WRONG ANSWER

The case against Algebra II

By Nicholson Baker

In 1545, Girolamo Cardano, a doctor, a wearer of magical amulets, and a compulsive gambler, published a math book in Latin called *Ars Magna*. The "great art" of the title was algebra. When Cardano was done, he knew he had come up with something huge and powerful and timeless; on the last page was the declaration, WRITTEN IN FIVE YEARS, MAY IT LAST AS MANY THOUSANDS. The equations in *Ars Magna* looked very different from the ones we are familiar with—here, for instance, is how Cardano wrote the solution to $x^3 + 6x = 20$:

Rv:cu.:R108p:10m:Rv:
cu.R108m:10

But the algebraic rules Cardano described and codified are variants of the techniques that millions of students are taught, with varying degrees of success, today.

That's what's so amazing and mysterious about the mathematical universe. It doesn't go out of date. It's bigger than history. It offers seemingly superhuman powers of interlinkage. It's *true*. Mathematics, said a professor named James Byrnie Shaw in 1918, is a kind of ancient sequoia of knowledge, rooted in the labors and learning of the dead:

> Its foliage is in the atmosphere of abstraction; its inflorescence is the outburst of the living imagination. From its dizzy summit genius takes its flight, and in its wealth of verdure its devotees find an everlasting holiday.

Then why, if math is so great and timeless and beautiful, do millions of people hate it so much? In particular, why do so many high school students hate algebra? On an opinion-gathering website called Amplicate, 86 percent of recent respondents registered a hatred for algebra—putting it near the top of Amplicate's list of disliked high school subjects, just below geometry. Grant Wiggins, an educational consultant and former teacher, told me it was a "nasty gatekeeper course": the compulsory Greek grammar of the modern era.

Lots of students love math, of course. It comes easily to them, or it doesn't come easily but they are willing to put in the hours and they enjoy the challenge. (That's my story, more or less: in high school, I took a week to memorize the problem-solving tactics

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Illustrations by Thomas Allen

in a Barron's test-prep paperback and got a 93 on the New York State Regents Algebra II exam, learning, in the process, almost no actual math.) But many math conscripts are angry, many resigned, and some have reached states of real panic or despair. "From middle school until I graduated, math lessons were like Vogon poetry," says one blogger. "I only survived by gnawing one of my own legs off." Here are a few more of the thousands of anti-math opinions I encountered on the Web:

> Algebra Needs To Die. I have been on honor roll since 4th grade! And I got my first C in Algebra, now I have an F with grades about to close and I don't get it I just want to cry. Nothing makes sense. Where is this going to get me in life?
>
> Is poking my eye with a pencil an acceptable substitute for my algebra homework?
>
> Algebra is the huge fucking dam that prevents me from flowing, and being a better person.
>
> I need to take 11 algebra tests in 2 hours. its six in the morning and I've got to pass them or I fail and I can't start school till I pass. PRAY FOR THE GIRL IN PERPETUAL ALGEBRA HELL.
>
> I have my Algebra EOC tomorrow. I have no clue what I am doing. There is almost exactly 24 hours until the test. So, if I just study and study and study, maybe I will actually get a 70 on it? Hell, I'll take a 70. I ran my hand through my hair earlier when I woke up, and a bunch of hair came out. I'M STRESSING TO THE POINT WHERE MY HAIR IS FALLING OUT.
>
> Algebra. "Weightlifting for the brain" my ass. More like death of all happiness in the world.
>
> I really really hate Algebra 2, wish I was dead.... I want to kill myself. Help? If you can?

The reason these kids are upset is that they are required to do something they can't do. They are forced, repeatedly, to stare at hairy, square-rooted, polynomialed horseradish clumps of mute symbology that irritate them, that stop them in their tracks, that they can't understand. The homework is unrelenting, the algorithms get longer and trickier, the quizzes keep coming. Sooner or later, many of them hit the wall. They fail the course and have to take it again. And then again.

