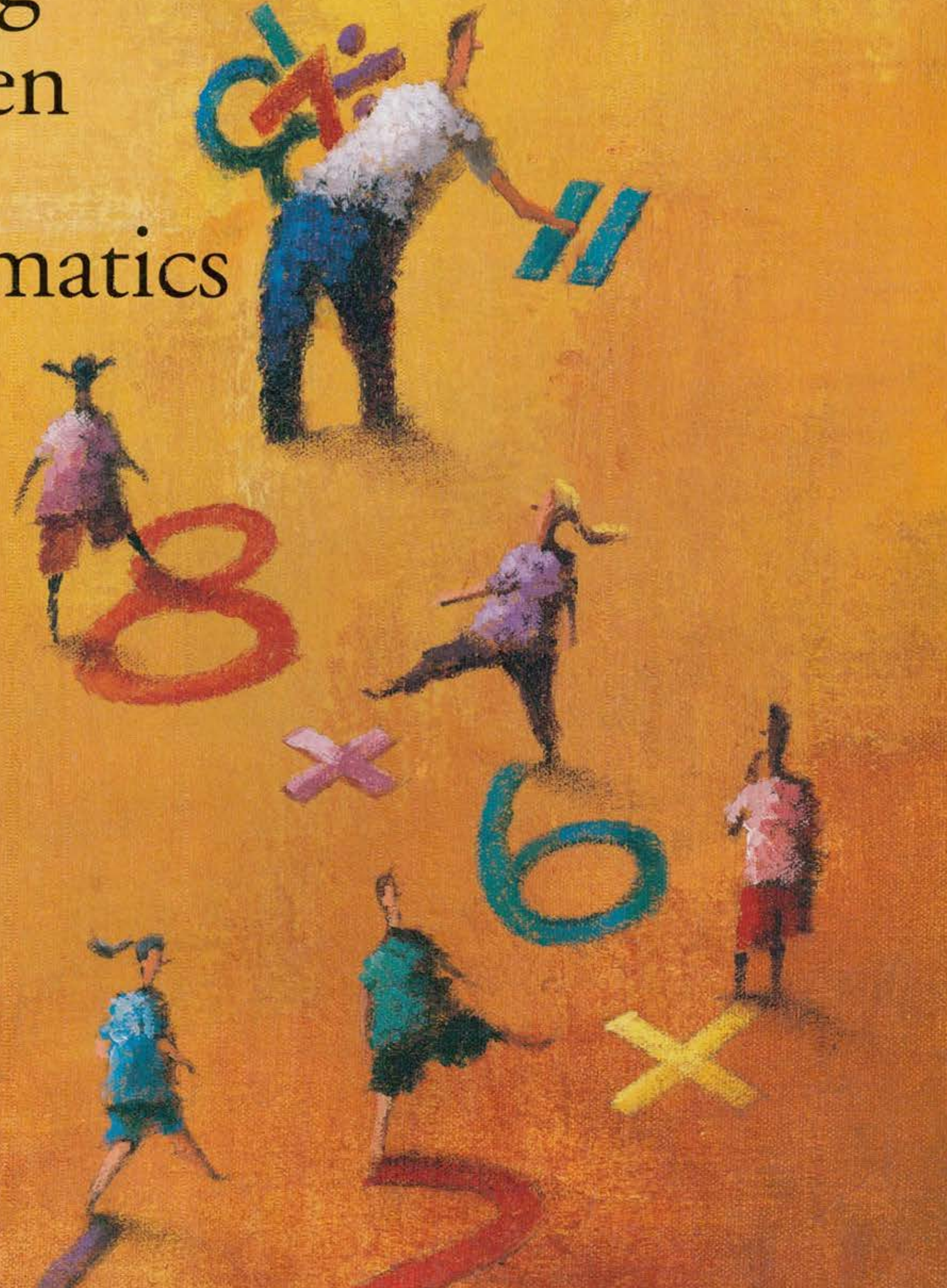
AMERICAN FEDERATION
OF TEACHERS
FALL 2005

AMERICAN Educator

Helping Children Learn Mathematics



AMERICAN Educator

Fall 2005

Cover illustrated by Paul Zwolak

AMERICAN Educator

The Professional Journal of the American Federation of Teachers
Volume 29, No. 3
Fall 2005

American Educator (USPS 008-462) is published quarterly by the American Federation of Teachers, AFL-CIO
555 New Jersey Ave. N.W.
Washington, DC 20001-2079
Telephone: 202-879-4420

American Educator is mailed to all AFT teacher, higher education, and other school-related professional members. Non-AFT members may subscribe by mailing $8 per year by check or money order to the address above.

Periodicals postage paid at Washington, D.C., and additional mailing offices.

Postmaster: Send address changes to
American Educator
555 New Jersey Ave. N.W.
Washington, DC 20001-2079

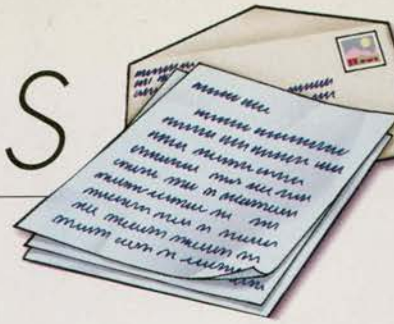
Members: To change your address, please cut out your label with code numbers from the back of the magazine and mail it with your new address to the address above. In addition, please notify your local treasurer.

American Educator cannot assume responsibility for unsolicited manuscripts. Please allow a minimum of four weeks for copyright permission requests. Letters to the editor may be sent by regular mail to the address above or via e-mail to **amered@aft.org**.

Signed articles and advertisements do not necessarily represent the viewpoints or policies of the American Federation of Teachers.

American Educator is produced with the assistance of members of Local 2, Office and Professional Employees International Union, AFL-CIO, and members of AFT Staff Union. Composition and printing are done in 100 percent union shops.

LETTERS



Supporting Good Reading Instruction

The Fall 2004 issue, "Preventing Early Reading Failure—and Its Devastating Downward Spiral," was so enlightening and helpful. It impressed me so much that I spent several hours of my winter vacation reading, rereading, and developing ideas on how to better teach when I get back to my classroom. Issues of *American Educator* like this are the best evidence that the American Federation of Teachers cares for us, those who are in the trenches of the teaching profession.

—ANGEL HERRERO
Sunset Elementary School
Miami, Fla.

Rethinking the Value of Standards and Accountability

With standards-based education often being the subject of only narrow-minded fanaticism or blanket condemnation, I appreciated the comprehensive, sophisticated, and thought-provoking treatment of the issue offered in the Spring 2005 articles. It definitely inspired me to move past my frustrations with the No Child Left Behind law and persist in considering the value that standards, testing, curriculum, and accountability can hold for my teaching.

—AARON BOYLE
Bushwick Community High School
Brooklyn, N.Y.

Seeing the Summer Activity Gap Up Close

As I picked up my *American Educator*, I was pleasantly surprised to find such a well-timed article by Tiffani Chin and Meredith Phillips ("Season of Inequality," Summer 2005). They pinpointed the concern that I have as I interact with my students this summer. I am a 7th- and 8th-grade humanities teacher—it makes me sad to hear my students say they are bored or that their summers are "horrible" because they have nothing to do. It disturbs me that so many kids seem to "want" to come to summer school because they have nothing structured to do over the summer. My hunch is that if there were more positive, productive options for the summer of the type that Chin and Phillips recommend, fewer of them would "want" to come to summer school.

—CHRIS TSANG
The Harbor School
Boston, Mass.

Focusing on Content

I enjoyed Dan Willingham's article in the Summer 2005 issue ("Do Visual, Auditory, and Kinesthetic Learners Need Visual, Auditory, and Kinesthetic Instruction?"). As alluded to in the article, it seems to me that the educator's function is to provide an environment in which the student is actively engaged (mentally, if in no other way) in the instruction, and using a variety of modalities helps students remain focused. I have a question with regard to one of the studies cited: Vandever and Neville, 1974. In the initial phase, approximately 25 percent of the students seemed to have a preferred modality for learning. Yet in phase two, these students had no modality effect. Why did that effect "disappear"?

—RON McDERMOTT
Mahopac High School
Mahopac, N.Y.

The cognitive scientist replies:

You've put your finger on an ongoing problem in this literature. The most probable explanation is that the initial categorization into visual, auditory, or

(Continued on page 48)

NOTEBOOK

Celebrate World Teachers' Day October 5

World Teachers' Day is an annual event celebrated in over 100 countries around the globe. On that day, teachers carry out a range of activities, attend public meetings, and meet and lobby political leaders in order to draw attention to teachers and the valuable role they play in society. The celebration is coordinated by Education International (EI), of which the AFT is an affiliate. The theme this year is "Quality Teachers for Quality Education," with a special focus on "training for a stronger teaching force." EI offers a lot of ideas about how to celebrate the day—examples include organizing school plays, parades, and media events. For more information, go to **www.ei-ie.org/worldteachersday/en/index.htm**.

Send Wal-Mart Back to School

AFT members shopping for school supplies are invited to sign a pledge that they will not purchase supplies at Wal-Mart in support of a nationwide union campaign to convince the retail giant to become a responsible employer and corporate citizen.

In the past year alone, Wal-Mart has repeatedly violated child labor laws, abused sweatshop labor in third world countries, and exploited immigrant labor. A notoriously anti-union company, Wal-Mart also has a record of discrimination against its 2 million female workers and has failed to provide company healthcare coverage to more than 600,000 employees.

