have had difficulty in certain subjects, as parents we want to ensure that our children go beyond what we ourselves have achieved. We expect that what they learn will be beneficial to their growth and future opportunities. We also hope that they will gain certain personal characteristics that, together with their knowledge and skills, will help them build a better future for our society and the world.

The Western tradition starts this conversation in ancient Greece with Socrates arguing that virtue is central to the education of the young. Aristotle teaches us that the ultimate goal of education should be happiness -- the durable contentment of a creative and intellectual life. St. Augustine shows us that we should not depend on teachers to teach us everything, that there is much to be learned from the internal wisdom of the heart, which itself is cultivated by our moral compass. Rousseau argues that children need to be exposed to the world as they grow to learn to live within the society to which they belong. Locke and Mill teach us that education should be well-rounded, cultivating an intellectually capable mind aware of the complexities of the world.

Mathematics educators agree. We know that in mathematics, as in any other knowledge system that builds on itself, the procedures that work so well are only part of the package. That in the center is the student, but always situated in the midst of a society that is constantly evolving. That students learn best when encouraged and supported by knowledgeable teachers who help them explore and understand underlying concepts. That intellectual stimulation and growth are possible and enjoyable for all children. That in our classrooms, we can help students sharpen their ability to persist in the face of apparent failure. That today's students need to learn to tackle

complex and ill-defined problems requiring both individual and collaborative effort.

And to these ends, we have been working to improve what we do. Mathematics teachers, mathematics education researchers and mathematicians are working together in classrooms, in math circles [5], in conferences and workshops, in curricular reform efforts and in policy discussions. We are working to create meaningful mathematical experiences for students to encourage critical thinking, foster creative reasoning and enhance problem-solving abilities. (See here [6] and here [7] for two collections of mathematics lesson plans and modules that were developed by or in collaboration with researchers. See here [8] for a college-level initiative for revamping the mathematics curriculum.)

We are working to engender the sense of wonder and accomplishment that mathematics -- when done right -- naturally inspires. We are working to develop and support a coherent set of curricular standards that will help tomorrow's adults live up to the expectations of this nation from its children. We are working to discover and share with parents, teachers and educators what works well in the classroom even if it is not typical, and what doesn't work even if it "just makes sense" and "it's the way I learned things." (How many people believe that the point of multiplication tables is to torture students till they can recite them at the speed of light? Linda Gojak, past president of the National Council of Teachers of Mathematics, is one among many educators speaking out about fluency in mathematics [9] and how it is no longer acceptable to equate it with "fast and accurate.")

Admittedly, we mathematics instructors don't always help our own cause. People remember how their middle school math teacher made them feel, and I don't need to tell you that it's generally not a good memory. (I was lucky -- mine made me feel like there wasn't a problem I couldn't solve if I put in the time and effort.) But dropping mathematics from the required K-12 curriculum would be a perfect example of the cliché of throwing out the baby with the bathwater. (While I myself have argued elsewhere [10] that we might just do that, my tongue was decidedly set in my cheek, and my concern was the essence of what is lost in most mainstream experiences of school mathematics. Now, can I get a book contract, too?)

The current state of mathematics education in the United States is certainly not ideal. Yet the fact is that teachers, parents, mathematicians, mathematics education researchers and policy makers are working on it. Furthermore, this is definitely a problem worth working on. It is tough, it is messy [11] and there are many nuances to the issue and many implications to any avenue of resolution.

Hacker writes of high school graduates unable to perform simple numeracy tasks. I'd venture to guess that more than a handful of high school grads are also incapable of understanding IRS publications, may occasionally be unable to interpret correctly the user manuals of their DVD players and can't foresee all repercussions of a ballot measure they are willing to vote for or against. But we do not blame all of these insufficiencies on K-12 English teachers. Nor do we suggest replacing English courses with courses on reading ballot measures or user manuals. What do we do? We demand that English Language Arts curricula be developed that are more sensitive to the range of literacy demands of our daily lives.

Hacker gets it right at least in one instance; quantitative literacy *is* crucial in today's society. And it should be one of the essential outcomes we expect from our education system, as I argue [12] elsewhere [13]. However, the role of mathematics in our education system goes beyond quantitative literacy. (And conversely, quantitative literacy as a goal itself should not be limited to

the mathematics classroom. Most science and social studies classrooms offer excellent contexts for quantitative literacy.)

