Facing the Future: Mathematics for Everyone

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Three months ago the President of the United States issued a report called *America 2000: An Education Strategy* that outlines a national plan to improve education in the United States. In most other countries a presidential report on education would not be the least bit unusual. But in the United States it is almost without precedent. Anyone who hopes to understand the current educational reform movement in the United States must first come to understand just why it is that never before in our history has the leadership of the United States government taken seriously the matter of setting national standards for education.

Historically and constitutionally, the "United" States is a federation of independently governed states and commonwealths that voluntarily relinquished certain powers to the federal government. Our President and Congress properly exercise only those powers granted to them by our constitution. Education, like health and transportation, is one of many responsibilities reserved by our constitution to the fifty states. The recent effort to establish national standards for education in the United States is, in light of our history, a *very* surprising development, especially coming from an administration that seeks in most domestic matters to minimize the intrusive role of government.

Preparing students for an international economy confronts each nation with distinctive challenges to its educational traditions. Although the recent U.S. experience in educational reform is still unfolding and is far from the point where one can assess its accomplishments, I believe that certain aspects of our endeavors should be of interest to mathematics educators in other nations. Mathematics has been the lead discipline in all aspects of this reform movement, from public persuasion of the need for improvement, through development of national standards, to pilot efforts at nation-wide assessment. A more compelling reason, however, is that debates about mathematics education that have arisen in the United States illustrate in very concrete terms profound points of tension that arise in any multicultural society—tensions between aspirations of individuals and demands of society, between education for the many and excellence for the few.

The metaphor for mathematics education reform in the United States was provided by a 1989 report of the U.S. National Academy of Sciences provocatively titled *Everybody Counts.* I wrote this report for the Academy as a consensus of three Academy committees representing mathematicians, educators, and policy leaders from many different backgrounds. *Everybody Counts* marked the opening chapter in a story still unfolding, a chapter that signaled both the determination of the National Academy of Sciences to exercise sustained leadership in mathematics and science education, and the consensus of our nation's leaders that educational goals in the United States must benefit *all* students. The commitment signaled by *Everybody Counts* has been effectively summarized in a single slogan: *Mathematics must become a pump not a filter in the educational pipeline.*

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In the time available to me today, I plan to examine how emerging principles concerning mathematics education in the United States lead to important policy debates concerning priorities for educational reform.

Setting Standards

The most important thing to know about the movement to establish national standards for mathematics education in the United States is that it was led by teachers, not by governmental leaders. Admittedly, the original challenge did come from the government, specifically, from a surprisingly candid 1983 report by the U.S. Secretary of Education called *A Nation at Risk.* Subsequent newspaper reports from the Second International Mathematics Study corroborated significant weaknesses in U.S. achievement when measured against international standards.

The mathematics community in the United States responded to these challenges through aggressive and unprecedented leadership by professional societies such as the National Council of Teachers of Mathematics (NCTM), the Mathematical Association of America (MAA), and the Conference Board of the Mathematical Societies (CBMS). In 1985 these societies persuaded the National Academy of Sciences, a private, self-governing organization composed of the nation's leading scientists and engineers, to establish a Mathematical Sciences Education Board (MSEB) to promote excellence in mathematical sciences education "for all students at all levels." The roots of *Everybody Counts* were planted in this charter for MSEB. Two other Academy committees, one devoted to mathematical research, the other to issues of college and university mathematics instruction, joined MSEB in developing the plan of action on which we are now embarked.

In the last few years, these societies and boards have published a series of reports ranging from school mathematics to university curricula;

1989: *Everybody Counts: A Report to the Nation on the Future of Mathematics Education.*

1989: *Curriculum and Evaluation Standards for School Mathematics.*

1990: *Reshaping School Mathematics: A Philosophy and Framework for Curriculum.*

1990: *A Challenge of Numbers: People in the Mathematical Sciences.*

1990: *Challenges for College Mathematics: An Agenda for the Next Decade.*

1990: *On The Shoulders of Giants: New Approaches to Numeracy.*

1991: *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics.*

1991: *Professional Standards for Teaching Mathematics.*

1991: *Moving Beyond Myths: Revitalizing Undergraduate Mathematics.*

These reports serve many purposes. The process of creation—of writing, of review, and of board approval—helps diverse communities reach consensus. The process of publication helps alert the public, including mathematicians and mathematics educators, to important issues and the urgent need for action. Finally, the reports themselves, as volumes that are available for many years after publication, help support a continuing national dialogue about mathematics education—a dialog that will, we hope, forge a national consensus.