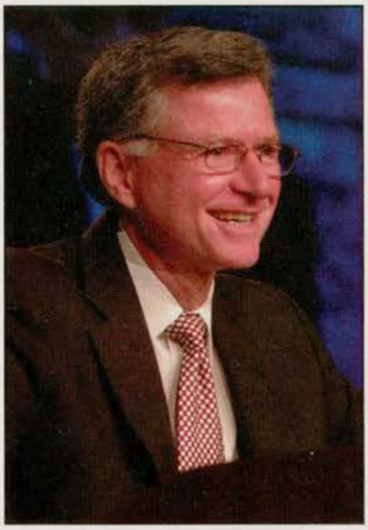
This summer, AFL-CIO convention delegates adopted a resolution endorsing campaigns to change Wal-Mart's corporate behavior. In 2004, the AFT convention adopted a "Shop Union, Not Wal-Mart" resolution pledging to support Wal-Mart workers. Part of this effort is the "Send Wal-Mart Back to School" campaign, asking teachers, school staff, and parents to sign a pledge to buy their back-to-school supplies somewhere other than Wal-Mart.

To sign the pledge, go to **www.unionvoice.org/campaign/WalMart_Pledge**.

The Federal Role in Education: Looking Back, Moving Forward

Forty years ago, former school teacher Lyndon Johnson signed the Elementary and Secondary Education Act (ESEA) into law. As one of the law's pioneers, Jack Jennings, president of the Center on Education Policy, reflected on ESEA and its successor, the No Child Left Behind Act (NCLB), in his remarks to AFT's QuEST conference on July 9, 2005. In this excerpt, he calls on the AFT to take a leading role in fixing NCLB's flaws.

The early 1960s were a time of great concern about poverty, civil rights, and social inequities. The country was grappling with how to implement the U.S. Supreme Court's decision in *Brown v. Board of Education.* Politicians, including Presidents John Kennedy and Lyndon Johnson, expressed great interest in reducing poverty. Education was a major focus, with the hope that better educational opportunities could provide American families with a way to escape poverty. Head Start, Title I, the Bilingual Education Act, programs for disabled children that later became the Individuals with Disabilities Education Act, grant and loan programs to help poor and working-class students attend college—all were created to help level the playing field for the poor, disadvantaged, and disabled by providing extra services and some legal protections.



These programs survive to this day, making assistance for the more disadvantaged in our society the federal government's primary concern in education for the past 40 years.

Three years ago, the No Child Left Behind Act was signed into law. Despite its problems, the equity goals of the 1960s remain at its core. The law is exactly right to hold schools accountable for the education of every racial and ethnic group, for poor children, for children with limited English, and for children with disabilities. Requiring that all children in America be proficient by 2014 is a civil rights goal. Requiring that all students be taught by highly qualified teachers helps disadvantaged students, who today are more likely to have less experienced teachers.

As a result of these goals in NCLB, schools in thousands of districts around the country are more focused on raising the achievement of disadvantaged students and on closing the achievement gap. I know that many educators have been working hard to improve education for decades, but this law has certainly focused additional attention on the students who need the most help.

In addition to its 40-year tradition of addressing equity concerns, the law now serves the newer purpose of trying to raise overall student achievement. In 2002, when it was signed into law, NCLB became the latest version of the nation's support for standards-based reform—a cause long championed by the AFT and Al Shanker, its late president.

The timelines, penalties, and funding of this legislation are all highly controversial, as is the question of whether it intrudes on state and local control of education. These controversies should not distract us, though, from seeing that there is general national agreement that all students must be held to higher academic standards, that there must be some way to measure how students are doing, and that schools where students aren't doing well must be improved.

I believe that agreement on these principles will survive and, as a consequence, the basic contours of the No Child Left Behind Act will be retained when it is reauthorized in 2007 or 2008. The more significant question is: How will its defects be corrected?

If NCLB is to be changed for the better, two steps must be taken, sooner rather than later. First, several basic questions must be answered and the answers used to fashion new policies. Some of these questions are:

- How do you design a good assessment and public accountability system?
- What does it take to turn around a failing school? Additional funds can help, but what more is needed?
- If nearly all students are to be proficient in math and reading by 2014, what will it cost in terms of extra programs and services?
- What does it really mean to be a "highly qualified" teacher?
- What will it take to get more experienced teachers into impoverished, low-performing schools?

There is an old political principle that you can't beat something with nothing. That means that critics of NCLB have to show how the worthy goals of this law can be attained by improving schools, not penalizing them. After better answers are found, a second step must be taken. Educators will have to fight for their ideas. Another basic political principle is that good ideas, alone, are not good enough. You also have to know how to fight effectively to get those ideas accepted.

If the AFT can take the lead in meeting this challenge, you will be providing millions of youngsters with the opportunity to lead a better life. You will also be strengthening the fabric of American society and honoring the memory and legacy of a great leader, Albert Shanker.

Harold Stevenson Remembered

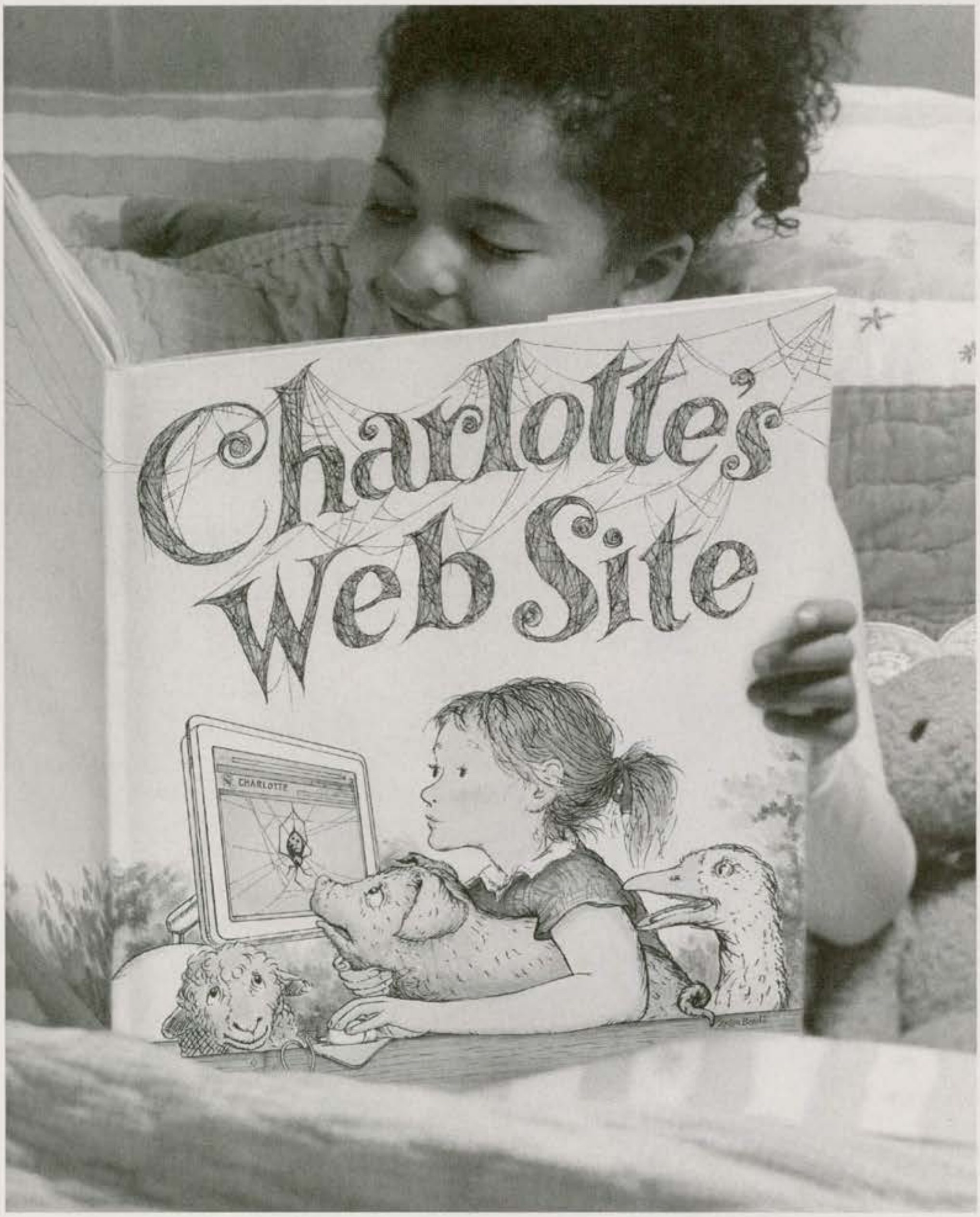
Harold Stevenson, a developmental psychologist and pioneer in cross-national studies of student achievement, passed away in July 2005. A recipient of the AFT QuEST Award in 1995 and author of three articles for *American Educator* ("The Asian Advantage: The Case of Mathematics," Summer 1987, "How Asian Teachers Polish Each Lesson to Perfection," Spring 1991, and "Lessons from Abroad: The Learning Gap," Summer 1993), his work continues to influence the debate over education reform.

Stevenson became interested in comparisons of U.S. and Asian educational practices in the early 1970s, after joining the first delegation of American child development experts to visit China after the communist takeover. Stevenson's surveys were the first to show that U.S. students lagged behind their Asian counterparts in reading and, even more so, in mathematics from the time they entered school.

In 1992, Stevenson and his colleague James Stigler published *The Learning Gap: Why Our Schools Are Failing and What We Can Learn from Japanese and Chinese Education,* a book that illuminated some of the many reasons for this achievement gap. Among their other findings, Stevenson and Stigler concluded that different cultures place a significantly different value on the role that hard work plays in achievement. In Japan and China, the belief is that "people are basically the same and that the difference between success and failure lies in how hard you work," said Stevenson. "Americans give more importance to native ability, so they have less incentive to work hard in school."

