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Is Algebra Necessary?

By ANDREW HACKER

A TYPICAL American school day finds some six million high school students and two million college freshmen struggling with algebra. In both high school and college, all too many students are expected to fail. Why do we subject American students to this ordeal? I've found myself moving toward the strong view that we shouldn't.

My question extends beyond algebra and applies more broadly to the usual mathematics sequence, from geometry through calculus. State regents and legislators — and much of the public — take it as self-evident that every young person should be made to master polynomial functions and parametric equations.

There are many defenses of algebra and the virtue of learning it. Most of them sound reasonable on first hearing; many of them I once accepted. But the more I examine them, the clearer it seems that they are largely or wholly wrong — unsupported by research or evidence, or based on wishful logic. (I'm not talking about quantitative skills, critical for informed citizenship and personal finance, but a very different ballgame.)

This debate matters. Making mathematics mandatory prevents us from discovering and developing young talent. In the interest of maintaining rigor, we're actually depleting our pool of brainpower. I say this as a writer and social scientist whose work relies heavily on the use of numbers. My aim is not to spare students from a difficult subject, but to call attention to the real problems we are causing by misdirecting precious resources.

The toll mathematics takes begins early. To our nation's shame, one in four ninth graders fail to finish high school. In South Carolina, 34 percent fell away in 2008-9, according to national data released last year; for Nevada, it was 45 percent. Most of the educators I've talked with cite algebra as the major academic reason.

Shirley Bagwell, a longtime Tennessee teacher, warns that "to expect all students to master algebra will cause more students to drop out." For those who stay in school, there are often "exit exams," almost all of which contain an algebra component. In Oklahoma, 33 percent failed to pass last year, as did 35 percent in West Virginia.

Algebra is an onerous stumbling block for all kinds of students: disadvantaged and affluent, black and white. In New Mexico, 43 percent of white students fell below "proficient," along with 39 percent in Tennessee. Even well-endowed schools have otherwise talented students who are impeded by algebra, to say nothing of calculus and trigonometry.

California's two university systems, for instance, consider applications only from students who have taken three years of mathematics and in that way exclude many applicants who might excel in fields like art or history. Community college students face an equally prohibitive mathematics wall. A study of two-year schools found that fewer than a quarter of their entrants passed the algebra classes they were required to take.

"There are students taking these courses three, four, five times," says Barbara Bonham of Appalachian State University. While some ultimately pass, she adds, "many drop out."

Another dropout statistic should cause equal chagrin. Of all who embark on higher education, only 58 percent end up with bachelor's degrees. The main impediment to graduation: freshman math. The City University of New York, where I have taught since 1971, found that 57 percent of its students didn't pass its mandated algebra course. The depressing conclusion of a faculty report: "failing math at all levels affects retention more than any other academic factor." A national sample of transcripts found mathematics had twice as many F's and D's compared as other subjects.

Nor will just passing grades suffice. Many colleges seek to raise their status by setting a high mathematics bar. Hence, they look for 700 on the math section of the SAT, a height attained in 2009 by only 9 percent of men and 4 percent of women. And it's not just Ivy League colleges that do this: at schools like Vanderbilt, Rice and Washington University in St. Louis, applicants had best be legacies or athletes if they have scored less than 700 on their math SATs.

It's true that students in Finland, South Korea and Canada score better on mathematics tests. But it's their perseverance, not their classroom algebra, that fits them for demanding jobs. Nor is it clear that the math we learn in the classroom has any relation to the quantitative reasoning we need on the job. John P. Smith III, an educational psychologist at Michigan State University who has studied math education, has found that "mathematical reasoning in workplaces differs markedly from the algorithms taught in school." Even in jobs that rely on so-called STEM credentials — science, technology, engineering, math — considerable training occurs after hiring, including the kinds of computations that will be required. Toyota, for example, recently chose to locate a plant in a remote Mississippi county, even though its schools are far from stellar. It works with a nearby community college, which has tailored classes in "machine tool mathematics."

That sort of collaboration has long undergirded German apprenticeship programs. I fully concur that high-tech knowledge is needed to sustain an advanced industrial economy. But we're deluding ourselves if we believe the solution is largely academic.

A skeptic might argue that, even if our current mathematics education discourages large numbers of students, math itself isn't to blame. Isn't this discipline a critical part of education, providing quantitative tools and honing conceptual abilities that are indispensable — especially in our high tech age? In fact, we hear it argued that we have a shortage of graduates with STEM credentials.

