WHY IS ALGEBRA IMPORTANT TO LEARN?

(Teachers, this one's for your students!)

BY ZALMAN USISKIN

We have all heard or read eloquent expositions on the value of studying history. Likewise, most people can quickly summon up a compelling case for the importance of good writing skills, the benefits of being exposed to quality literature and art, the need to understand basic scientific concepts, and the indispensable requirement to master the tools of everyday arithmetic.

But when it comes to providing the rationale for learning mathematics beyond arithmetic—namely, algebra, geometry, and their extensions—most people are likely to mumble something about needing it for college. Indeed, just this past year, a book questioning the importance of math education in general and arguing that almost no one really needs algebra received considerable attention and quite favorable reception in the popular press. And, more importantly, every day across this country countless numbers of students sit in algebra or geometry classes wondering (as did generations before them) why they are studying linear (not to mention quadratic) equations or a method for finding the volume of a cylinder. "What's the point? I'll never use any of this stuff," they say.

They deserve an answer. And while it is true that the newer textbooks do a better job than the older ones did of showing the practical applications of algebra and geometry, most do so in a scattered, piecemeal fashion. For some students, this poses no problem. They love math, they're good at it, they never question its value or appeal. But there are many others who need the whys and wherefores set forth in a convincing manner. And since more and more school districts are replacing dumbed-down "consumer math" courses with a requirement that all students take algebra and geometry, we thought the time was ripe to pull together, for a student audience, the case for studying post-arithmetic math. We convinced Zalman Usiskin, the director of the widely acclaimed University of Chicago School Mathematics Project, to take up the question of algebra in this issue. Perhaps in a future issue, we'll ask him to do the same for geometry. He wrote this essay for your students, and we hope you will share it with them.

—Editor

MOST PEOPLE realize that they need to know arithmetic. Whole numbers, fractions, decimals, and percents are everywhere. You need them to do any work with money, to deal accurately with measurements, to understand probability, to follow the results of election polls or sports or lotteries, and a wide range of other things. Numbers are everywhere. Just pick up a newspaper or magazine, open to any page at random, and count the numbers on it. You may be surprised at how many there are.

Algebra seems different. Scan the same newspaper and you are not likely to see any algebraic formulas. The need to know algebra isn't as obvious.

Furthermore, we all know adults who live productive lives without ever using algebra. Even adults who studied the subject as youngsters may not have studied its practical applications; hence it is difficult for them to see—let alone explain to others—what value they derived from it.

It is true that the value of algebra is not as obvious as the value of arithmetic. In actuality, however, its usefulness is all around us. But for those who don't know where or how to look, it is often hidden. It is well worth the effort to dig a little deeper to uncover the many ways this discipline is at work in the world and why mastering it greatly enriches our lives. In this essay, we hope to do some of that digging.

TO SAY "You need algebra for college," or "You won't do well on the SAT or ACT without it" are true statements, but they don't tell us very much. *Why* is algebra