Stevenson also reported that American students tend to do less homework, devote fewer hours to studying in school, and spend more class time engaged in "academically irrelevant" behavior—such as whispering to classmates or wandering around the room. At the same time, he found that high-performing Asian nations tend to have common, clearly defined academic standards, high expectations, large heterogeneous classes, and a cadre of highly trained teachers who are given ample time to work together to perfect lessons that include a lot of hands-on exercises for students.

These findings, as Al Shanker said in a 1992 *New York Times* column, challenged us "to take a new look at some education practices that we have come to take for granted.... If teaching is a performing art, as Asian teachers seem to think it is, teachers don't have to worry about composing a new concerto—or painting a new picture—for every class. They can practice and perfect ones they develop together with other teachers. They can rethink the questions that led to deep silence, instead of a lively discussion, and they can discard examples that failed last year or yesterday and think up new ones. And as they collaborate with other teachers, they can break out of the isolation in which they now work. It's worth thinking about."


Charlotte's
Web Site
CHARLOTTE

Helping Children Learn Mathematics

"What caused you to quit school?" That's the main question that researchers from the United Negro College Fund asked of 62 high school dropouts in a West Virginia Job Corp program last year.[†] Most had the same answer: mathematics.

The finding is hardly surprising. Many Americans regard the subject of mathematics with fear and loathing—probably because people tend to dislike the things they're not good at. And, for several decades, American students' inadequate mathematics achievement has been well documented by national and international assessments, studies, and reports. Although math scores increased somewhat for both fourth- and eighth-graders on the most recent National Assessment of Educational Progress long-term trend report, the increases weren't large enough to close the gap between the U.S. and the world's high-achieving countries and, disappointingly, scores for 12th-graders remained stagnant.

For those involved in education, persistent reports of students' low mathematics achievement can be frustrating—especially since mathematics education, like the teaching of reading, has been the subject of one type of reform plan or another for the past half a century. Like reading, math is universally accepted as one of the core academic subjects. Both are taught from the earliest grades, are regularly included in high-stakes assessments, and are understood to be gateways to future learning opportunities. Mathematics in particular is the gateway to future studies in the economically vital fields of science, engineering, and technology. But unlike reading, which has been carefully studied for roughly 40 years, the study of math education has been much more haphazard. As a consequence, the research on improving mathematics instruction is still dismayingly thin. One result is that much of the debate over mathematics education reform has been based, in the words of William Schmidt, not "on scientific evidence, but rather on opinion and someone's ideology."

So what *do* we know? Thanks to the work of Harold Stevenson (see p. 5), James Stigler, and others, we know that the culture of schooling is an important factor in how mathematics is taught and learned. The data on some 50 countries, collected and analyzed as a part of the Third International Mathematics and Science Study, reveal the central importance of a mathematics curriculum that is focused, logical, and coherent—characteristics that are sorely lacking in U.S. curricula (see p. 11). And, perhaps most important, we know that teachers' knowledge of the mathematical content to be taught is absolutely crucial.

But what else do mathematics teachers need to know? To teach multiplication to third-graders, for example, is it enough to know how to multiply reliably oneself, or does the teacher also need to know how to quickly diagnose and correct students' mistakes? What about knowing how to react if a student gets the right answer by making up a new algorithm? Broadly speaking, is there a deeper knowledge of elementary mathematics that is needed "just" to teach multiplication to third-graders?

Fortunately, Deborah Loewenberg Ball and her colleagues have been asking questions like these for over a decade. They don't yet have definitive answers—but they do have an exciting program of research that has already tied teachers' mathematical content knowledge to student achievement and, in the years to come, promises to identify exactly what knowledge successful mathematics teachers need to have. Deborah Ball, Heather Hill, and Hyman Bass explain their work and findings to date starting on p. 14.

While Ball and her colleagues have been working on large-scale assessments of teachers' mathematical knowledge and its connection to student achievement, Ron Aharoni has been in the classroom discovering, through many less-than-perfect lessons and the occasional home run, what elementary mathematics teachers need to know. A professional mathematician, Aharoni accepted the challenge of working in elementary math classrooms several years ago. We open this special section on teaching mathematics (p. 8) with his personal reflections and insights.

—*Editor*

[†] Viadero, D. (March 25, 2005). Math emerges as big hurdle for teenagers. *Education Week*—**www.edweek.org/ew/articles/2005/03/23/28math.h24.html.**

What I Learned in Elementary School

By Ron Aharoni

A friend of mine left a high-tech career in mid-life to work in mathematical education. In September 2000, just before the school year began, he called me: There is a project to promote mathematical education in elementary schools; come join. The project was in a development town called Maalot, in the far north of Israel. (Israeli development towns, built in the 1950s to settle new immigrants, are usually considered to be rather backward.)

I am a professional mathematician and, although I have been strongly interested in teaching (which is the reason that my friend had the idea of offering me the job), I had not set foot in an elementary school since I was a child. So I consulted whomever I could. The advice I got was uniform: Don't do it. Elementary math education is a profession in itself. There is no connection between it and teaching math at the university level.

In hindsight, sobriety should have dictated listening to this advice. Yet, had I listened, I would have missed one of the most fascinating adventures of my life.

The banner I was carrying at that time was that of "experience." The children should experience abstract concepts concretely, I thought, after which the abstractions should occur by themselves. I took the kids out to the playground. We measured lengths of shadows and compared them to the lengths of the objects themselves, then used this information to calculate the height of trees according to their shadows. (This idea is borrowed from Thales, who was born in the 7th century B.C.[†]) Then we measured the length and width of the classroom in various ways to find how many floor tiles fit into one square meter, and what the ratio was between the length of the classroom in meters and its length in tiles.

I learned the price of conceit the hard way—most of my lessons were a mess. I remember my first day of insight well: I took a fourth-grade class to the playground to draw circles on the pavement and then measure the diameters and circumferences. It soon became apparent that the kids were mainly using this opportunity to have fun outside, at which point the teacher I was working with suggested that we go back in and discuss what we had done. We drew circles on the board and, with the active participation of the children, discovered the ratio of perimeter to diameter. For me, this was a first glimpse of the power of common class discussion.

Fortunately, at around the same time, I started teaching first grade. This was a wonderful experience. First-graders are still open-minded; they go along with you wherever you lead them. Their reactions are direct, and they make it apparent to you what is working and what is not. First grade is the best place to learn about teaching. Further, by great good fortune, I was paired with an excellent teacher. She was ready to accompany me in the joint adventure, to our mutual gain. I would open the lesson, introduce an activity or an idea, and she would intervene when she felt that my didactics were less than perfect. Usually, that was when I had skipped a stage.

Since then, I have been learning intensively from each lesson and every conversation with teachers. I learn from unsuccessful lessons no less than from the better ones; mostly, I learn from those lessons that limp in the beginning, until the right thing is done and they take off.

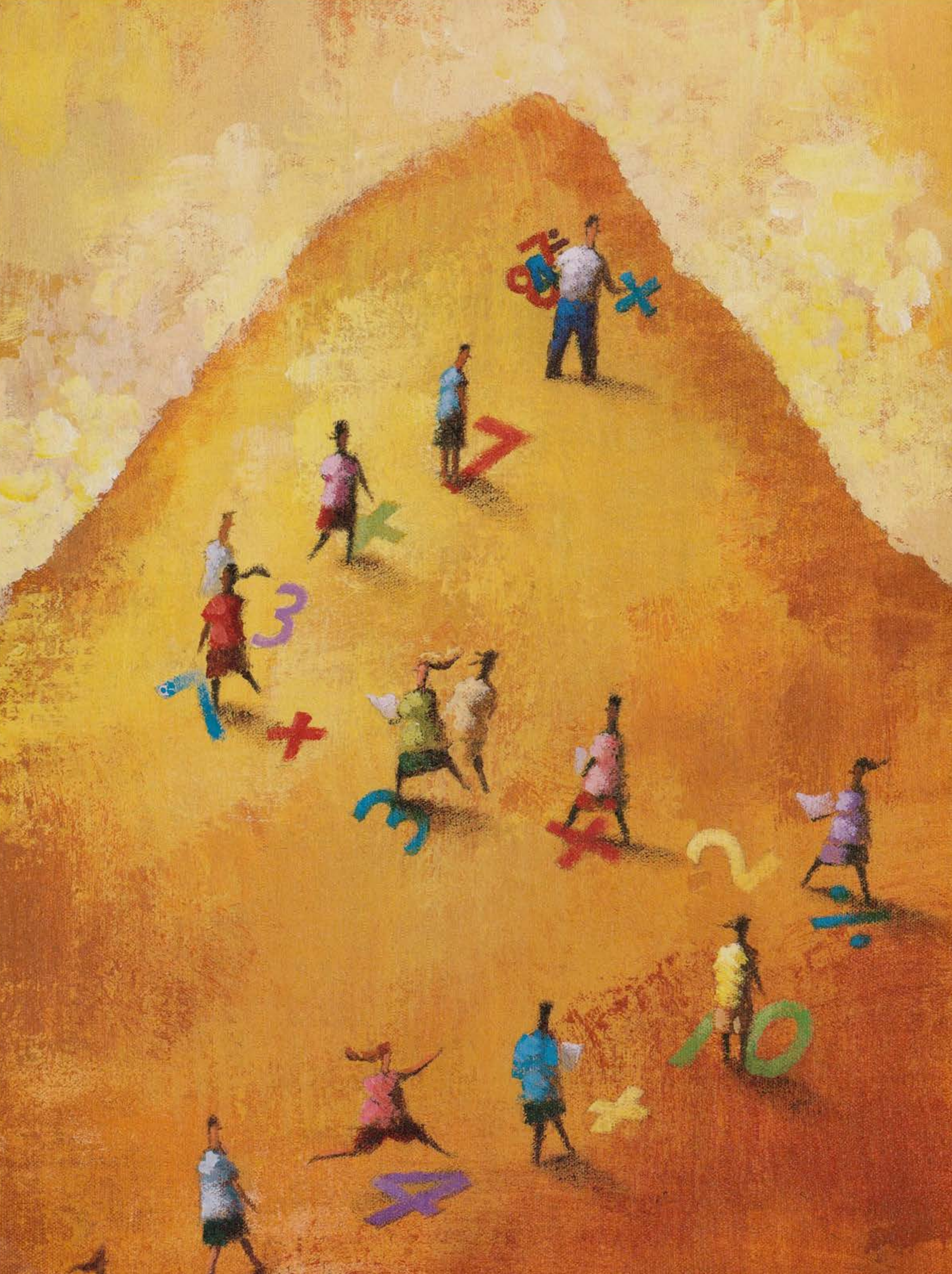
What Did I Learn?