As a result, they feel angry, dumb, sometimes downright suicidal. A college professor, now in his fifties, who in high school unsuccessfully took algebra three years running, responded to a *Washington Monthly* blog post on the subject with his own tale of woe:

> I have no idea, to this day, why I find math, and algebra in particular, so excruciatingly hard, but I do. I admire those who can learn it, but I could no more master algebra than I could leap off the roof and fly. The experience of being made to reenact your inability, over and over, is deeply warping.... If you continually ask a one-armed man to play the guitar, he'll either come to hate himself or hate you.

Imagine for a moment that you are a high school student, halfway through a required Algebra II class. It's a Monday, and this week, it seems, you're moving into something called "rational functions." (Last week was a strenuous forced march through logarithms.) You're sleepy, bored, and discouraged. There's an inspiring poster on the wall—it shows a photograph of Einstein in a sweater, saying, "Do not worry about your difficulties in mathematics; I can assure you that mine are still greater." The word ASYMPTOTE is on the whiteboard, and below it, QUIZ THURSDAY! The teacher is hard-working, jokey, smart, exhausted—she knows most of the kids in her class don't want to be there.

You look down at your textbook, which is published by Pearson. It's very new and very heavy. It's called *Algebra 2 Common Core*. Your state has benefited from a federal Race to the Top grant that has encouraged your school to buy many copies of this new, expensive textbook, along with the associated workbooks and software licenses, all of which conform on every page and every screen to the guidelines spelled out in the new Common Core State Standards for math, now adopted throughout the country.

The textbook's cover is black, with a nice illustration of a looming robotic gecko. The gecko robot has green compound eyes and is held together with shiny chrome screws. It has a gold jaw and splayed gold toenails. Perhaps you like the idea of robotic geckos, and you might expect, reasonably, that there would be something about the mathematics either of geckos or of robots somewhere in this book. There isn't.

There is, however, at the beginning of Chapter 8 ("Rational Functions"), an interesting high-speed photograph of a basilisk lizard, also known as a Jesus Christ lizard, that is dashing on tiptoe across the surface of a body of water. A facing caption says:

> Rational functions help explain how surface tension allows some animals to tread across a pond's surface. How can you graph rational functions and solve rational equations? You will learn how in this chapter.

But again you discover, to your disappointment, that the lizard image is just a bit of bait-and-switch. There's nothing about surface tension or walking on water in Chapter 8—and indeed, the caption would puzzle an expert on reptilian locomotion, since basilisk lizards don't actually rely on surface tension to run on water. They're not like water striders; they're much too heavy. The real miracle of the basilisk lizard is that it can scamper over Costa Rican rivers (and over laboratory tanks at Harvard's Museum of Comparative Zoology) by relying on the momentary inertia of the boluses of water beneath its fleet, long-toed feet. If basilisk lizards had to rely instead on equations of surface tension they would sink immediately, as many algebra students do.

So no lizards, no geckos, no robots. Here's what you actually learn about rational functions in Chapter 8 of Pearson's *Algebra 2 Common Core*:

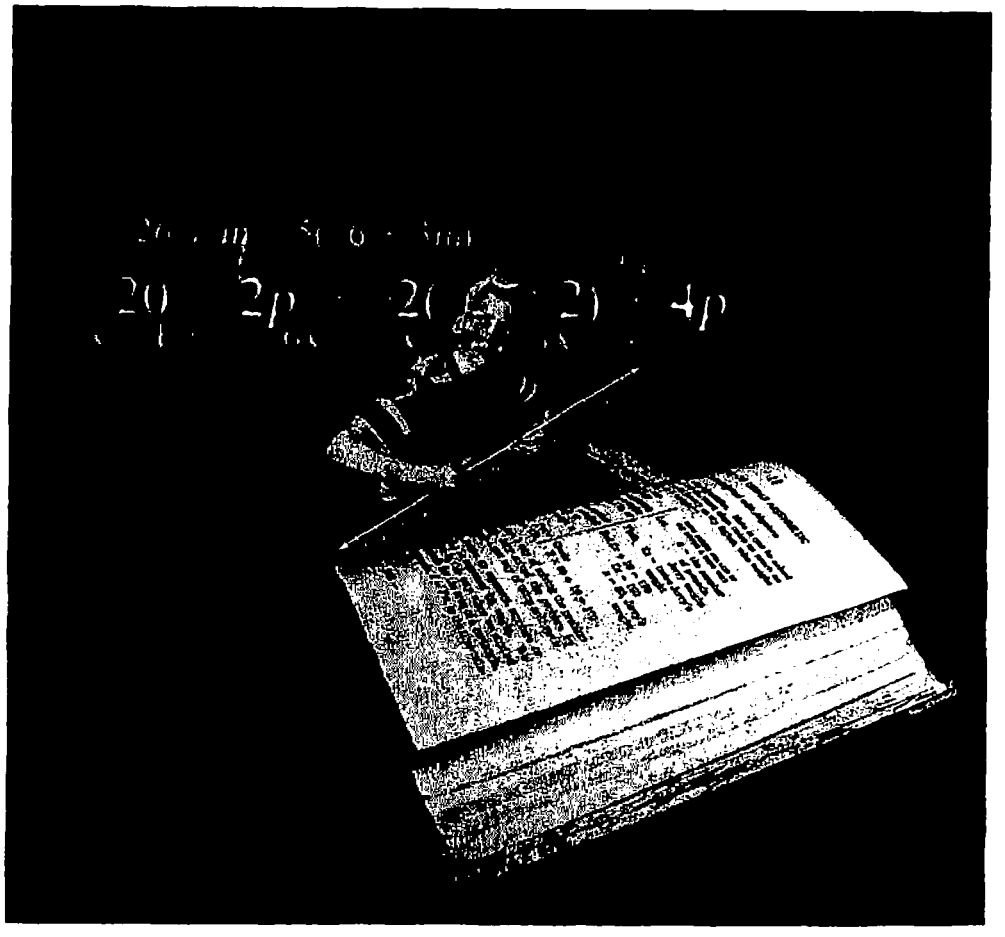
> A rational function is a function that you can write in the form $f(x)=\frac{P(x)}{Q(x)}$, where $P(x)$ and $Q(x)$ are polynomial functions. The domain of $f(x)$ is all real numbers except those for which $Q(x)=0$.

Not only that, a rational function can be continuous or discontinuous, and a continuous rational function is one that, if you graph it, "has no jumps, breaks, or holes." No holes? We'll see about that.

Next you are presented with a salient feature of discontinuous functions:

> If a is a real number for which the denominator of a rational function $f(x)$ is zero, then a is not in the domain of $f(x)$. The graph of $f(x)$ is not continuous at $x=a$ and the function has a point of discontinuity at $x=a$.

Then you learn something more about points of discontinuity: they can be either removable or nonremovable. For instance: "The graph of $y=\frac{(x+3)(x+2)}{x+2}$ has a removable discontinuity at $x=-2$." Simple as pie on a parsonage table.



To reinforce your learning—to make it really bake itself in your mind, so that you'll be able to call upon it in times of quantitative uncertainty in the years to come—there are some exercises to do. Then come a few word problems. These have a familiar ring. One is about how many times a girl would have to get a perfect score on a series of tests to bring her average up from 82 percent to 95 percent. Another is about a basketball player who has made 21 of her last 30 free throws, an average of 70 percent: "How many more consecutive free throws does she need to raise her free throw percentage to 75%?"

How very odd, you think: I don't have to know any algebra at all in order to figure out that the answer to this free-throw question is 6. All I need is arithmetic and a little trial and error. But that's not what the textbook wants. It wants you to *model* the free-throw percentage as a rational function and make a little graph. Show your work, or you fail. FML!

Algebra 2 Common Core is, in other words, a typical, old-fashioned algebra textbook. It's a highly efficient engine for the creation of math rage: a dead scrap heap of repellent terminology, a collection of spiky, decontextualized, multistep mathematical black-box techniques that you must practice over and over and get by heart in order to be ready to do something interesting later on, when the time comes.