Basic Messages

One important factor contributed significantly to the special influence of these reports: their publication was orchestrated by the various Academy committees and several professional societies in order to reinforce certain messages that we believe are crucial to improving mathematics education in the United States. Here are some of those basic messages:

1. Beliefs

All students can learn mathematics. Evidence from effective schools in the United States and in other countries shows that with proper expectations and appropriate contexts for learning, children of every social, ethnic, racial, and economic background can learn school mathematics. This is the primary message of our reform campaign, since effective education is impossible unless society believes in the capabilities of its children.

You may well wonder why I cite this as our most important message, since it sounds self-evident. But the evidence from school practice in the United States shows that many mathematicians, teachers, and parents simply do not believe that everybody can learn mathematics. Parents who themselves never learned much from their own school experience with mathematics often excuse their children's poor performance, believing that only those few who possess some special and relatively rare talent are able to learn mathematics. This common belief has led in the United States to widespread tracking of children in the middle grades, an insidious practice that rations effective opportunities for learning to those who are mathematically well-to-do, shunting those most at risk onto a dead-end curricular siding from where one cannot easily progress to higher levels of education.

The United States is not well served by an educational system that reinforces class distinctions. The power of mathematics to unlock prestigious jobs compels educators to ensure that all children learn school mathematics. America's character as a nation was shaped by our Civil War, fought over Abraham Lincoln's belief that a nation cannot remain united half slave and half free. This same belief once again motivates the reform of education in the United States—that if we are to survive as a nation, we dare not permit education to adopt practices that free the privileged for the good life of an educated elite while enslaving the disadvantaged to marginal productivity as mathematical illiterates in a technological society. When the American mathematics community calls, as it has in the new NCTM *Standards*, for a national commitment to a single core curriculum for all students up to approximately age 17, it echoes the deepest principles of American democracy—that all be given equal opportunity to succeed.

2. Objectives

All student must learn mathematics. Both national and international assessments show that typical secondary school graduates in the United States fall far short of the expectations of employers or of higher education. The most recent report of our National Assessment of Educational Progress, released just two months ago, shows that only three out of four high school seniors—those on the verge of graduating—could correctly add the cost of three items from a menu; only two in four understood decimals and fractions; and only one in twenty knew the type of algebra and geometry that is routinely used in college courses in many disciplines. These results are consistent with other studies done over the past decade; they document a record that the public has rightly concluded is a disgraceful failure.

Our students' failure to learn basic mathematics despite 10-12 years of study was described in a 1987 report on the Second International Mathematics Study as evidence of an "underachieving curriculum." This assessment is now widely acknowledged at all levels of society, from local school boards to the President of the United States. There is no longer any debate in the United States about the need for improvement, only debates about strategies.

Some policy leaders advocate more rigorous testing of students, and in some states, of teachers too. Others call for curricula that meet the new *Standards* for school mathematics. Still others seek improvement by restructuring the organization of schools, to reduce bureaucracy and empower teachers to be more inventive and flexible. Advocates of technology often argue that students can learn more efficiently in an environment that effectively uses modern multi-media computer equipment. The latest movement, almost a fad, is the argument that increased parental choice about which school their children attend will bring to bear the supposedly constructive forces of the marketplace to improve schooling for all.

Debates about strategies appear endless. Nevertheless, regardless of proposed means, all claim the same objective: that students really learn mathematics—as well as history, English, geography, science, and other school subjects.

3. Curriculum

Students must learn different mathematics. The widespread impact of computers on science and business has enlarged enormously the scope of the mathematical sciences. Computers change the questions that mathematicians ask as well as the tools we have available for answering them. Calculators and computers make certain parts of the curriculum less important, and other parts more important. In school, estimation and mental arithmetic are now of greater value than mastery of complex hand-calculations; in college, modelling—including numeric, analytic, graphic, and stochastic representations—are more important than formerly, while facility at calculating closed-form formulas is less crucial.

As mathematics itself has changed and broadened, the mathematics that students study must change. At one level, that of curriculum planning, new areas of greater importance will gradually supplant others of lesser current value. The breadth of mathematics and its applications is now so enormous—stretching from number theory and logic on the one hand to statistics, control theory, and operations research on the other hand—that no student can study all of it. Thus at another level, that of student choice, the mathematics that one student learns will differ in significant ways from the mathematics that another studies, depending on each student's interests and choices. The old idea of a common curriculum stretching for eighteen years from arithmetic to algebraic geometry is no longer an effective or viable model for mathematics.