I learned a lot about how to approach young kids and the way children think. I learned the importance of being systematic, a characteristic that my teaching so desperately lacked in the beginning. I learned that concepts that adults perceive as a whole are in fact constructed from many small components, built one on top of the other, and none of them can be skipped. I learned that explaining in elementary school is usually futile; the youngster should experience the concepts for him or herself. In that notion, I was right from the beginning. It's just that I had no idea what "experiencing" really means. It does not refer to complex notions. Learning through experience relates to the most basic concepts, like that of number or of "smaller than" and "larger than," which can be revealed through the counting of objects.

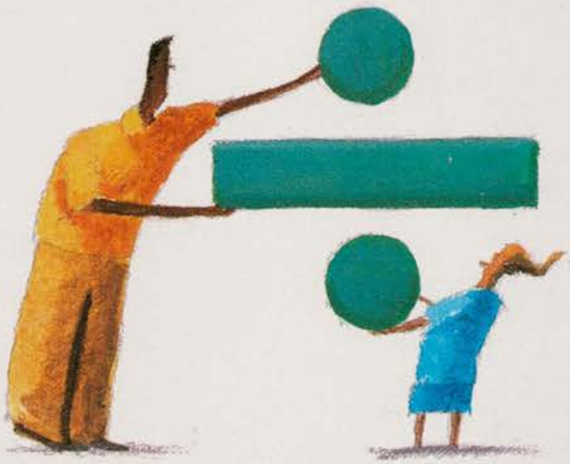
Ron Aharoni is a professor of mathematics at the Technion-Israel Institute of Technology in Haifa, Israel, and author of Arithmetic for Parents, *a book for grownups on children's mathematics, published by Schocken Press in 2004. This article is adapted from a 2003 address to the British Mathematical Colloquium in Birmingham, England.*

[†]Thales was the first mathematician in history to be mentioned by name. He used this method to calculate the height of the pyramids.

ILLUSTRATED BY PAUL ZWOLAK



Elementary mathematics is usually not sophisticated, but it is deep.



But what surprised me most was that I learned mathematics. Actually, a lot of it. This would not be the case had I gone to teach in a high school. The mathematical concepts there are known to a professional mathematician. In elementary school, it's the teaching of the most basic principles that counts—the nature of numbers, the meaning of the arithmetical operations, the principles of the decimal system. About these, it is rare for a mathematician to stop and think.

I also learned that the understanding of these principles is inseparable from the didactics. Good teaching means bringing the children to experience the fine fundamental points.

Layers

Elementary mathematics is structured in the same way as high-level mathematics. Namely, it is layered. Each layer is built on top of the previous one. Just as in a complicated proof, the order in which the components are put together is important. So, in elementary mathematics, it is essential not to skip stages.

The difference is that the layers in elementary school are those at the bottom of the tower. The structures that are built are not tall. But, as if to compensate, there can be difficulties. They are often hidden, as if they were built under water, meaning that it is not always easy to realize what they are. Elementary mathematics is usually not sophisticated, but it is deep.

Here is an example. A first-grade class was given a picture of five apples, three of them green and two red. The children were supposed to tell arithmetical "stories," one on addition and one on subtraction. The importance of telling such stories cannot be overestimated. In order to understand the meaning of the operations, it is not enough to hear or read such stories. One has to be able to invent them on his or her own.

The addition story posed no difficulty: "I had three green apples and two red apples, how many apples did I have altogether?" But when they came to the subtraction story contained in the picture of three green and two red apples, confusion prevailed—and, as usually happens in elementary school, it manifested as inattention. Eventually, one of the children said: "I had five apples. I ate two. How many do I have left?" The problem was that this wasn't the "correct" story. It wasn't based on the drawing. The drawing didn't show two apples disappearing, by being eaten or any other way. That is why the children found the task difficult.

I was experienced enough to know that such confusion almost always originates from having skipped a stage. In this case the missing stage was the understanding that *subtraction has more than one meaning.* There is the meaning of "diminution," where objects are removed: I had 5 balloons, 2 of them burst, how many do I have left? This is the meaning the child used in his story—his apples disappeared. But there is also the meaning of "comparison of quantities," where nothing disappears: There are 5 children in a group, 2 of them are boys. How many are girls? Or perhaps: How many more green apples than red apples are there? In these cases, too, the exercise is one of subtraction, $5-2$ or $3-2$, but the meaning is different. This is the meaning depicted in the drawing.

The various meanings of subtraction are an example of a fine point that has to be taught explicitly. Skipping this stage will result in later difficulties with word problems.

The Importance of Explicit Naming

When I started teaching in elementary school, I was convinced that precise formulations and the explicit naming of principles was a matter for grownups. Children should learn things on an intuitive level, I thought. One of the greatest surprises that awaited me was to realize how wrong I was about that. Children need precise formulations. Such formulations consolidate their knowledge of the present layer and make it a safer basis on which higher layers can be built. Moreover, children love "adult" formulations and notations, and are proud of being able to use them. First-grade children who learn the notation "1/2" are happy to discover the notation for "1/3" by themselves.

The different meanings of subtraction—diminution and comparison—gave me the opportunity to realize the importance of the explicit naming of principles. I was lucky to accompany three different classes on this very same page in the first-grade textbook. The first lesson I taught was described above; we moved directly from the addition story to the subtraction story. In the second class, before getting to the subtraction story, I stopped the lesson and started an explicit discussion of the various meanings of subtraction. This went

The Role of Curriculum

In the main article, Ron Aharoni describes his discovery of the importance of "layering" in elementary mathematics, with each layer of knowledge built upon the previous one. It is an insight that is borne out by research on the educational practices of the world's highest performing nations. Below, William Schmidt describes how TIMSS data demonstrate the importance of a coherent mathematics curriculum, in which the topics are chosen carefully. For a more comprehensive treatment of this subject, including a stunning visual comparison of the topics covered in U.S. and international mathematics curricula, see "A Coherent Curriculum: The Case of Mathematics," Dr. Schmidt's Summer 2002 article for American Educator ***(www.aft.org/pubs-reports/american_educator/summer2002/curriculum.pdf)****.*

—*EDITOR*

By William H. Schmidt

The data are clear. Recent results from the Third International Mathematics and Science Study (TIMSS) show that U.S. eighth- and 12th-graders do not do well by international standards—ranking below average in both grades and, in fact, near the bottom of the international rankings on a mathematics literacy test at the end of high school. Even our best students, taking an advanced mathematics test, do not fare well against their counterparts in other countries. Those results were obtained in 1995, but retesting in 1999 and 2003 found few gains. Put simply, there is no evidence to suggest that we as a nation are doing better, at least relative to other countries.

People from other nations often ask me why U.S. student achievement does not improve, especially given that we are constantly reforming mathematics education in the U.S. The short answer is that we often engage in reform that is not based on scientific evidence but rather on opinion and someone's ideology. TIMSS offers us a good opportunity to use scientifically collected data on some 50 countries to find a more promising answer to the question of what we can do to improve the mathematics education of all children.

TIMSS results suggest that the top achieving countries have coherent, focused, and demanding mathematics curricula. What would a coherent curriculum look like? A coherent curriculum leads students through a sequence of topics and performances over the grades, reflecting the logical and sequential nature of knowledge in mathematics. Such a curriculum helps students move from particular knowledge and skills toward an understanding of deeper structures, more complex ideas and mathematical reasoning including problem solving. For example, students should be expected to master the basic concept of number and basic computational skills in the early grades before they tackle more difficult mathematics.

What does the U.S. curriculum look like? The U.S. curriculum, as reflected in many of the states' standards and in our nation's textbooks, tends to reflect an arbitrariness, with topics appearing somewhat haphazardly throughout the grades. For example, teachers are expected to introduce relatively advanced mathematics in the earliest grades, before students have had an opportunity to master basic concepts and computational skills. In addition, the curriculum continues to focus on basic computational skills through grade eight and perhaps beyond. Jumping back and forth between basic and advanced topics obscures the logic of mathematics. I would argue that if the logic of mathematics is not transparent to students, then it becomes difficult for them to develop a deep understanding that could lead to higher achievement.

What do curricula look like in the top achieving countries? They are focused and rigorous. The number of topics that children are expected to learn at a given grade level is relatively small, permitting thorough and deep coverage of each topic. For example, on average, nine topics are intended in the second grade. The U.S., by contrast, expects second-grade teachers to cover twice as many mathematics topics. As a result, the U.S. curriculum is accurately characterized as "a mile wide and an inch deep."

Coherent standards move from the simple to the complex. By the middle grades, the top achieving countries do not intend that children should continue to study basic computation skills. Rather, they begin the transition to the study of algebra, including linear equations and functions, geometry and, in some cases, basic trigonometry. By the end of eighth grade, children in these countries have mostly completed mathematics equivalent to U.S. high school courses in algebra I and geometry. By contrast, most U.S. students are destined for the most part to continue the study of arithmetic. In fact, we estimate that, at the end of eighth grade, U.S. students are some two or more years behind their counterparts around the world.