Arne Duncan, the U.S. secretary of education, wants everyone working their asymptotes off, learning about rational functions and their points of discontinuity. He is one of the required-algebra "Standardistas" (as the education blogger Susan Ohanian calls them), and he is backing up his views with the financial power of the federal government. In 2011, Duncan—a broad-shouldered, well-meaning, Harvard-educated former basketball player from Chicago who occasionally scrimmages with President Obama—gave a speech under a spotlighted infinity symbol at the annual meeting of the National Council of Teachers of Mathematics (NCTM).

"In recent years," he told the crowd, "it has become increasingly clear to the country—not just to you guys as teachers—that algebra is a key, maybe *the* key, to success in college. Students who have completed Algebra II in high school are twice as likely to earn a degree as those who didn't." A rigorous dose of algebra teaches students reasoning and logic, he claimed, leading to academic success "not just in math but across the curriculum."

Even if you don't plan to go to college, Duncan argued, you should take Algebra II. "Airplane mechanics do complex measurements and work with proportions and ratios," he said. "X-ray technicians calculate time exposures to capture the cleanest possible image. Most factory workers need to understand Algebra II or even some trigonometry to operate complex manufacturing electronic equipment. These are the jobs and these are the skills required to compete successfully in today's economy."

"Rigor" is Duncan's watchword—he used it several times in his speech. His first experiment with algebraic rigor

began in 2003, when he was superintendent of the Chicago school system. Distressed that students were doing so poorly in math, he instituted something called "double-dose algebra," which required every incoming ninth grader who had a below-average score on a placement test to take not one but two back-to-back periods of algebra each day. Teachers called it "double-period hell."

The results were not encouraging. Test scores for the double-dosed draftees did improve slightly. But according to a study of the program, "failure rates actually increased for higher-skill students who continued to take single-period algebra, and their average grades declined." Duncan was undeterred. Everyone must master algebra, he continued to insist, because if everyone learns it, everyone will be ready for college, and if everyone is ready for college, everyone will be above average. Algebra II, he believes, is the mystic portal to prosperity.

Duncan is especially enthusiastic about the rigor built into the Common Core standards, developed by a nonprofit called Achieve and paid for by grants from the Bill and Melinda Gates Foundation. ("High standards mean more than just teaching all students Algebra II," said Melinda Gates in a 2009 speech. "It means teaching all students the skills necessary for success in Algebra II, so they can apply them in different areas throughout their lives and their careers.") The Common Core vade mecum starts whanging away at algebraic thinking skills as early as kindergarten. By the end of seventh grade, the minds of Common Cored children will supposedly be so handy with algebraic unknowns that they'll be able to, in the words of the official document, "solve word problems leading to equations of the form $px + q = r$ and $p(x+q) = r$, where p, q, and r are specific rational numbers." These micromanagerial, misbegotten, joy-stunting standards are, said Duncan, a "real game changer," and will be rolled out nationwide this academic year.

There was plenty of polite applause after Duncan's NCTM speech, but not all educators agree with what he's doing. "I'm a math guy," Grant Wiggins told me. "It's not like I'm some fuzzy-headed humanist." But where, he wondered, was the next generation of plumbers and carpenters going to come from? "You don't need algebra for the majority of jobs. You need it for the burgeoning field of high-tech, but that's not all the jobs. I just don't get it. We've eviscerated vocational-training programs over the past fifteen years." Programs in graphic design and the building trades have disappeared, he notes, while billions are spent on math enrichment and testing.

Underwood Dudley, a number theorist who taught for many years at DePauw University, is another longtime critic of math requirements. He's against them because he loves the subject. As he wrote in *The American Mathematical Monthly* in 1987:

> Mathematics is so useful that there could be no civilization without it, and it is so beautiful that some theorems and their proofs—those which cause us to gasp, or to laugh out loud with delight—should be hanging in museums.

And yet: "The vast majority of the human race, and the vast majority of the college-educated human race never need any mathematics beyond arithmetic to survive successfully."