Curricular change threatens the mathematical establishment. Even more, it threatens parents. Mathematicians believe that to learn advanced mathematics, students must study in school just what today's mathematicians studied when they were in school; parents believe that mathematics *is* just what they studied when they were in school. Many scientific, political, and educational leaders—regardless of their own mathematical training—try to preserve the past against the onslaught of recommendations for change, arguing that what is wrong today is not insufficient responsiveness to modern trends but inadequate application of traditional topics and principles.

Controversy is the constant companion of curriculum reform. Even though our many recent reports recommend significant curricular change, it would not be fair to claim that we have achieved national consensus on the nature, speed, or direction of this change. The NCTM *Standards*, for example, call for much greater emphasis on geometry, data analysis, statistics, and discrete mathematics. Although most scientists and mathematicians support these recommendations, they often disagree emphatically about what might be cut out of the curriculum to make way for these new emphases.

A recent National Academy study called *On the Shoulders of Giants* seeks to advance the curricular discussion one step beyond the NCTM *Standards*. This volume suggests significantly different approaches to elementary mathematics based on strands such as dimension, quantity, shape, uncertainty, and change. The goal is to plant in young minds the seeds of important ideas that, if properly nurtured, will grow deep roots of immense value to future scientific or mathematical study. Whereas the *Standards* are for today, for the 1990s, the ideas in *Giants* are for tomorrow, for the next curriculum that will be available to students at the beginning of the twenty-first century.

4. Instruction

Teachers must teach mathematics actively. Two strands of evidence converge on this consensus recommendation. First is insight from educational research that mathematical knowledge is uniquely personal, constructed by each student through his or her own engagement with the subject. Learning acquired by memorization or passive listening—without active engagement that leads to construction of knowledge—rarely lasts beyond the course in which it takes place.

A second strand of evidence concerns characteristics of programs that work, from primary grades through college. These programs use active forms of learning—group work, projects, discussion, writing, investigation—and embed students in a community of learners that engages the whole range of their interests and talents. Community, context, and engagement are features of mathematics programs that work.

Everybody Counts exhorts mathematics teachers to engage students in learning—to encourage exploration, argumentation, and inventiveness. Teachers are urged to lecture less and listen more; to ask questions that are real rather than rhetorical; and to help students learn for themselves rather than merely learn what they are told to learn. *Moving Beyond Myths* echoes these same themes for college and university faculty, arguing for a complete change in the lecture-dominated climate of university mathematics departments.

The same message is reiterated in the 1991 MAA report on teacher preparation, *A Call for Change.* Since teachers tend to teach as they were taught rather than as they were taught to teach, this report asserts that only if prospective teachers learn mathematics in an active mode can they successfully teach it in like manner. In the United States, most prospective secondary school teachers study mathematics in regular college and university courses along with all other mathematics students. This argument clearly implies that improvement in the schools cannot happen without simultaneous improvement on college and university campuses.

Nevertheless, changing teaching habits is very difficult. Despite universal recommendations to the contrary, lecturing continues as the predominant mode of mathematics instruction at virtually all grade levels. But there are many alternatives being explored, some based on computers and calculators, others on projects and modelling, still others on writing and group work. The key to instructional reform in the United States is not national decree—since our national government has no authority in these matters—but a strategy that we describe using a phrase attributed to China's former leader Mao Zedong: "Let a thousand flowers bloom." Indeed, President Bush rephrased Mao's expression in his inaugural address as a "thousand points of light."

We need inventiveness and discovery among teachers exploring effective methods of instruction every bit as much as we need opportunities for exploration and invention by students. We know that traditional methods of instruction work well only for a small proportion of students, primarily for those whose family and home traditions are already well attuned to the expectations of school. (This reality was confirmed in the recent U.S. national assessment, where the major variables that correlated well with mathematics performance were conditions in the family and home. State-controlled variables such as length of school, teacher salaries, and course requirements do not relate persuasively to educational accomplishment.)

We know that traditional lecture-intensive methods do not work for the majority of students; that non-traditional methods work better for certain students; and that no single method works equally well for all students. So we urge teachers continually to invent, to be open to change, to seek methods that work for them and for their students.