All of this is related to what students learn. If we are serious about providing all students with a challenging mathematics curriculum, it must be coherent and demanding—not by our own sense of what this might mean, but by international standards. It must be focused. It must require our middle schools to expect more of our students. It must be for *all* children. And it must be taught by teachers who are well-prepared in mathematics and in instructional approaches that are steeped in mathematics, as well as cognitive theories about how children learn.

William H. Schmidt is a University Distinguished Professor at Michigan State University and the director of the U.S. National Research Center for the Third International Mathematics and Science Study. This article was adapted with permission from a presentation to the U.S. Department of Education's 2003 Secretary's Summit on Mathematics.

very smoothly, and the children had no difficulty identifying the type of subtraction in the picture. In the third class, I conducted an experiment. Instead of explicit discussion, I preceded the work on the page with an example: the problem of the five children of whom three were girls. This did not work. The example did not provide the children with a solid enough ground upon which to build. This was a good lesson to me on how important it is to formulate principles explicitly.

What Arithmetic Should Be Covered in Elementary School?

The embarrassingly simple answer is: the four basic operations—addition, subtraction, multiplication, and division.

Yet, this seemingly simple answer is deceptive in two ways. One is that there are actually *five* operations. In addition to the four classical operations, there is a fifth one that is even more fundamental and important. That is, *forming a unit,* taking a part of the world and declaring it to be the "whole." This operation is at the base of much of the mathematics of elementary school. First of all, in counting, when you have another such unit you say you have "two," and so on. The operation of multiplication is based on taking a set, declaring that this is the unit, and repeating it. The concept of a fraction starts from having a whole, from which parts are taken. The decimal system is based on gathering tens of objects into one unit called a "10," then recursively repeating it.

The forming of a unit, and the assigning of a name to it, is something that has to be learned and stressed explicitly. I met children who, in fifth grade, knew how to find a quarter of a class of 20, but had difficulty understanding how to find "three-quarters" of the class, having missed the stage of the corresponding process of repeating a unit in multiplication.

But there is another reason why learning "the four operations" in elementary school is not such a simple answer. That is because the operations have two distinct components. One is their meaning, and the other their calculation. I stress this seemingly simple fact because this distinction is not always clear to education policymakers, especially the writers of textbooks. Some textbooks start with calculation. Some do not stress the difference between "2 times 3" and "3 times 2." Most of them do not make the distinction between the two types of division ($6 \div 2 = 3$, because $3 + 3 = 6$, and $6 \div 2 = 3$, because two goes into six three times, namely $2 + 2 + 2 = 6$).

The meaning of an operation is the link between it and reality, the real world operation corresponding to it. The calculation is finding the result. But again, there is something that is not often realized: It is not really finding the result. It is finding the *decimal representation* of the result. Ancient man, when adding eight and four, drew eight lines beside four lines, and represented the result by twelve lines—there is no "calculation" here, and ancient man did not have to send his children to school to learn this. In "$8 + 4 = 12$," on the other hand, there is calculation, and an invisible operation is performed: that of collecting ten units into one "10." And of course there is also the "place value" writing of the number, another non-trivial principle. Thus, understanding the algorithms for calculation is tantamount to deep understanding of the decimal system. If policymakers realized this, they might be less apt to introduce the use of calculators into elementary school.

In international mathematics assessments, Israel dropped from first in the world in 1964 to 29th place in 1999—behind everyone except the developing nations.

To summarize, in elementary school, children (and mathematicians) learn the *meaning of five operations* and the *decimal system.*

Another important fact should be known about elementary school mathematics: Division has a special status in the study of arithmetic. This is true in most syllabi all over the world, and with good reason. It is awarded a greater portion of teaching time than any other operation. The turnabout occurs around the middle of the fourth grade. From this point on, until the end of the sixth grade, the children are taught the meanings of division, ratio problems (which are expressed by division), and the efficient, systematic tool used when discussing division and ratios: the fraction—both the simple fraction and the decimal fraction.

Why is division so special? Because addition and subtraction are operations too simple to describe the world. When things get complicated, multiplication and division are required. A large part of our world operates according to the principles of linear relationship. In elections, for example, the number of mandates each party receives is more or less linearly related to the number of votes it received. And linear relationships are expressed by division.

Another reason for spending more time on division is that it is more difficult than the other operations. Of the four operations, it has the most meanings, it is the hardest to calculate, and the problems it can represent are the most complicated.

The Curious Story of Mathematical Education in Israel

As an academic subject, mathematics education is very young, and all of us have had the misfortune of being its guinea pigs. Arguably, Israel has paid a higher price than anywhere else in the world for this experimentation.

The American "new math" reform of the 1960s was brought to Israel in a most strange and extreme form, called "structuralism" by its authors. It was imposed on practically all Israeli schools for a full quarter of a century. Its story may reflect on the politics of education, not only in Israel.

Two Australian researchers, Ken Clements and Nerida Ellerton, wondered why so many American and British educational "reforms" have been exported to other countries, despite having failed miserably in their country of origin. Their explanation was that people, studying for their PhD degrees in the U.S. or the U.K. at the time of the reform, returned home to their own countries bringing the untested gospel of reform with them.[‡]

In this case, new math "structuralism" meant that no concept or operation was taught directly or through its meaning. For every concept there was a "representation," or substitute, whose study was supposed to lead to an understanding of the original concept. The four operations were taught using Cuisenaire rods. A face-like picture into which three numbers are put, two in the places of the eyes and one at the mouth, was supposed to teach children when to add and when to subtract. If the two numbers were at the eyes, and the missing number was at the mouth, it was an addition problem. If one number was at an eye and another at the mouth, it was a subtraction problem. (The children were made to recite: "Eye and eye is plus; mouth and eye is minus.") Division was taught as the reverse operation of multiplication, using so-called "multiplication rectangles." Most extreme was the teaching of the decimal system. Instead of the principle of the collection of tens, strange creatures were invented called "bodytails," which had bodies representing the tens and tails representing the units. And those are just a few of many such devices.

In international mathematics assessments, Israel dropped from first in the world in 1964 to 29th place in 1999—behind everyone except the developing nations.

Mathematics education in Israel has recently undergone a profound change. Together with other mathematicians and classroom teachers, we established a nonprofit organization, the Israeli Foundation for Math Achievement for All, to work for the improvement of mathematical education in Israel. We successfully lobbied the Ministry of Education to remove the "structuralist" textbooks from schools, replacing them with a more traditional curriculum that puts the focus on the content to be learned, rather than on how it should be taught.

Currently, the foundation is working directly in about 10 percent of the nation's Hebrew-speaking schools (a parallel movement has begun in Arabic-speaking schools). These schools are using translations of mathematics textbooks from Singapore, one of the world's highest performing nations in international assessments of mathematics achievement. These texts are direct, devoid of the use of sophistication for the sake of sophistication, and are based on mathematical wisdom. Mathematical concepts and procedures are introduced carefully, step by step, so as to minimize the possibility of missed stages and future confusion. The texts focus on the meaning of mathematical operations before they teach how to calculate using those operations.

Our approach is based on two principles: Start with the concrete *and* a lot of class discussion. There is much less individual work in workbooks than there used to be. In a typical lesson, the children experience some principle together, in a concrete way, and verbalize what they have experienced. For example, if the children calculate $23-5$, they will have two groups of 10 sticks, bound by rubber bands, and 3 loose sticks. They are then asked to explain how 5 sticks can be subtracted, including why it is necessary to unbind one of the groups of 10 in order to accomplish this. They are then asked to write what they did, in vertical form, and relate this to the concrete process of subtraction. Although students do a lot of the talking, they sit facing a teacher at the front of the classroom, where she can guide the discussion and lead the children to the right concepts.

Our organization offers a lot of support to teachers as they implement the new methods and materials (every class is visited at least once a month), with professional development provided on a constant basis. We find that the teachers learn a lot of mathematics along with the children—just as I did.

"How" vs. "What"

I started by making the point that elementary mathematics has a lot of depth, with many subtle and sometimes hidden principles. To summarize, let me return to this point.

For the last 50 years, education policymakers have been researching *how* to teach mathematics. Our experience with this approach makes it clear that the *what* should come before the *how.* Sound teaching is based, first of all, on the understanding of the fine points of elementary mathematics and on the systematic unfolding of its concepts. "Fine points" do not mean sophistication. Quite the contrary; they mean that even ideas that may look obvious should be experienced and verbalized.

The current trend in education is to make children happy in their studies, so as to prevent "math anxiety." My experience is that children are happiest when they truly understand the principles of mathematics, not when we make believe that they do. □

[‡] Clements, M.A. and Ellerton, N.F. (1996). *Mathematics education research: Past, present and future.* Bangkok: UNESCO. Also see Clements, M.A. (2003). An outsider's view of North American school mathematics curriculum trends. In G.M.A. Stanic and J. Kilpatrick (Eds.), *A history of school mathematics* (Vol. 2). Reston, Va.: National Council of Teachers of Mathematics.

Knowing Mathematics for Teaching

Who Knows Mathematics Well Enough To Teach Third Grade, and How Can We Decide?

By Deborah Loewenberg Ball, Heather C. Hill, and Hyman Bass

With the release of every new international mathematics assessment, concern about U.S. students' mathematics achievement has grown. Each mediocre showing by American students makes it plain that the teaching and learning of mathematics needs improvement. Thus, the country, once more, has begun to turn its worried attention to mathematics education. Unfortunately, past reform movements have consisted more of effort than effect. We are not likely to succeed this time, either, without accounting for the disappointing outcomes of past efforts and examining the factors that contribute to success in other countries. Consider what research and experience consistently reveal: Although the typical methods of improving U.S. instructional quality have been to develop curriculum, and—especially in the last decade—to articulate standards for what students should learn, little improvement is possible without direct attention to the practice of teaching. Strong standards and quality curriculum are important. But no curriculum teaches itself, and standards do not operate independently of professionals' use of them. To implement standards and curriculum effectively, school systems depend upon the work of skilled teachers who understand the subject matter. How well teachers know mathematics is central to their capacity to use instructional materials wisely, to assess students' progress, and to make sound judgments about presentation, emphasis, and sequencing.