We must stop telling students lies, Dudley maintains, to the discomfiture of some of his colleagues. "We cannot justify teaching mathematics to 18-year-olds by asserting that they will find it useful," he wrote. "We cannot claim that we are presenting beauty, either. We are, of course, but what percentage of our students can see it, however dimly?"

I called Dudley and asked him point-blank whether we should be requiring Algebra II of all high schoolers. "Good heavens, no," he said. "Forcing people to take mathematics is just terrible. We shouldn't do it. But we are." He then warned me that I would get in trouble for writing this article, although he also said that he thought, or hoped, that his opinions were shared by a silent majority of math teachers.

Andrew Hacker, a political scientist at CUNY, took a similar position in a 2012 op-ed for the *New York Times* called "Is Algebra Necessary?" His piece caused an earthquake in the math world, and there were ripostes from some professors, most notably UC Berkeley's Edward Frenkel, who wrote passionately but confusingly about the right to bear "mathematical arms." (As if making algebra an elective would remove that right.) But others endorsed Hacker's piece, some publicly, some privately.

Cornell's Steven Strogatz, a mathematician of crowds and swarms and oscillating bridges, told me that he agreed with much of what Hacker wrote. "As someone who is working on the front lines, it's alarming to me, and discouraging, that year after year I see such a large proportion of people really not learning anything—and just suffering while they're doing it." We need less math for the average kid, Strogatz said, but more meaningful math. "We spend a lot of time avalanching students with answers to things that they wouldn't think of asking."

Strogatz is right: less is more. We should, I think, create a new, one-year teaser course for ninth graders, which would briefly cover a few techniques of algebraic manipulation, some mind-stretching geometric proofs, some nifty things about parabolas and conic sections, and even perhaps a soft-core hint of the infinitesimal, change-explaining powers of calculus. Throw in some scatter plots and data analysis, a touch of mathematical logic, and several representative topics in math history and math appreciation. Would it hurt kids to learn that Boole, the inventor of modern logic, was almost entirely self-taught, or that the Bernoulli brothers competed between them to work out the brachistochrone problem, or that Sofia Kovalevskaya first became interested in math when she saw some strange differential equations printed on sheets of paper that had been used to wallpaper a room in her house, or that Cardano lost so much money and wasted so much time at the card tables that it prompted him to write the first full study of the mathematics of probability?

Make it a required course. Six weeks of factoring and solving simple equations is enough to give any student a rough idea of what the algebraic *ars magna* is really like, and whether he or she has any head for it. Use as textbooks well-written, inexpensive works such as Strogatz's *The Joy of x* or William Dunham's *Journey Through Genius*, which are fascinating whether or not you can follow all the doodling with variables. Take students to see the mathematical

sequoia, tell them how great it is, but don't force them to climb it until their arms go numb and they fall. Then turn the rest of algebra, geometry, and trigonometry into elective courses, just as music and art and AP biology are. Pay math teachers better and—this is important—*stop requiring Algebra II for admission to college.*

If we did this, American science and technology would be unharmed, and a lot of poisonous math hatred would go away instantly. Kids don't hate smelting, or farming, or knitting, or highway design, or portrait painting, or neurology, or juggling rubber balls, or sonnet-writing, because they don't have to take three years of instruction in any of these arts. If Algebra II were an elective and colleges didn't ubiquitously demand it, fewer people would learn it. But fewer people would fail it, too, and fewer people might drop out of high school, and the level of cheating would go down, and the sum total of student misery would be substantially reduced. And those for whom Fourier analysis is a joy and a marvel, a way of hearing celestial music, would be in classes with other students who get a similar buzz.

That's what should happen. Life's prerequisites are courtesy and kindness, the times tables, fractions, percentages, ratios, reading, writing, some history—the rest is gravy, really.

During these recent hand-wringing decades, a few experienced teachers have written books that argue persuasively against the wrongheadedness of obligatory math. In 1994, Michael Smith, a consultant and test-prep coach then teaching at the University of Tennessee, published *Humble Pi: The Role Mathematics Should Play in American Education*. The book grew out of an article he originally wrote for *The Atlantic*. No study, he claimed,

> has supported the contention that the abstractions of algebra, geometry, and trigonometry, which so many students are required to learn, are practical in any general sense, except for a small number of occupations.

