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# Debating Mathematics Curriculum
## A Review of Andrew Hacker's *The Math Myth: And Other Stem Delusions*

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Broadly speaking, school mathematics has been placed in a double bind. From state policymakers, there is the culmination of decades of increasing requirements to teach more mathematics, which now often means a requirement of four full years of mathematics in high school or every student progressing through at least a second course in algebra (Remillard et al., 2017). From the mathematics education community, there is growing consensus around the call to ban tracking (e.g., National Council of Teachers of Mathematics, 2018; National Council of Supervisors of Mathematics & TODOS, 2016) because of the known harms of identifying and segregating students based on mathematical "ability." But tracking is one of the primary strategies that schools (and communities) conceive of when trying to meet the demand for all students to complete more mathematics courses.

This double bind is one of the central problems addressed in *The Math Myth: and Other STEM Delusions* by Andrew Hacker. Hacker, a political scientist rather than a mathematics education, came onto the scene of the broad mathematics curriculum debate when he published the opinion piece "Is algebra necessary?" (2012) in the New York Times. The article points out the struggles and frustrations that many students have in algebra and wonders whether it is necessary to subject all students to this "ordeal." Hacker's position was that it should not necessarily be required. The article received such a massive response, with outcry from both sides of the debate, that he wrote *The Math Myth* as a more thorough dive into these issues of mathematics curriculum and requirements.

Around the time of Hacker's article, I wrote my own opinion piece entitled "Cornered by the real world: A defense of mathematics" (Otten, 2011). Like Hacker, I acknowledged

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students' frustrations with having to learn mathematics, especially from algebra onward. When they ask, "Why do we have to learn this?" I recognized they are expressing a need for motivation and relevance with regard to the subject matter. I argued that appeals to tangible real-world connections between the algebra content and students' everyday lives often rang hollow or were downright dishonest. On this point, Hacker would seem to agree with me. He does not perceive relevance of algebra and higher mathematics to people's everyday lives. But where our earlier articles diverge is in regard to the solution to this situation: Hacker proposes reducing or eliminating students' experiences with higher, more abstract mathematical content, whereas I still sought a role for that mathematics, albeit with a different approach to the teaching and the classroom culture wherein mathematical processes and collaborative interactions were emphasized rather than specific content.

Overall, I agree with many of the premises that Hacker articulates in *The Math Myth* and I even agree with some elements of his proposed solution, but there are also disagreements that I believe are worth expressing. In the remainder of this review, I briefly summarize what I see as the core of Hacker's argument, pointing out the boundaries of my agreement and disagreement.

## The Myth

What is the central myth about mathematics education that Hacker seeks to expose? In short, he views it as a myth or a collective delusion that mathematics education must be a formal progression through a sequence of abstract topics, ultimately culminating in university-level mathematics. Hacker attacks this myth from a few different angles. He argues that it need not be exclusively formal and abstract in nature, and he also makes the case that the mathematics curriculum need not lead exclusively toward university-level mathematics.

Additionally, Hacker contends that it is a myth that mathematics is uniquely positioned with esteem and mandates above other subjects. As he stated on page 70, "this book has agreed that mathematics is an honorable calling and deserves an esteemed place in the pantheon of learning. But it is something else again to make it central to entering the citadel of merit." He sees no reason that mathematics should be required as such a "prolonged sequence of a single discipline, with no alternatives or exemptions" (p. 13), and in fact there are many reasons *not* to rigidly require it, as I summarize in the next section.

I agree with these broad-based myths in mathematics education as Hacker has identified them. As a subject, mathematics is not any better or worse than other subjects in terms of the potential to encapsulate aspects of the human experience. And mathematics may be one of the worst offenders with regard to the reality of how students experience the subjects, with mathematics being a dehumanizing force (e.g., Martin, 2019) and a contributor to economic inequality (e.g., Morton & Riegle-Crumb, 2019). Where I disagree, however, is with the notion that this rigid, abstract, dehumanizing school subject is representative of mathematics as a discipline. Many would contend, for example, that mathematics has the potential to be humanizing (Cirillo, 2007), creative (Lithner, 2008), and a force for equity (Rubel, 2017).