During this election year, I offer you another analogy. Today there are many, including some reading this, who worry that the American democratic machine is not producing the results they would like. So shall we give up on democracy? I'd like to believe that the overwhelming majority would agree with me when I say no. Instead, we continue working to improve our system; we continue to fight for broader access; we continue to work to further political and social justice.

Mathematics education is perhaps not on the same level of importance and urgency, but the solutions are the same. We must work to improve the system. We must fight for broader access. And we must work to further political and social justice.

Today mathematics acts as a gateway (or a gatekeeper, depending on your perspective) in terms of who has access to the lucrative STEM jobs that many aspire to. Students who learn mathematics as far as their school contexts allow have many more opportunities open to them when they graduate from high school. Knowing the fundamental building blocks of mathematics today leads well-prepared high school graduates to a range of rigorous paths of college-level study in many disciplines. And those are also the students who will become the adults who will create the new mathematical, statistical and computational tools we will need in the future.

What would happen if we dropped mathematics? Which schools and school districts would not be offering those "now optional" advanced mathematics courses? Which students would be deprived of the opportunity to learn, and, can I suggest, find meaning, confidence and opportunity through advanced mathematics? And which students would be able to move forward with those STEM careers that many parents dream of?

People can succeed without mathematics in their lives. You can also choose to never try sushi, to vacation only within the continental United States despite being able to afford international travel, to never wear flip-flops or learn to ride a bike, and still lead a happy and productive life. But nobody's job prospects are affected by their decision to avoid sushi (unless you want to be a sushi chef, which would be odd if you didn't like sushi to start with). And having the choice to decline comes out of privilege. Can this nation afford to make such a decision for all its children? When people choose to drop mathematics later in their academic paths, we can say they made a decision knowing their options and the opportunities they are letting go. But do we want to make these decisions ahead of time for all students?

The American education system differs from many of the nations that are touted as high performers. In most of those countries, students are channeled into various tracks early on. This nation does not regiment its schoolchildren, because we believe that all children have potential and that they can make choices once they are old enough to know what is out there.

And the American education system is still one of the best in the world. I know the international test scores and rankings, but I also know to read the fine print. Therein you learn that once you restrict to schools where less than 50 percent of the class is in the free lunch program, the performance of students is in par with those high-performing nations. The schools that are "failing" are the ones that have 75 percent or more of their students in free lunch programs. So our schools are not failing our students; it is our society that is failing them. As most education researchers (and teachers in classrooms across the nation) will agree, the problem of public education in the United States is one of poverty. And that problem is not going to get solved by

dropping the mathematics requirement in the K-12 curriculum.

In fact mathematics can help. Here is where Plato's virtue and St. Augustine's moral compass come back into school mathematics. Brazilian mathematician Ubiratan D'Ambrosio has been telling us for years [14] that it is mathematics that will help our children solve the varied problems of today and tomorrow -- if we can teach them to see the inherent mathematics involved. Mathematics, historian Judith Grabiner points out [15], has evolved precisely to describe social, environmental and political, as well as industrial and scientific, problems that a society happens to confront. And it remains, to this day, our most successful method to seek out creative and productive solutions for them. (Readers perplexed by my inclusion of social, environmental and political problems above might like to google "mathematics for social justice" or "mathematics of sustainability.")

I write this with the hope that some good may come out of Hacker's simplistic recommendations. Students reciting their multiplication tables as fast as a bullet train are not the desired outcome of mathematics education. We want students to understand the power and limitations of the mathematics they are learning. We want students to move flexibly from one specific model of a situation to another. We want students to be able to find unexpected and novel solutions to problems that are ever-growing in their complexity.

Mathematics is where we can train young minds to do all these things. Mathematics is where we can teach that critical ability to reason analytically. Mathematics is also where we can encourage creative exploration of the multitude of options a problem solver invariably has. As college and university educators, these are points we must not forget when the next cycle of general education debates begins to shake things up on our campuses.

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[1] http://www.nytimes.com/2012/07/29/opinion/sunday/is-algebra-necessary.html
[2] http://devlinsangle.blogspot.com/2016/03/the-math-myth-that-permeates-math-myth.html
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[4] https://xkcd.com/1050/
[5] https://www.mathcircles.org/Wiki_WhatIsAMathCircle
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[10] http://magazine.pomona.edu/2015/fall/what-if/
[11] http://www.open.ac.uk/cpdtasters/gb052/index.htm
[12] http://scholarcommons.usf.edu/numeracy/vol1/iss2/art6/
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[15] http://mag.uchicago.edu/science-medicine/beauty-numbers
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