At the last minute, *The Atlantic* had doubts and killed the article. Smith published it instead in the *Phi Delta Kappan*, where it inspired a barrage of mail, some supportive, some enraged. "The entire math department at the University of Tennessee stopped speaking to me," he told me.

In 2005, Derek Stolp, who worked for thirty years as a high school math teacher, published a small classic called *Mathematics Miseducation*. "Any implication that logical thinking is taught only through mathematics is plainly false," Stolp wrote, "and the argument that it is taught most effectively through mathematics is, at best, questionable." Stolp told me that although he loves teaching algebra, he doesn't believe children should be compelled to master abstract algebraic techniques that they find meaningless.

Michael Wiener took on our national obsession with college-prep math courses in *The Algebra Conspiracy* (2000). "Many students who are weak in mathematics, given the chance, can excel in college in other disciplines," Wiener wrote. "They can be language teachers or probation officers

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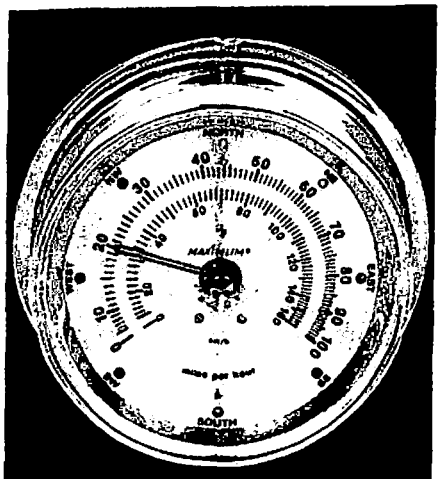

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or musicians." I asked Wiener, who taught journalism after switching over from math in the 1960s, about the plan to impose stringent Common Core math standards on all students in all states. "These people in charge, they think that just because they raise the standards, the kids are going to level themselves up," he said. "And I have news for them. A kid that can meet the standards is going to meet the standards, but a kid that can't, won't. It's as simple as that." As we were saying goodbye, Wiener added, "You've got a very tough subject to tackle, and I feel sorry for you. It's like quicksand. The more you get into this, the more you'll sink."

I would respectfully suggest that Arne Duncan and Bill and Melinda Gates and all the Standardistas at Achieve take a few days to read these three short books, plus an amazing cri de coeur by Paul Lockhart called A *Mathematician's Lament.* And then I'd ask them to reconsider their plan to jam gobs of rational functions dressed up in water-striding lizards down the throats of every high school student in America. Their endlessly repeated defense of Algebra II is derived from an obvious statistical tautology: people who take Algebra II are more likely to go to college, since Algebra II is, after all, a college requirement. In their eagerness to impose "reasoning skills" on young people, they have in fact succumbed to an old bit of illogic: the *post hoc ergo propter hoc* fallacy of misplaced causation.

Here's the funny thing. This has all happened before, beginning about a hundred years ago, and much of the controversy centered around Chicago, Arne Duncan's hometown. In 1907, education laws changed in Chicago, more or less in concert with changes happening across the country. Instead of being allowed to leave school at fourteen, children were now required to attend through the age of sixteen. There they sat by the thousands at their wooden desks, awaiting daily instruction. But what was there for teachers to teach?

Well, first they taught the things they'd always taught, the things that colleges required: Latin grammar, English grammar and composition, algebra, geometry, and trigonometry. The result, especially in math classes, was that failure rates soared. It was clear to many educators that there was a serious problem: compulsory schooling for all wouldn't work if algebra was a part of the required curriculum.