In other words, when Hacker and I look upon the situation of too much abstract mathematics in school, he focuses on there being "too much" of it and I focus on the "it" being the wrong sort of stuff. The creative, problem solving, reasoning-rich mathematical discipline that has garnered society's esteem is not the same as the mathematics that is being required in school and causing the double bind noted at the start. Of course, there is more nuance on both accounts, to which I now turn.

## The Situation

Hacker's (2016) book is especially helpful as a non-expert's guide to the current status of mathematics education and its place in society, particularly 21st Century American society. In each chapter, he includes the voices of students, teachers, and other individuals expressing their frustrations with school mathematics. Hacker makes a compelling case with regard to the fact that mathematics, although given opportunities year and year, has dampened most people's spirits on the subject and has squandered the potential to build excitement about mathematics. “No other field—not history or philosophy or chemistry—has such a chance to display its wares to such a wide swath of students” (p. 95), Hacker writes but the animosity and frustration tends to grow rather than recede.

Because of mathematics’ poor track record of spurring creativity and promoting human flourishing, and because it is an academic gatekeeper, Hacker points out that it has played a substantial role in “denying society a wealth of varied talents” (p. 12). Its hurdles contribute to our social divide, including the extreme wealth inequality and the racial wealth gaps in the United States. Hacker cites mathematics as the “primary academic cause” (p. 29) for college attrition while also recognizing that (a) poverty is more of a root cause for inequality than is the mathematics curriculum and (b) the shortage of STEM workers in the U.S. has more to do with low pay rates than the STEM training pipeline. As Hacker succinctly put it, “A nation that leads much of the world in inequality cannot expect to have stellar mathematics scores across the board” (p. 132).

I agree with the assessment that mathematics has been required of more and more students but we are failing to use that exposure to build more interest in mathematics. I also agree that our current approach in school mathematics is often excluding students from historically-marginalized groups and is closing doors on individuals with a lot to offer, just because they are not resonating with the rigid way in which mathematics is taught. I disagree, however, with the predominant economic lens that Hacker uses to view the situation. Although Hacker does briefly acknowledge the “truth and beauty” of mathematics and admits that its quantitative and spatial aesthetics are in the “national interest” (p. 88), he more often relies on economic statistics, career outcomes, and other social measures. As Shah (2019) stated in his own thinking about mathematics in the school curriculum, “A more racially just world can’t only be about economics. It must also be one where people of color are recognized as full human beings.”

An even more fundamental disagreement I have is with Hacker’s prevalent tendency to view school mathematics from the perspective of the topics being taught. Here are just a few of the many instances where I detected his focus on mathematical topics (emphasis added):

> New talents of many sorts will surely be needed. But first to require that all show proficiency in *parabolic geometry* will actually hinder the emergence of strengths not based on equations. (p. 19)
>
> The reasoning for [requiring advanced algebra] purports to be practical; even midlevel occupations, we are being told, will have tasks involving *trinomials*. (p. 33)
>
> In the one hundred fifty minutes the [computer science] classes were in session, not a single *mathematical notation or equation* was alluded to or projected on a screen or board. While computer programs use *numbers* as raw materials, the codes that do the organizing are almost entirely composed of symbols. (p. 50)

In these examples, Hacker is thinking about specific mathematical topics and pointing out their lack of connection to the workplace or related STEM fields like computer science. The book also contains several instances where Hacker selects items from the Common Core State Standards (2010), the GAISE report (2007), or a standardized assessment with his point being to show the abstract and esoteric nature of the items, detached from practical usefulness. Putting aside the fact that Hacker refers to the Common Core standards as a set of "unbending lesson plans" (p. 102), which they most certainly are not, my primary difference from him is that I tend to look at school mathematics through the lens of process and practice, not content topics. I would look for the forms of reasoning, the precision of communication, the culture of critique, or the problem-solving strategies (Koestler et al., 2013) that are evident in workplaces or computer science classes, not for specifically recognizable mathematics formulas or algorithms. In fact, it is this broad range of rich mathematical practices that I would hope could also be evident in people's personal lives and their interactions with their communities, as a way for mathematics to support human flourishing and a "more racially just world" as Shah (2019) described.

