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The Power of X

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Abstract
In his recent book, *The Math Myth: And Other STEM Delusions*, political scientist Andrew Hacker argues, among other things, that we should not require high school students to take algebra.

Part of his argument, based on data some have questioned, is that algebra courses are a major contributor to students dropping out of high school. He also argues that algebra is nothing more than an "enigmatic orbit of abstractions" that most people will never use in their jobs. [*excerpt*]

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In his recent book, *The Math Myth: And Other STEM Delusions*, political scientist Andrew Hacker argues, among other things, that we should not require high school students to take algebra.

Part of his argument, based on data some have questioned, is that algebra courses are a major contributor to students dropping out of high school. He also argues that algebra is nothing more than an "enigmatic orbit of abstractions" that most people will never use in their jobs.

There is no doubt that this kind of argument resonates with people who had bad experiences in a math class in their past, and for this reason Hacker's book is getting lots of attention. On the

other hand, there are many reasons why I and many others in the mathematical community disagree with Hacker's opinions.

Fundamentally, Hacker has a misunderstanding of what algebra is.

The word *algebra* comes from the Arab word *al-jabr*, which means "to balance." Using it in a mathematical context dates back to a Persian manuscript in the ninth century, which introduced the beginnings of what grew into what we now study in high school.

The big idea that distinguishes algebra from the mathematics that had come before is to think of operations taking place simultaneously on whole collections of numbers rather than on a single number.

We all learn early in life that two plus one equals three and that two times three equals six - that's simple arithmetic. A natural follow-up question would be whether there are any numbers other than two that, if you multiply them by the number that is one greater, gives a result of six.

This is cumbersome to say in words, which is why mathematicians prefer to phrase the question in terms of variables and ask about the numbers x that give you x(x+1)=6, or equivalently, x'+x-6=0.

At this point, you may be having flashbacks to a high school class where you had to memorize something called the quadratic formula, which allowed you to deduce that the only numbers x satisfying that equation are 2 and -3. But the right way of thinking about the quadratic formula is not as a tedious expression but as a process that allowed you to find the solutions x for *any* relationship of the form ax'+bx+c=0.

In other words, using algebra has allowed us to go from solving a single arithmetic problem to solving many problems simultaneously without doing substantially more work.

Hacker believes that algebraic thinking will not be relevant to most students in their later lives. I could not disagree more.

The idea of performing operations on a collection of numbers at the same time is exactly what you are doing when you put a formula into a spreadsheet and then use the same formula on different cells.

You use algebraic thinking when you figure out how to adapt the recipe you use for a family of four to a dinner party of 12.

You use algebra to calculate how the results of the next ballgame will affect your favorite team's winning percentage.

You use algebra when you decide whether it makes more sense to itemize the deductions on your income tax return or take the standard deduction.

Even people whose jobs never require them to write down an equation, let alone solve an equation for x, use algebraic thinking all the time in their daily lives.

In Hacker's defense, I have no doubt that some high school algebra teachers, maybe even a majority of them, spend their time emphasizing arcane definitions and complicated formulas instead of the problem-solving skills, copious applications, and intrinsic beauty that should be at the core of an algebra class.

As with too much of education these days, the push toward standardized testing has led to an increased emphasis on memorization over conceptual understanding, and that is a shame.

But if math classes are not doing what we think they should, then we need to address those issues directly through better support and training for our teachers and better curricula, rather than holding them up as a straw man that we can use to attack the idea of students taking mathematics at all.

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