The solution was reform. In 1919, Henry C. Morrison, who'd been in charge of public schools in New Hampshire, took over superintendence of the influential Chicago Laboratory Schools, founded on progressive principles by John Dewey. From his years of teaching math (as well as history and Latin), Morrison had definite ideas about what was and wasn't possible in secondary education in the twentieth century. He rejected the notion—still held by many then and now—that a child's mind is like an underdeveloped quadriceps muscle, to be strengthened by the more or less arbitrary tasks of classical-grammar parsing and vigorous mathematical squat thrusting. Morrison didn't believe, in particular, that the study of mathematics trained the mental faculties in ways that dependably transferred into other areas of life. In a 1915 paper, "Reconstructed Mathematics in the High School," he wrote:

> The mind which has been molded to the method of mathematics will use that method in mathematics, and in thinking allied to mathematics, alone. The mathematician himself behaves in about the same manner as other mortals in a social or a political situation, but he reacts more efficiently in a certain type of scientific situation than does he who is devoid of mathematical training.

The high school syllabus had to change to accommodate the needs of universal education, Morrison believed. "School administrators and school patrons," he wrote in 1921, "have come to the conclusion that algebra and geometry as traditionally taught in the high schools are intolerable failures."

Morrison's beliefs were seconded by another University of Chicago professor, John Franklin Bobbitt, who wrote in 1922 that "students in general do not need algebra, geometry, or trigonometry," and by a strong-willed reformer, William McAndrew, who became superintendent of Chicago schools in 1924. McAndrew, like Morrison, had taught algebra and geometry, and he could discern (as he told an audience of

teachers in 1908) no correspondence between these high school subjects and "the educative processes of real life."

These assaults on the algebraic citadel alarmed the traditionalists, chief among them a high school math teacher named C. M. Austin, founder of the Men's Mathematics Club of Chicago. In the early 1920s, Austin, lamenting that "high school mathematics courses have been assailed on every hand," launched a counterattack by organizing the National Council of Teachers of Mathematics—the same group that Arne Duncan addressed in 2011. Its appointed task was to make the case for required math and stop the spread of freethinking, Deweyite, student-friendly doctrines. Austin was its first president.

But though the NCTM published hundreds of articles on curriculum reform and on the disciplinary and work-ethical and even religious values that came with a strong mathematical education, they fought a losing battle. Ohio was among the first states to remove the math requirement from high school, in 1921, declaring that "it is not fair to impose a study upon a pupil on the contingency that he may some day utilize it in a practical way when the indications all point in the opposite direction."

In 1931, with about half of New York's elementary-algebra students failing the statewide Regents exam, an NYU professor of education, Philip Cox, wrote an editorial in a journal called *The Clearing-House*. "If the mathematics enthusiasts would study the failure rates of mathematics throughout the junior- and senior-high-school period," he said, "they might be aghast at the death and destruction that prescribed and even recommended mathematics scatter in their trains."

The most widely read denunciation of required algebra came that same year, from a syndicated advice columnist named Arthur Dean. Dean was a former engineer and a graduate of MIT who had taught math for years; his column, called Your Boy and Your Girl, was full of compassion and good sense. In an item published on March 27, 1930, Dean wrote:

> I cannot see that algebra contributes one iota to a young person's health or one grain of inspiration to his spirit.... It is the one subject in the curriculum that has kept children from

finishing high school, from developing their special interests and from enjoying much of their home study work. It has caused more family rows, more tears, more heartaches and more sleepless nights than any other school subject.

A math teacher read Dean's column aloud to her class, and 80 percent of the students raised their hands in agreement with it. One mother sent a dissenting note in favor of algebra. "Because a girl may never make a dress," she wrote, "would you have plain sewing dropped from our schools?" Dean's answer was, no, don't drop sewing. Just make it, and algebra, an elective.

So pervasive and forceful were the arguments by Dean, Cox, McAndrew, and others against required high school math that Eric Bell, a mathematician and science-fiction writer, maintained in 1937 that the entire discipline was under siege: "Are not mathematicians and teachers of mathematics in liberal America today facing the bitterest struggle for their continued existence in the history of our Republic?" Mathematics was, Bell said, "fighting a desperate rear-guard action to ward off annihilation."