Regardless of our different lenses for viewing mathematics in the world, the situation remains the same. School mathematics as it is currently imposed on students seems to provide neither the useful content that Hacker seeks nor the dynamic processes that I seek. So we turn to potential solutions.

## The Solution

Hacker (2016) cites a mathematician who makes the claim that not all students need “complex numbers, rational exponents, systems of linear inequalities, and inverse functions” (p. 24). This is, in a nutshell, Hacker’s main point—that the advanced *topics* of school mathematics are unnecessary in life and are detrimental with regard to equity because they frustrate too many students. What does he propose as the remedy? Again, he focuses on the substance or the topics to be taught, although admittedly with some attention to the depth of reasoning that should be involved.

Hacker believes that it is “feasible to ask for creativity in geometry and originality with algebra” (p. 136), and I agree. He proposes as the way to get there a renewed focus on arithmetic and statistics at the secondary level. Hacker thinks that the realm of arithmetic and number sense can be tapped for much more potential than occurs just in the elementary grades. He thinks that numerical situations from the adult world can be made the focus of secondary mathematics, with both number sense and statistics as the means for delving into those situations. With his economic perspective again rearing its head, he states that in the workforce today, “what’s wanted is not traditional mathematics, but agility with numbers, usually geared to specific processes or equipment” (p. 36). Hacker’s contention is that “time and effort that might have been devoted to nurturing numerical agility has been given over to asymptotes, rational exponents, and other esoteric topics that only those who choose to major in mathematics in college will ever encounter again” (p. 140).

He also sees a role for some geometry, but with deeper investigations into lower-level content rather than pushing to abstract upper heights. He gives an example of students being led to “discover” and better understand π by measuring the diameter and circumference of a cylindrical cake pan. I agree that such a lesson may be more engaging and fruitful to students than endless exercises computing formulas with π, but Hacker’s lack of experience in mathematics education shows when he simply has students measure a single circle to estimate π, omitting the most crucial part of the concept which is that π is invariant across all circles. Thus, for me with a focus on the processes of exploring and generalizing mathematical truth, I would extend the lesson to involve many different sizes of circle.

To be fair, one mathematical process that Hacker (2016) does dedicate substantial attention to is reasoning-and-proving. He points out that mathematics education scholars assume studying mathematical reasoning should lead people to also behave more logically and intelligently in their lives. Hacker cites a 1980 NCTM source book saying as much, although it should be noted that this was actually from a joint committee of the Mathematical Association of America and NCTM, not solely NCTM. Nevertheless, in response to the claims that mathematical reasoning extends to other arenas, Hacker argues that it is "largely wishful thinking and far from proven propositions. Rather… the claim that studying mathematics uniquely instills desirable modes of thought is built on premises that have never been verified and erode on closer examination" (p. 74). I have done substantial work on reasoning-and-proving (e.g., Otten et al., 2013; Otten et al., 2017) and I have to agree that the direct link between mathematical reasoning in school and students' logical reasoning later in life is dubious at present, but note in the previous quote that Hacker shifted the goalpost by inserting the word "uniquely". Hacker focuses on other subjects besides mathematics that could also contribute to people's rationality in life. He states that "there are other, more fruitful, ways to understand the meanings and processes of real-world proof than from the study of mathematics. These alternative approaches can challenge our mental powers no less profoundly than geometry and algebra, and relate far better to our personal and public lives" (p. 81). He gives examples of legal arguments and cumulative scientific evidence. And while I agree that multiple subjects can make contributions toward a society of logical reasoning, I do not think the most important question is "which subject(s) should be the sites for teaching reasoning?" A better question is "*how* can we provide opportunities for students to engage in reasoning in ways that support human and societal flourishing?" This goes for every subject, including mathematics. If we are not teaching reasoning in a way that promotes logic in people's lives, rather than abandoning reasoning in mathematics, we need to approach it differently.