Of course, people should learn basic numerical skills: decimals, ratios and estimating, sharpened by a good grounding in arithmetic. But a definitive analysis by the Georgetown Center on Education and the Workforce forecasts that in the decade ahead a mere 5 percent of entry-level workers will need to be proficient in algebra or above. And if there is a shortage of STEM graduates, an equally crucial issue is how many available positions there are for men and women with these skills. A January 2012 analysis from the Georgetown center found 7.5 percent unemployment for engineering graduates and 8.2 percent among computer scientists.

Peter Braunfeld of the University of Illinois tells his students, "Our civilization would collapse without mathematics." He's absolutely right. Algebraic algorithms underpin animated movies, investment strategies and airline ticket prices. And we need people to understand how those things work and to advance our frontiers.

Quantitative literacy clearly is useful in weighing all manner of public policies, from the Affordable Care Act, to the costs and benefits of environmental regulation, to the impact of climate change. Being able to detect and identify ideology at work behind the numbers is of obvious use. Ours is fast becoming a statistical age, which raises the bar for informed citizenship. What is needed is not textbook formulas but greater understanding of where various numbers come from, and what they actually convey.

What of the claim that mathematics sharpens our minds and makes us more intellectually adept as individuals and a citizen body? It's true that mathematics requires mental exertion. But there's no evidence that being able to prove $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ leads to more credible political opinions or social analysis.

Many of those who struggled through a traditional math regimen feel that doing so annealed their character. This may or may not speak to the fact that institutions and occupations often install prerequisites just to look rigorous — hardly a rational justification for maintaining so many mathematics mandates. Certification programs for veterinary technicians require algebra, although none of the graduates I've met have ever used it in diagnosing or treating their patients. Medical schools like Harvard and Johns Hopkins demand calculus of all their applicants, even if it doesn't figure in the clinical curriculum, let alone in subsequent practice. Mathematics is used as a hoop, a badge, a totem to impress outsiders and elevate a profession's status.

It's not hard to understand why Caltech and M.I.T. want everyone to be proficient in mathematics. But it's not easy to see why potential poets and philosophers face a lofty mathematics bar. Demanding algebra across the board actually skews a student body, not necessarily for the better.

I WANT to end on a positive note. Mathematics, both pure and applied, is integral to our civilization, whether the realm is aesthetic or electronic. But for most adults, it is more feared or revered than understood. It's clear that requiring algebra for everyone has not increased our appreciation of a calling someone once called "the poetry of the universe." (How many college graduates remember what Fermat's dilemma was all about?)

Instead of investing so much of our academic energy in a subject that blocks further attainment for much of our population, I propose that we start thinking about alternatives. Thus mathematics teachers at every level could create exciting courses in what I call "citizen statistics." This would not be a backdoor version of algebra, as in the Advanced Placement syllabus. Nor would it focus on equations used by scholars when they write for one another. Instead, it would familiarize students with the kinds of numbers that describe and delineate our personal and public lives.

It could, for example, teach students how the Consumer Price Index is computed, what is included and how each item in the index is weighted — and include discussion about which items should be included and what weights they should be given.

This need not involve dumbing down. Researching the reliability of numbers can be as demanding as geometry. More and more colleges are requiring courses in "quantitative reasoning." In fact, we should be starting that in kindergarten.

I hope that mathematics departments can also create courses in the history and philosophy of their discipline, as well as its applications in early cultures. Why not mathematics in art and music — even poetry — along with its role in assorted sciences? The aim would be to treat mathematics as a liberal art, making it as accessible and welcoming as sculpture or ballet. If we rethink how the discipline is conceived, word will get around and math enrollments are bound to rise. It can only help. Of the 1.7 million bachelor's degrees awarded in 2010, only 15,396 — less than 1 percent — were in mathematics.

I've observed a host of high school and college classes, from Michigan to Mississippi, and have been impressed by conscientious teaching and dutiful students. I'll grant that with an outpouring of resources, we could reclaim many dropouts and help them get through quadratic equations. But that would misuse teaching talent and student effort. It would be far better to reduce, not expand, the mathematics we ask young people to imbibe. (That said, I do not advocate vocational tracks for students considered, almost always unfairly, as less studious.)

Yes, young people should learn to read and write and do long division, whether they want to or not. But there is no reason to force them to grasp vectorial angles and discontinuous functions. Think of math as a huge boulder we make everyone pull, without assessing what all this pain achieves. So why require it, without alternatives or exceptions? Thus far I haven't found a compelling answer.

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