That the quality of mathematics teaching depends on teachers' knowledge of the content should not be a surprise. Equally unsurprising is that many U.S. teachers lack sound mathematical understanding and skill. This is to be expected because most teachers—like most other adults in this country—are graduates of the very system that we seek to improve. Their own opportunities to learn mathematics have been uneven, and often inadequate, just like those of their non-teaching peers. Studies over the past 15 years consistently reveal that the mathematical knowledge of many teachers is dismayingly thin.[1] Invisible in this research, however, is the fact that the mathematical knowledge of most adult Americans is as weak, and often weaker. We are simply failing to reach reasonable standards of mathematical proficiency with most of our students, and those students become the next generation of adults, some of them teachers. This is a big problem, and a challenge to our desire to improve.

Deborah Loewenberg Ball is interim dean of the School of Education and the William H. Payne Collegiate Professor in Education at the University of Michigan. Her areas of specialization include the study of efforts to improve teaching through policy, reform initiatives, teacher education, and mathematical knowledge for teaching. Heather C. Hill is associate research scientist at the School of Education, University of Michigan. Her areas of specialization include educational policy, instruction, and teachers' content knowledge. Hyman Bass is the Roger Lyndon Collegiate Professor of Mathematics and of Mathematics Education in the Department of Mathematics and the School of Education, University of Michigan. His areas of specialization include algebra (geometric methods in group theory), teacher education, and mathematical knowledge for teaching.

[1] For example, Liping Ma's 1999 book, *Knowing and Teaching Elementary Mathematics,* broadened interest in the question of how teachers need to know mathematics to teach (Ma, 1999). In her study, Ma compared Chinese and U.S. elementary teachers' mathematical knowledge. Producing a portrait of dramatic differences between the two groups, Ma used her data to develop a notion of "profound understanding of fundamental mathematics," an argument for a kind of connected, curricularly-structured, and longitudinally coherent knowledge of core mathematical ideas. (For a review of this book, see the Fall 1999 issue of *American Educator*, **www.aft.org/pubs-reports/american_educator/fall99/amed1.pdf**.)

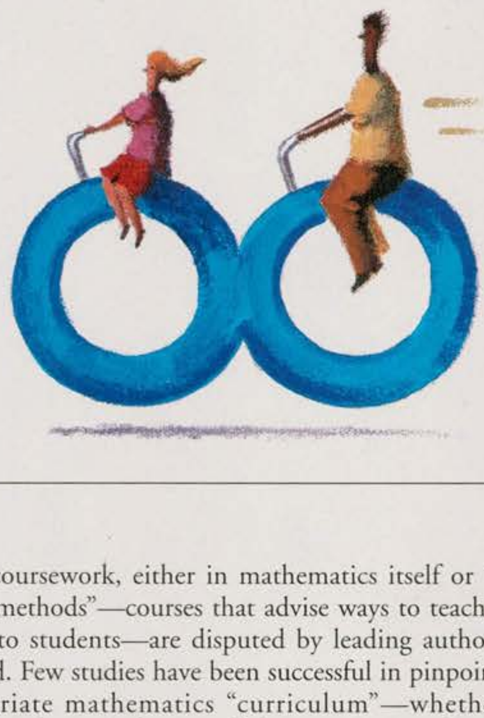
What is less obvious is the remedy. One often-proposed solution is to require teachers to study more mathematics, either by requiring additional coursework for teachers,[2] or even stipulating a subject-matter major.[3] Others advocate a more practice-grounded approach, preparing teachers in the mathematics they will use on the job. Often, these advocates call for revamping mathematics methods coursework and professional development to focus more closely on the mathematics contained in classrooms, curriculum materials, and students' minds. Still others argue that we should draw new recruits from highly selective colleges, betting that overall intelligence and basic mathematics competence will prove effective in producing student learning. Advocates for this proposal pointedly eschew formal education courses for these new recruits, betting that little is learned in schools of education about teaching mathematics effectively.

At issue in these proposals is the scope and nature of the mathematical knowledge needed for teaching. Do teachers need knowledge of advanced calculus, linear algebra, abstract algebra, differential equations, or complex variables in order to successfully teach high school students? Middle school students? Elementary students? Or do teachers only need to know the topics they actually teach to students? Alternatively, is there a professional knowledge of mathematics *for teaching,* tailored to the work teachers do with curriculum materials, instruction, and students?

Despite the uproar and the wide array of proposed solutions, the effects of these advocated changes in teachers' mathematical knowledge on student achievement are unproven or, in many cases, hotly contested. Although many studies demonstrate that teachers' mathematical knowledge helps support increased student achievement, the actual nature and extent of that knowledge—whether it is simply basic skills at the grades they teach, or complex and professionally specific mathematical knowledge—is largely unknown. The benefits to student learning of teachers' additional coursework, either in mathematics itself or "mathematics methods"—courses that advise ways to teach mathematics to students—are disputed by leading authorities in the field. Few studies have been successful in pinpointing an appropriate mathematics "curriculum"—whether it be purely mathematical, grounded in practice, or both—that can provide teachers with the appropriate mathematics to help students learn (Wilson and Berne, 1999). Similarly, we know too little about the effectiveness of recruits who bypass traditional schools of education. What is needed are more programs of research that complete the cycle, linking teachers' mathematical preparation and knowledge to their students' achievement.

In this article, we describe one such program of research that we have been developing for more than a decade. In 1997, building on earlier work (see Ball and Bass, 2003), we

Although many studies demonstrate that teachers' mathematical knowledge helps support increased student achievement, the actual nature and extent of that knowledge—whether it is simply basic skills at the grades they teach, or complex and professionally specific mathematical knowledge—is largely unknown.



[2] For example, in the 2001 report, *The Mathematical Education of Teachers,* the Conference Board of the Mathematical Sciences, American Mathematical Society, and Mathematical Association of America call for prospective elementary teachers to take at least nine semester-hours on fundamental ideas of elementary school mathematics; prospective middle-grades math teachers to take at least 21 semester-hours of mathematics, including at least 12 semester-hours on fundamental ideas of school mathematics appropriate for the middle grades; and prospective high school mathematics teachers to complete the equivalent of an undergraduate major in mathematics, including a 6-hour capstone course connecting their college mathematics courses with high school mathematics. The report recommends that prospective teachers take mathematics courses "that develop a deep understanding of the mathematics they will teach," and "a thorough mastery of the mathematics in several grades beyond that which they expect to teach, as well as of the mathematics in earlier grades."

[3] NCLB requires that all new middle- and high-school teachers demonstrate subject-matter competency by 1) passing a state academic subject test in each of the subjects in which they teach; or 2) completing an academic major, a graduate degree, coursework equivalent to an undergraduate academic major, or advanced certification or credentialing in each of the subjects in which they teach (Public Law 107-110, Section 9101 [23]).

began a close examination of the actual work of teaching elementary school mathematics, noting all of the challenges in this work that draw on mathematical resources, and then we analyzed the nature of such mathematical knowledge and skills and how they are held and used in the work of teaching. From this we derived a practice-based portrait of what we call "mathematical knowledge for teaching"—a kind of professional knowledge of mathematics different from that demanded by other mathematically intensive occupations, such as engineering, physics, accounting, or carpentry. We then rigorously tested our hypothesis about this "professional" knowledge of mathematics, first by generating special measures of teachers' professional mathematical knowledge and then by linking those measures to growth in students' mathematical achievement. We found that teachers who scored higher on our measures of mathematical knowledge for teaching produced better gains in student achievement. This article traces the development of these ideas and describes this professional knowledge of mathematics for teaching.

What Does It Mean To Know Mathematics for Teaching?

Every day in mathematics classrooms across this country, students get answers mystifyingly wrong, obtain right answers using unconventional approaches, and ask questions: Why does it work to "add a zero" to multiply a number by ten? Why, then, do we "move the decimal point" when we multiply decimals by ten? And is this a different procedure or different aspects of the same procedure—changing the place value by one unit of ten? Is zero even or odd? What is the smallest fraction? Mathematical procedures that are automatic for adults are far from obvious to students; distinguishing between everyday and technical uses of terms—mean, similar, even, rational, line, volume—complicates communication. Although polished mathematical knowledge is an elegant and well-structured domain, the mathematical knowledge held and expressed by students is often incomplete and difficult to understand. Others can avoid dealing with this emergent mathematics, but teachers are in the unique position of having to professionally scrutinize, interpret, correct, and extend this knowledge.

Having taught and observed many mathematics lessons ourselves, it seemed clear to us that these "classroom problems" were also mathematical problems—but not the kind of mathematical problems found in the traditional disciplinary canons or coursework. While it seemed obvious that teachers had to know the topics and procedures they teach—factoring, primes, equivalent fractions, functions, translations and rotations, and so on—our experiences and observations kept highlighting additional dimensions of the knowledge useful in classrooms. In keeping with this observation, we decided to focus our efforts on bringing the nature of this additional knowledge to light, asking what, in practice, teachers need to know about mathematics to be successful with students in classrooms.

To make headway on these questions, we have focused on the "work of teaching" (Ball, 1993; Lampert, 2001). What do teachers *do* in teaching mathematics, and in what ways does what they do demand mathematical reasoning, insight, understanding, and skill? Instead of starting with the curriculum they teach, or the standards for which they are responsible, we have been studying teachers' work. By "teaching," we mean everything that teachers do to support the instruction of their students. Clearly we mean the interactive work of teaching lessons in classrooms, and all the tasks that arise in the course of that. But we also mean planning those lessons, evaluating students' work, writing and grading assessments, explaining class work to parents, making and managing homework, attending to concerns for equity, dealing with the building principal who has strong views about the math curriculum, etc. Each of these tasks involves knowledge of mathematical ideas, skills of mathematical reasoning and communication, fluency with examples and terms, and thoughtfulness about the nature of mathematical proficiency (Kilpatrick, Swafford, and Findell, 2001).