Returning to Hacker's main solution, though, I must say that I am not opposed to developing deeper arithmetic and number sense into the secondary grades, akin to what Paulos promotes in his books (e.g., Paulos, 1997). I also agree that number and statistics should get more time in middle and high school at the expense of certain specific topics in algebra, trigonometry, or precalculus. But the overarching solution, in my view, comes not from the correct set of topics but instead from a process- and community-oriented approach to mathematical activity, regardless of the topic of the day. My emphasis on the community interactions brings us back to the notion of tracking. If a relevant sort of school mathematics involves learning how to share and critique ideas respectfully and develop skills of consensus building, then it does not make sense to segregate students along the way. The whole point is that we maintain a diverse and inclusive community as we engage in these processes together.

Hacker (2016) also seems to oppose tracking. He notes that, because of ever-increasing mathematics requirements in high school and our failure to support the success of each and every student in mathematics, a high school diploma itself has become a de facto tracking mechanism. He also notes that, within high schools, mathematics is the worst offender when it comes to tracking and that the push for tracking stems from the requirement that all students are forced to take mathematics, and even though the desire is to support academic success, the "human fallout can be enduring" (p. 129). Hacker's solution is to reduce the requirements for school mathematics and to also change the topics taught so that more students will be engaged and successful. I agree that, if rigorous mathematics requirements mean that schools will necessarily implement tracking in an attempt to meet the requirements, then it would be best to eliminate the requirements and the tracking together rather than maintain both together. But another solution that I hope for is to keep some of the big ideas from algebra, geometry, or precalculus—even if they happen to be abstract—but engage those ideas through rich mathematical practices and with an entire, diverse mathematics classroom community.

## Conclusion

Regarding the double bind on school mathematics, many critics are working to convince schools and communities to eliminate tracking. But to be fair to schools, this may be too much to ask unless we are also willing to advocate for a reduction in the "rigor" or the extent of the mathematics requirements. As Shah (2019) pointed out, the school curriculum is a zero-sum game, and the more time that is staked out for mathematics, the less that is left for other subject areas. Shah, as a mathematics educator, sees profound value in other subjects. If our staking out of substantial amounts of time on secondary mathematics topics also brings with it a tracking model of student segregation, then I contend it is not worth the cost.

Hacker's (2016) *The Math Myth* provides a compelling case for the inadequacy of our current approach to mathematics curriculum and offers some reasonable suggestions for a change in the topics covered and an emphasis on numerical and statistical reasoning that he feels would be more beneficial to society and more engaging for students. I have also argued for a focusing in on fewer topics to be covered, with an emphasis on the mathematical processes to be cultivated among the classroom community (Otten, 2011). Yet another path forward may come from the technological tools available to us. For example, tools like Photomath, which do algebraic computations for students, can be viewed as an opportunity to refocus our efforts in school on the humanizing elements of mathematics such as problem solving, making connections, and drawing conclusions (Webel & Otten, 2015). Conrad Wolfram (2020), in a podcast episode discussing his book *The Math(s) Fix*, also describes how the ubiquitousness of computing power should lead to a change in the mathematics curriculum, with technology welcome to do the menial calculations while students can spend their efforts on formulating problems and interpreting results.

Overall, what we all seem to agree on, whether our guiding light is everyday relevance, student engagement, economic demands, equitable opportunity, or human flourishing, is that there are many opportunities to improve the current situation with respect to the mathematics curriculum.

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