5. Access

More students must study more mathematics. Of all the issues confronting mathematics education in the United States, mathematicians have been most concerned about the declining numbers of U.S. students receiving college and university degrees in the mathematical sciences. Between 1970 and 1985, the numbers of mathematics degrees granted to U.S. students declined by approximately 50% at all three degree levels—what we call baccalaureate, masters, and doctoral levels. These alarming trends led the National Academy of Sciences to undertake a special study of people in the mathematical sciences which was published under the descriptive title *A Challenge of Numbers.*

This report documents very serious problems that help explain the decline of degree candidates, especially the disproportion evident in the origin of students receiving mathematics degrees. Two-thirds of the population of the United States, namely women and those of Hispanic or Afro-American ancestry, contribute very few students to advanced degree levels. The proportion of women pursuing mathematics falls from 50% in school to 20% at doctoral levels; the proportion of minority students falls even more dramatically, from nearly 25% to less than 5%.

Like other large nations such as China, India, and the U.S.S.R., the United States is a multicultural society with citizens whose family roots are culturally, ethnically, and historically diverse. In fact, the ancestral roots of citizens of the United States penetrate to all corners of the globe. Moreover, because of differential immigration and birth rates, the composition of the United States continually changes. In California, our most populous state, those of non-European ancestry already form what we call a "majority of minorities," as do public school children in our 25 largest cities. Primary schools in Los Angeles must be prepared to teach children who come to school speaking over 75 different languages.

On this cultural potpourri our schools try to impose a mathematics curriculum of venerable and mostly Western tradition, a curriculum which, especially at higher levels, is dominated by ideas that were developed, almost always by males, as part of the intellectual and scientific revolutions in Europe. The style of teaching in mathematics classrooms, the choice of material and historical allusions, even the names of terms and theorems offer little that makes cultural connection with the majority of students in the United States. (A good example can be seen in the nomenclature used to describe the triangle of coefficients produced under binomial expansion. All Western texts call this pattern Pascal's triangle, even though Western historians of mathematics have known for many decades that the pattern was fully explored in China four centuries before Pascal.)

It is hardly surprising, then, to find among non-European and non-male students a disproportionate decline in interest both in the mathematical sciences and in all sciences that use mathematics. Despite popular opinion to the contrary, the evidence shows that this decline is due more to factors such as motivation, opportunity to learn, and styles of teaching than to any significant disparity in natural talent for the study of mathematics. A recent report called *Changing the Odds: Factors Increasing Access to College* shows that among students who complete geometry in secondary school—which in our curriculum represents the median mathematical level of high school graduates—there is relatively little difference across ethnic groups in the likelihood of a student fulfilling aspirations for a college degree. The gap between minority and majority students in college completion rates virtually disappears among students who take high school geometry, and the gap between poor and affluent students is cut in half.

A different study of typical college classes in science shows how rigid instructional styles can easily discourage even very able students from pursuing the study of science or mathematics. In this study, published under the provocative and controversial title *They're Not Dumb, They're Different*, graduate students in the humanities enrolled in beginning college science courses and reported extensively on the class dynamics and on their own personal struggles with the instructional approach. These dramatic and depressing eye-witness reports by sophisticated and generally sympathetic learners reveal consistent instructional patterns that discourage all but the most committed students—information without context, individuals without community, and instruction without motivation.

These data and studies show clearly that the traditional U.S. approach to mathematics education succeeds with only a small fraction of our students. As the world's demand for quantitatively literate workers increases, and as our own society becomes ever more pluralistic and multicultural, the need to change mathematics education in ways that will permit more students to learn more mathematics becomes a paramount priority for the United States.

6. Quality

Schools must ensure that students learn mathematics. In the American system, the pattern of "social promotion" largely independent of exams or course grades makes it possible for students to progress in school with ever-increasing deficiencies in basic knowledge. Our popular press is filled with stories of school graduates who do not know how to read, or how to locate the United States on a map of the world. Mathematics is no exception to this trend: nearly one in four high school graduates has not really mastered the elementary school arithmetic curriculum, not to mention any part of algebra or geometry taught in the upper grades.

Each year nearly 2.5 million students study mathematics in our colleges and universities. But over 70% of those students study pre-calculus level courses ordinarily taught in high school, and another 20% take some version of calculus. Fewer than 10% of all mathematics enrollments in U.S. colleges and universities are in post-calculus courses. Thus the preponderant mathematics curriculum of U.S. higher education is essentially that of U.S. high schools.

Repetition on this scale is wasteful of educational resources, of student motivation, and of public patience. Business leaders have little tolerance for a system that does not deliver what it promises; their concern fuels public hysteria against taxes by lending credence to those who say that public expenditures on services such as education are too often wasted. Popular talk of this type has created significant political momentum for radical actions against incompetence in the schools. Indeed, in a few of our states, the judicial branch of government—which traditionally has little or nothing to do with education—has intervened to demand restructuring which neither the legislative nor executive leaders had been willing to enact.