To illustrate briefly what it means to know mathematics for teaching, we take a specific mathematical topic—multiplication of whole numbers. One aspect of this knowledge is to be able to use a reliable algorithm to calculate an answer. Consider the following multiplication problem:

$$\begin{array}{r} 35 \\ \times\ 25 \\ \hline \end{array}$$

Most readers will remember how to carry out the steps of the procedure, or algorithm, they learned, resulting in the following:

$$\begin{array}{r} \mathit{1} \\ \mathit{2} \\ 35 \\ \times\ 25 \\ \hline 175 \\ 70 \\ \hline 875 \end{array}$$

Clearly, being able to multiply correctly is essential knowledge for teaching multiplication to students. But this is also insufficient for teaching. Teachers do not merely do problems while students watch. They must explain, listen, and examine students' work. They must choose useful models or examples. Doing these things requires additional mathematical insight and understanding.

Teachers must, for example, be able to see and size up a typical wrong answer:

$$\begin{array}{r} 35 \\ \times\ 25 \\ \hline 175 \\ 70 \\ \hline 245 \end{array}$$

Recognizing that this student's answer as wrong is one step, to be sure. But effective teaching also entails analyzing the source of the error. In this case, a student has not "moved over" the 70 on the second line.

(Continued on page 20)

Mathematical Knowledge for Teaching: A Research Review

In the main article, Ball, Hill, and Bass describe a program of research on the link between student achievement and teachers' mathematical knowledge for teaching. Across all sides of the debate over how to strengthen mathematics education, there is general agreement that teachers' knowledge of the mathematical content to be taught is the cornerstone of teaching for proficiency. There is also general agreement that many American teachers, particularly those at the elementary and middle school levels, do not know enough mathematics and do not know it deeply enough to provide effective instruction to students. The mathematical education they received, both as K-12 students and in teacher preparation programs, has not provided them with sufficient opportunities to learn mathematics. But exactly what and how much mathematics they need to know remains a matter of controversy. One of the reasons is that, despite many years of attention to the subject, the research into teachers' mathematical preparation and knowledge—that is, what teachers need to know and be able to do to raise students' math achievement—remains surprisingly thin. The following excerpt from Adding it Up, *the National Research Council's 2001 report on mathematics education, provides an overview of the state of the research on this subject. (To read the full report, go to* **www.nap.edu/catalog/9822.html**.*)*

—EDITOR

For the better part of a century, researchers have attempted to find a positive relation between teacher content knowledge and student achievement. For the most part, the results have been disappointing: Most studies have failed to find a strong relationship between the two. Many studies, however, have relied on crude measures of these variables. The measure of teacher knowledge, for example, has often been the number of mathematics courses taken or other easily documented data from college transcripts. Such measures do not provide an accurate index of the specific mathematics that teachers know or of how they hold that knowledge. For example, a study of prospective secondary mathematics teachers at three major institutions showed that, although they had completed the upper-division college mathematics courses required for the mathematics major, they had only a cursory understanding of the concepts underlying elementary mathematics.[1]

Teachers may have completed their courses successfully without achieving mathematical proficiency. Or they may have learned the mathematics but not know how to use it in their teaching to help students learn. They may have learned mathematics that is not well connected to what they teach or may not know how to connect it. Similarly, many of the measures of student achievement used in research on teacher knowledge have been standardized tests that focus primarily on students' procedural skills. Some evidence suggests that there is a positive relationship between teachers' mathematical knowledge and their students' learning of advanced mathematical concepts.[2] There seems to be no association, however, between how many advanced mathematics courses a teacher takes and how well that teacher's students achieve overall in mathematics.[3] In general, empirical evidence regarding the effects of teachers' knowledge of mathematics content on student learning is still rather sparse.

In the National Longitudinal Study of Mathematical Abilities (NLSMA), conducted during the 1960s and still today the largest study of its kind, there was essentially no association between students' achievement and the number of credits a teacher had in mathematics at the level of calculus or beyond.[4] Commenting on the findings from NLSMA and a number of other studies of teacher knowledge, the director of NLSMA later said,

> It is widely believed that the more a teacher knows about his subject matter, the more effective he will be as a teacher. The empirical literature suggests that this belief needs drastic modification and in fact suggests that once a teacher reaches a certain level of understanding of the subject matter, then further understanding contributes nothing to student achievement.[5]

The notion that there is a threshold of necessary content knowledge for teaching is supported by the findings of another study in 1994 that used data from the Longitudinal Study of American Youth (LSAY).[6] There was a notable increase in student performance for each additional mathematics course their teachers had taken, yet after the fifth course there was little additional benefit.[7]

Data from the 1996 NAEP on teachers' college major rather than the number of courses they had taken provide a contrast to the general trend of this line of research. The NAEP data revealed that eighth-graders taught by teachers who majored in mathematics outperformed those whose teachers majored in education or some other field. Fourth-graders taught by teachers who majored in mathematics education or in education tended to outperform those whose teachers majored in a field other than education.[8]

Although studies of teachers' mathematical knowledge have not demonstrated a strong relationship between teachers' mathematical knowledge and their students' achievement, teachers' knowledge is still likely a significant factor in students' achievement. That crude measures of teacher knowledge, such as the number of mathematics courses taken, do not correlate positively with student performance data supports the need to study more closely the nature of the mathematical knowledge needed to teach and to measure it more sensitively.

The persistent failure of the many efforts to show strong, definitive relations between teachers' mathematical knowledge and their effectiveness does not imply that mathematical knowledge makes no difference in teaching. The research, however, does suggest that proposals to improve mathematics instruction by simply increasing the number of mathematics courses required of teachers are not likely to be successful. Courses that reflect a serious examination of the nature of the mathematics that teachers use in the practice of teaching do have some promise of improving student performance. Teachers need to know mathematics in ways that enable them to help students learn. The specialized knowledge of mathematics that they need is different from the mathematical content contained in most college mathematics courses, which are principally designed for those whose professional uses of mathematics will be in mathematics, science, and other technical fields.

Why does this difference matter in considering the mathematical education of teachers? First, the topics taught in upper-level mathematics courses are often remote from the core content of the K-12 curriculum. Although the abstract mathematical ideas are connected, of course, basic algebraic concepts or elementary geometry are not what prospective teachers study in a course in advanced calculus or linear algebra. Second, college mathematics courses do not provide students with opportunities to learn either multiple representations of mathematical ideas or the ways in which different representations relate to one another. Advanced courses do not emphasize the conceptual underpinnings of ideas needed by teachers whose uses of mathematics are to help others learn mathematics.[9] Instead, the study of college mathematics involves the increasing compression of elementary ideas into the more and more powerful and abstract forms needed by those whose professional uses of mathematics will be in scientific domains. Third, advanced mathematical study entails using elementary concepts and procedures without much conscious attention to their meanings or implications, thus reinforcing the making of prior learning routine in the service of more advanced work. While this approach is important for the education of mathematicians and scientists, it is at odds with the kind of mathematical study needed by teachers.

Consider the proficiency teachers need with algorithms. The power of computational algorithms is that they allow learners to calculate without having to think deeply about the steps in the calculation or why the calculations work. That frees up the learners' thinking so that they can concentrate on the problem they are trying to use the calculation to solve rather than having to worry about the details of the calculation. Over time, people tend to forget the reasons a procedure works or what is entailed in understanding or justifying a particular algorithm. Because the algorithm has become so automatic, it is difficult to step back and consider what is needed to explain it to someone who does not understand. Consequently, appreciating children's difficulties in learning an algorithm can be very difficult for adults who are fluent with that algorithm.

The necessary compression of ideas in the course of mathematical study also shortchanges teachers' mathematical needs. Most advanced mathematics classes engage students in taking ideas they have already learned and using them to construct increasingly powerful and abstract concepts and methods. Once theorems have been proved, they can be used to prove other theorems. It is not necessary to go back to foundational concepts to learn more advanced ideas. Teaching, however, entails reversing the direction followed in learning advanced mathematics. In helping students learn, teachers must take abstract ideas and unpack them in ways that make the basic underlying concepts visible.[10] □

Endnotes

[1] Ball, 1990, 1991.

[2] Mullens, Murnane, and Willet, 1996; see Begle, 1972.

[3] Monk, 1994.

[4] Begle, 1979.

[5] Begle, 1979, p. 51.

[6] The Longitudinal Study of American Youth (LSAY) was conducted in the late 1980s and early 1990s with high school sophomores and juniors. Student achievement data were based on items developed for NAEP.

[7] Monk, 1994, p. 130.

[8] Hawkins, Stancavage, and Dossey, 1998.

[9] In fact, it appears that sometimes content knowledge by itself may be detrimental to good teaching. In one study, more knowledgeable teachers sometimes overestimated the accessibility of symbol-based representations and procedures (Nathan and Koedinger, 2000).

[10] Ball and Bass, 2000; Ma, 1999.

References

Ball, D.L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *Elementary School Journal, 90*, 449-466.

Ball, D.L. (1991). Research on teaching mathematics: Making subject matter knowledge part of the equation. In J.Brophy (Ed.), *Advances in research on teaching, Vol. 2: Teachers' knowledge of subject matter as it relates to their teaching practice* (pp. 1-48). Greenwich, Conn.: JAI Press.

Ball, D.L., and Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J.Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics* (pp. 83-104). Westport, Conn.: JAI/Ablex.