Which was a ridiculous statement. Mathematics was flying high—it was nowhere near annihilation. There may have been fewer math teachers employed in public high schools as a consequence of the removal of the algebra requirement, but those who fancied math were working hard at it and doing it well, and the sciences that relied on applied-math proficiencies were making discoveries by the boatload. By 1950, at a time when only a quarter of American high school students were taking algebra, the nation's technological prowess was the envy of the planet.

Think carefully again about this number: 25 percent. As the curtain rose on the baby boom era—the purported golden age of American education, when high school was really high school and girls wore cardigans and boys wore narrow ties and everyone aspired to work for Ford and AT&T, when Dictaphones were king and food engineers gave us mashed-potato flakes, when GM was designing the Chevy small-block V-8 engine, when missile silos held freshly minted hydrogen bombs and Admiral Hyman Rickover's nuclear-powered submarines patrolled the waves—only a quarter of high schoolers learned algebra. In the misty childhood days of IBM's Louis Gerstner (who would later co-found Achieve) and of a thousand other brilliant businessmen, inventors, engineers, and innovators, algebra was a nonexistent force in the lives of the majority of high school students.

Even so, many Cold Warriors were troubled. Russia was training junior mathematicians at a frightening rate. (Higher math was stressed in postwar Russia over other sciences partly because it is cheap: you don't need a laboratory, just a pencil and paper.) And then there was Sputnik beeping away overhead. Admiral Rickover, in his popular 1959 book *Education and Freedom*, fretted over the "Russian success in combining mass education with highest-quality education for large numbers of her children." The Russians could not be allowed to pull ahead of us. "We are engaged in a grim duel," he wrote.

> We are beginning to recognize the threat to American technical supremacy which could materialize if Russia succeeds in her ambitious program of achieving world scientific and engineering supremacy by turning out vast numbers of well-trained scientists and engineers.

So we scrambled. Congress passed the National Defense Education Act in 1958, and curriculum designers came up with the New Math, which taught us about null sets and made us draw beautiful Venn diagrams, but was a flop. By 1966, about 65 percent of high schoolers were taking Algebra I and about 40 percent were taking Algebra II. We got Neil Armstrong to the moon, a feat that required huge supercooled tanks of liquid algebra, yet still the grim duelists banged their spoons on the pot lid of unprecedented crisis.

"The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a nation and a people," said a 1983 report, *A Nation at Risk*, emanating from the Reagan White House. By lowering our standards, the report said, America had been "committing an act of unthinking, unilateral educational disarmament." Math requirements and math homework were increased further, but this wasn't enough for defense-minded worriers. A national "report card" followed in 1989, making the case that we were in an educational death spiral because students tested so badly in math.

Actually, wrote Paul E. Burke, a federal statistician and former math teacher, what the report card showed was encouraging: "Two-thirds of students know most of what we want them to know in math." William Raspberry, a columnist for the *Washington Post*, interviewed Burke in April 1989. "Requiring unnecessary math does not create future scientists," Burke told Raspberry. "It creates dropouts and hatred for math and for school." (When I reached Burke at home, he said, "We should listen to the customers"—the students.)

Burke was ignored, as was another columnist for the *Washington Post*, Colman McCarthy, who wrote in 1991 that algebra was, for most, "useless torture." Since then, it's been decades of crisis, crisis, crisis. We are an innumerate nation, we don't know where enemy countries are on a map, we can't divide fractions, we're under-STEMed, we're worse at middle-school math than the Estonians. Bush's No Child Left Behind has become Obama's Race to the Top. We need more equations, more formulas, more benchmarks, more testing, more assessment software, more of what Arne Duncan calls "data-driven education."

Math-intensive education hasn't done much for Russia, as it turns out. But historical counterexamples don't seem to interest the latest generation of crisis-mongers. We've once again gotten ourselves caught up in a strangely self-destructive statistical cold war with other high-achieving countries. The recruits are young teenagers, their ammunition the little bubbles on standardized tests. America's technological future hinges, say the rigorists, on whether our student population can plug-and-chug the binomial theorem better than, say, Korean or Finnish or German or Chinese students. The childishness of this hypernationalistic mentality depresses me, and I want it to end, and I am not alone. ■