Nonetheless, part of the genius of the American system of education is its nearly unlimited patience for students who, for whatever reason, do not take full advantage of their education at its early stages. The new president of Howard University in Washington, DC, the most prestigious of our many historically Black colleges and universities, was himself denied admission to Howard as a prospective student—because of a very poor high school record. Now he is a respected scholar and university administrator, whose career was made possible by his hard work and by a system of higher education that allowed him to repeat what he had failed to learn while in high school.

Our extensive system of community and vocational colleges provides many adults with second, third, and fourth chances to learn the mathematics and other skills that they may not have mastered when they were in school. One will find on many campuses in the United States as many students over the age of 35 as under the age of 25. For these adult learners, higher education offers a chance to gain a better job or to keep up with the computer-based demands of their current job. It is a powerful feature of our educational system that few would wish to see curtailed.

However, the public's support of second chances applies more to students than to schools. The American people are now demanding that schools ensure that students actually do learn what is in the curriculum. Everyone would be better served if students left the public school system with a better mastery of the required curriculum, even though twenty years later they will probably still need to review and extend this knowledge through additional study in a community college or a university.

7. Assessment

Assessment must be aligned with curricular objectives. Arguments for improved testing come from numerous sources, often surprisingly diverse. Teachers argue that testing drives the curriculum since circumstances force teachers to teach to the test. Business leaders argue that testing is the only way one can be sure that ones' objectives are being met. Politicians argue that reliable tests are the only way to judge the return on public funds invested in education. Everyone wants tests to serve their own purposes. The result, all too often, is what has been called a “tyranny of testing.”

Assessment in the United States suffers from many ills. Most notable, especially because of its exceptional status on the world scene, is the plethora of multiple choice exams administered to children of all ages for a multitude of purposes: diagnosis, placement, progress, evaluation of teachers, monitoring of school systems, and now comparison among states. Yet the commonly stated objectives of education demand accomplishment in broad areas such as problem solving, literacy, and citizenship—not expertise at speedy completion of multiple choice tests. The result of our inexplicable attachment to atomized, short answer tests has been a growing disjunction in the United States between school skills and society skills, between the artificial world of the classroom and the real world of work.

The call for better alignment between assessment and objectives elicits many forms of educational jargon, for example, “performance based testing,” “outcome based education,” and “portfolio evaluation.” NCTM devotes a lengthy chapter in its *Standards* to criteria for effective assessment, emphasizing the need for authentic situations, for performance in several different dimensions, for multiple sources of measurement, for integrating testing into the instructional process, and for significant input from the child’s teacher into the overall judgment.

At the same time, however, political leaders have climbed aboard a testing bandwagon that often seems headed in the opposite direction. They urge, for the first time in U.S. history, national testing as a means of setting uniform national standards against which all school districts and all states can measure their progress. Not surprisingly, the leaders of this national testing movement decided to begin first with mathematics, since many people believe that mathematics, in contrast to other subjects, is relatively immune from intractable social controversies. Voluntary pilot state-by-state testing was just completed for eighth grade mathematics. It merely confirmed what we already knew: states with the best performance—which itself was none too good—are those that are relatively unencumbered by the burdens of large numbers of children from single-parent families, urban poverty, and drug-infested neighborhoods.

These two assessment movements are not well aligned with each other, although the leaders of both groups are engaged in constant discussion about means and ends. Teachers in many states are exploring innovative methods of assessment that are far removed from traditional norm-based objective tests. For example, my own state of Minnesota has recently adopted outcome-based education as the expectation for all school districts, which will require a very broad spectrum of assessment instruments. Meanwhile, the nation-wide state comparison tests are being developed as multiple choice instruments augmented by a limited number of free-response items. The gulf between these two approaches is still enormous, and remains to be bridged.

Implications

To summarize, seven issues unite all recent reports on mathematics education in the United States:

- **Beliefs**: All students can learn mathematics.
- **Objectives**: All students must learn mathematics.

- **Curriculum**: Students must learn different mathematics.
- **Instruction**: Teachers must teach mathematics actively.
- **Access**: More students must study more mathematics.
- **Quality**: Schools must ensure that students learn mathematics.
- **Assessment**: Assessment must be aligned with curricular objectives.

This consistency of issues and recommendations has given the mathematical community in the United States a reputation among scientists which it probably doesn't deserve, as a discipline that is united in objectives and strategies for improving education.