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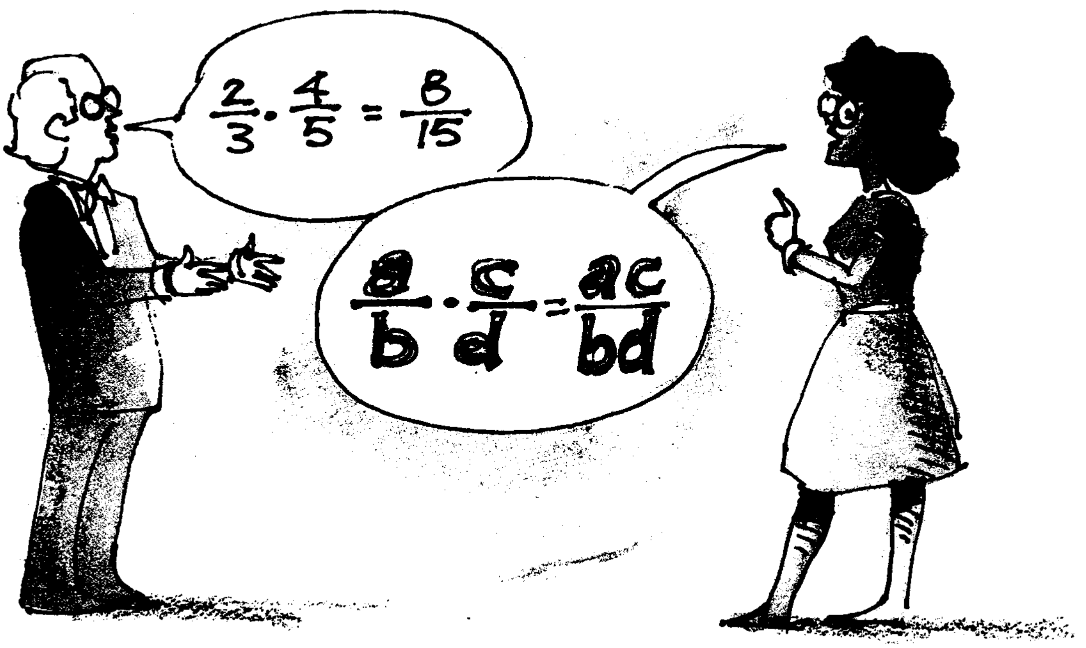

ILLUSTRATED BY ROBERT BARKIN

considered so important that it has become a requirement for entry to virtually every college? And why are more and more school districts requiring all students to study algebra, including those who may not be college-bound or who haven't yet made up their minds about their futures? In the pages that follow, we offer some answers to these questions. Here are some general reasons:

Without a knowledge of algebra,

- you are kept from doing many jobs or even entering programs that will get you a job;
- you lose control over parts of your life and must rely on others to do things for you;
- you are more likely to make unwise decisions, financial and otherwise; and
- you will not be able to understand many ideas discussed in chemistry, physics, the earth sciences, economics, business, psychology, and many other areas.

In these matters, algebra has much in common with reading, writing, and arithmetic: Lack of knowledge limits your opportunities. More specifically, what follows are the characteristics of algebra that cause it to be so important and some of the many things you could not do at all—or not do as easily—without it.

Algebra is the language of generalization. If you do something once, you probably don't need algebra. But if you are doing a process again and again, algebra provides a very simple language for describing what you are doing. Algebra is the language through which we describe patterns. For instance, here is the rule for multiplication of fractions, written in English words:

To multiply two fractions, multiply their numerators to get the numerator of the product, and then multiply their denominators to get the denominator of the product.

As an example,

$$\frac{2}{3} \bullet \frac{4}{5} = \frac{8}{15}$$

Here is the same rule, written in the language of algebra:

$$\frac{a}{b} \bullet \frac{c}{d} = \frac{ac}{bd}$$

Not only is the algebra much shorter, but it looks like the arithmetic!

Some general patterns are formulas. Formulas state one quantity in terms of another. There are formulas in every walk of life. For instance, there is a formula for finding Celsius temperatures from Fahrenheit temperatures

$$F = \frac{9}{5} C + 32,$$

and vice-versa

$$C = \frac{5}{9} (F - 32).$$

There are formulas for area that come in handy if you are looking for a place to live and want to know how much room you will have, or if you are sewing clothes and want to determine the amount of material you'll need. There are formulas for perimeter that tell how much fencing you might need for a field, or how much ribbon to tie a package. There are all sorts of formulas in sports, and they can help you calculate earned-run average in baseball (not hard), or rate a quarterback in football (rather complicated), or determine the probability of a particular player making two free throws in a row in a basketball game (easy but not certain). Income tax, discounts, sales tax, and virtually every money matter involve applying some formula. You can get along without the formulas—many people do—but you are less likely to be fooled by someone if you yourself can deal with the formulas.

Some patterns are not so simple. For instance, the formula

$$W = d + 2m + \left\lfloor \frac{3(m+1)}{5} \right\rfloor + y + \left\lfloor \frac{y}{4} \right\rfloor - \left\lfloor \frac{y}{100} \right\rfloor + \left\lfloor \frac{y}{400} \right\rfloor + 2$$

tells you on which day of the week a particular date will