The truth is much more complicated. Mathematicians and mathematics educators do not actually agree as much on strategies or priorities as these recommendations might make it appear. And even when they do agree with each other, their position is sometimes at odds with the desires of outsiders (such as community leaders or politicians) who are responsible for schools and colleges. The issues we argue about are common problems in all societies, and I would be less than honest if I suggested that we had found all the answers. We are still struggling to learn how to solve our problems. We need to learn about the experiences of others who have faced the same problems. I hope that dialogue at this ICMI regional conference will contribute to a productive understanding of experiences in different countries.

For the Few or the Many

Slicing across mathematics education is a deep philosophical difference of opinion concerning the relative priority of policies that serve the few or the many. What is in society's best long-term interest—to help identify and nurture students with special talent in mathematics or to seek to elevate the mathematical level of all students? Many mathematicians believe that reforms intended to help all students will inevitably weaken the preparation of the best students; many active parents who want to see their own children accelerate as rapidly as possible argue for programs that help the few rather than the many.

This debate erupts on many fronts, from budget to curriculum, from teaching to testing. Shortly after *Everybody Counts* was published, a respected research mathematician published an article of rebuttal titled "Perhaps Nobody Will Count" in which he argued that the changes recommended in curriculum and styles of teaching would undermine rather than enhance the immediate recall of algebraic facts that are required for success in calculus. A respected conservative national columnist argued in *The Washington Post* that the only students who need to study mathematics beyond elementary school arithmetic are those few who will go on to become scientists or engineers. Even high school teachers and administrators have become comfortable with a system in which they identify and advance the best students as early as possible, and provide only minimal (or "custodial") education for the others, often poor, minority, or from single-parent homes. It will take a sustained effort to convince American political and educational leaders that excellence is compatible with equity, that both can be achieved by maintaining appropriate expectations.

Performance or Procedures

Discussion of educational outcomes often leads to similar acrimony. Many scientists, mathematicians, and parents feel more comfortable with traditional outcomes that are specified in precise terms instead of broad performance goals. For example, most people place more confidence in standards such as using the quadratic formula or calculating the volume of geometric shapes than in vague goals such as asking good questions, identifying different approaches, explaining results clearly. Yet we know from experience that the ability to use the quadratic formula in school does not translate well into the kinds of flexible problem solving that business and industry expect, and that failure to master the quadratic formula does not prevent a person from succeeding in many careers. Nevertheless, public pressure for assurances that students are actually learning tends to translate into traditional tests that bear little relation to performance on the job.

This issue spills directly into major national policy discussions. Even as I write there is a great debate within our Congress, and between the President and the opposition Democratic leadership, over language in the law that determines civil rights in the United States. One part of this bill is intended to eliminate discrimination in employment by making it illegal for employers to require of prospective job applicants any test or certificate that is not demonstrably related to job performance. The purpose of this legislation, which both sides support, is to ensure that job requirements unrelated to performance are not used as an indirect means of limiting job opportunities for members of minority groups. For example, it would be very difficult to prove for many jobs that one really needs a knowledge of algebra, even though algebra is required for most high school diplomas, which in turn are required for most jobs.

In homely form, the question of our current civil rights debate can be phrased directly in terms of school mathematics: Does the specific requirement of quadratic equations instead of the performance-based requirement of "problem solving" result in illegal (albeit unintentional) discrimination by denying jobs to many capable members of minority groups who often have not studied algebra? These issues strike at the very heart of education in a multicultural society, and in the United States at this moment, mathematics is in the center of this argument.

Productive Debate

Policy issues concerning mathematics education continue to be debated in the United States, which is itself a very good sign. Ten years ago, popular newspapers never discussed mathematics education. The declines in test scores and in numbers of students pursuing careers in the mathematical sciences have attracted considerable public notice, so now we are engaged in a great national debate.

Today's public knows that mathematics matters. What is studied and learned counts for a great deal in later life. How it is taught makes a big difference in how well it is learned. What mathematics students learn makes a big difference in how well prepared students are for jobs.

Most of the public, apart from politicians, also knows that some things don't really matter all that much. Raising graduation requirements, lengthening the school year, adding computers, testing more—these are not by themselves effective levers for improved instruction. They satisfy society's craving for action, but do little to actually improve education.

What really matters are parents and teachers who believe that all children can learn mathematics. In the United States, where educational change is primarily in the hands of the people, we must convince the public that, indeed, "everybody counts."

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