Begle, E.G. (1972). *Teacher knowledge and student achievement in algebra* (SMSG Reports No. 9). Stanford, Calif.: Stanford University, School Mathematics Study Group.

Begle, E.G. (1979). *Critical variables in mathematics education: Findings from a survey of the empirical literature.* Washington, D.C.: Mathematical Association of America and National Council of Teachers of Mathematics.

Hawkins, E.F., Stancavage, F.B., and Dossey, J.A. (1998). *School policies and practices affecting instruction in mathematics* (NCES 98-495). Washington, D.C.: National Center for Education Statistics. **http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=98495**.

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Mahwah, N.J.: Erlbaum.

Monk, D.H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review, 13*, 125-145.

Mullens, J.E., Murnane, R.J., and Willett, J.B. (1996). The contribution of training and subject matter knowledge to teaching effectiveness: A multilevel analysis of longitudinal evidence from Belize. *Comparative Education Review, 40*, 139-157.

Nathan, M.J. and Koedinger, K.R. (2000). An investigation of teachers' beliefs of students' algebra development. *Cognition and Instruction, 18*, 209-237.

National Research Council. (2001). Adding it up: Helping children learn mathematics. *J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, D.C.: National Academy Press.*

(Continued from page 17)

Sometimes the errors require more mathematical analysis:

$$
\begin{array}{r}
\mathit{1}\\
\mathit{2}\\
35\\
\times\ 25\\
\hline
255\\
80\\
\hline
1055
\end{array}
$$

What has happened here? Teachers may have to look longer at the mathematical steps that produced this, but most will be able to see the source of the error.[4] Of course teachers can always ask students to explain what they did, but if a teacher has 30 students and is at home grading students' homework, it helps to have a good hypothesis about what might be causing the error.

But error analysis is not all that teachers do. Students not only make mistakes, they ask questions, use models, and think up their own non-standard methods to solve problems. Teaching also involves explaining *why* the 70 should be slid over so that the 0 is under the 7 in 175—that the second step actually represents 35×20, not 35×2 as it appears.

Teaching entails using representations. What is an effective way to represent the *meaning* of the algorithm for multiplying whole numbers? One possible way to do it is to use an area model, portraying a rectangle with side lengths of 35 and 25, and show that the area produced is 875 square units:

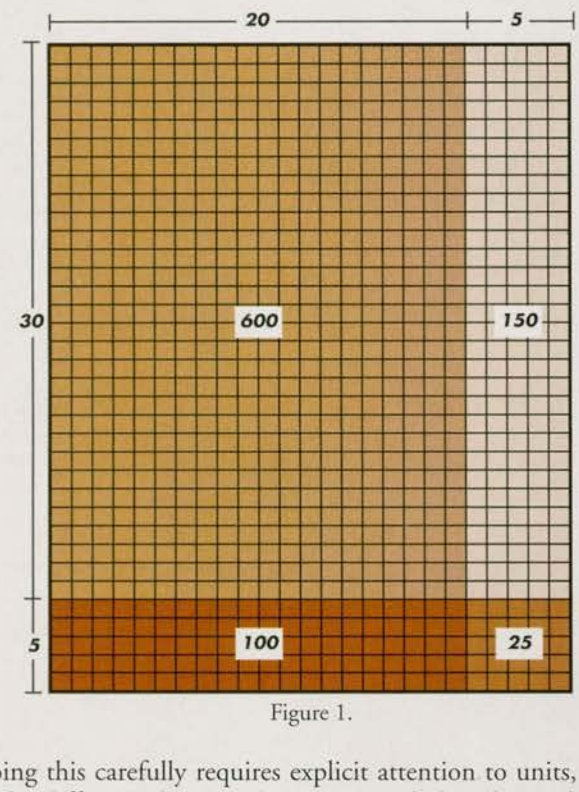


Figure 1.

Doing this carefully requires explicit attention to units, and to the difference between linear (i.e., side lengths) and area measures (Ball, Lubienski, and Mewborn, 2001).

Connecting Figure 1 to the full partial product version of the algorithm is another aspect of knowing mathematics for teaching:

$$
\begin{array}{r}
35\\
\times\ 25\\
\hline
25\\
150\\
100\\
+\ 600\\
\hline
875
\end{array}
$$

The model displays each of the partial products—25, 150, 100, and 600—and shows the factors that produce those products—5×5 (lower right hand corner), 20×5 (lower left hand corner), for example. Examining the diagram vertically reveals the two products—700 and 175—from the conventional algorithm illustrated earlier:

$$
\begin{array}{r}
35\\
\times\ 25\\
\hline
175\\
70\\
\hline
875
\end{array}
$$

Representation involves substantial skill in making these connections. It also entails subtle mathematical considerations. For example, what would be strategic numbers to use in an example? The numbers 35 and 25 may not be ideal choices to show the essential conceptual underpinnings of the algorithm. Would 42 and 70 be better? What are the considerations in choosing a good example for instructional purposes? Should the numerical examples require regrouping, or should examples be sequenced from ones requiring no regrouping to ones that do? And what about the role of zeros at different points in the procedure? Careful advance thought about such choices is a further form of mathematical insight crucial to teaching.[5]

Note that nothing we have said up to this point involves knowing about students. Nothing implies a particular way to teach multiplication or to remedy student errors. We do not suggest that such knowledge is unimportant. But we do argue that, in teaching, there is more to "knowing the subject" than meets the eye. We seek to uncover what that "more" is. Each step in the multiplication example has involved a deeper and more explicit knowledge of multiplica-

[4] Here the student has likely multiplied 5×5 to get 25, but then when the student "carried" the 2, he or she added the 2 to the 3 before multiplying it by the 5—hence, 5×5 again, yielding 25, rather than $(3 \times 5) + 2 = 17$. Similarly, on the second row, he or she added the 1 to the 3 before multiplying, yielding 4×2 instead of $(3 \times 2) + 1 = 7$.

[5] Two-digit factors, with "carries," present all general phenomena in the multiplication algorithm in computationally simple cases. The presence of zero digits in either factor demands special care. The general rules still apply, but because subtleties arise, these problems are not recommended for students' first work. For example, in 42×70, students must consider how to handle the 0. In general, it is preferable for students to master the basic algorithm (i.e., multiplication problems with no regrouping) before moving on to problems that present additional complexities.

tion than that entailed by simply performing a correct calculation. Each step points to some element of knowing the topic in ways central to teaching it.

Our example helps to make plain that knowing mathematics for teaching demands a kind of depth and detail that goes well beyond what is needed to carry out the algorithm reliably. Further, it indicates that there are predictable and recurrent tasks that teachers face that are deeply entwined with mathematics and mathematical reasoning—figuring out where a student has gone wrong (error analysis), explaining the basis for an algorithm in words that children can understand and showing why it works (principled knowledge of algorithms and mathematical reasoning), and using mathematical representations. Important to note is that each of these common tasks of teaching involves *mathematical* reasoning as much as it does pedagogical thinking.

We deliberately chose an example involving concepts of number and operations. Similar examples can be developed about most mathematical topics, including the definition of a polygon (Ball and Bass, 2003), calculating and explaining an average, or proving the completeness of a solution set to an elementary mathematics problem. Being able to carry out and understand multi-step problems is another site for explicit mathematical insight in teaching. Each of these requires more than being able to answer the question oneself. The teacher has to think from the learner's perspective and to consider what it takes to understand a mathematical idea for someone seeing it for the first time. Dewey (1902) captured this idea with the notion of "psychologizing" the subject matter, seeing the structures of the subject matter as it is learned, not only in its finished logical form.

It should come as no surprise then that an emergent theme in our research is the centrality of mathematical language and the need for a special kind of fluency with mathematical terms. In both our records from a variety of classrooms and our experiments in teaching elementary students, we see that teachers must constantly make judgments about how to define terms and whether to permit informal language or introduce and use technical vocabulary, grammar, and syntax. When might imprecise or ambiguous language be pedagogically preferable and when might it threaten the development of correct understanding? For example, is it fair to say to second-graders that they "cannot take a larger number away from a smaller one" or does concern for mathematical integrity demand an accurate statement (for example, "with the numbers we know now, we do not have an answer when we subtract a large number from a smaller one")? How should a rectangle be defined so that fourth-graders can sort out which of the shapes in Figure 2 are and are not called "rectangles," and why?

The typical concept held by fourth-graders would lead them to be unsure about several of these shapes, and the commonly-held "definition"—"a shape with two long sides and two short sides, and right angles"—does not help them to reconcile their uncertainty. Students who learn shapes only by illustration and example often construct images that are entirely wrong. For example, in a fourth-grade class taught by Ball, several students believed that "A" in Figure 2 was a rectangle because it was a "box," and, in an age of computer graphics, they translated "rectangle" to "box" without a blink. Teachers need skill with mathematical terms and discourse that enable careful mathematical work by students, and that do not spawn misconceptions or errors. Students need definitions that are usable, relying on terms and ideas they already understand. This requires teachers to know more than the definitions they might encounter in university courses. Consider, for example, how "even numbers" might be specified for learners in ways that do not lead students to accept $1\frac{1}{2}$ as even (i.e., it can be split into two equal parts) and, still, to identify zero as even. For example, defining even numbers as "numbers that can be divided in half equally" allows $\frac{1}{4}$, $1\frac{1}{2}$, $\frac{1}{5}$, and all other fractions to be considered even. Being more careful would lead to definitions such as, "A number is considered even if and only if it is the sum of an integer with itself" or, for students who do not work with integers yet: "Whole numbers that can be divided into pairs (or twos) with nothing left over are called *even* numbers." Although expressed in simpler terms, these definitions are similar to a typical definition taught in number theory: "Even numbers are of the form 2k, where k is an integer." They are accessible to elementary students without sacrificing mathematical precision or integrity.

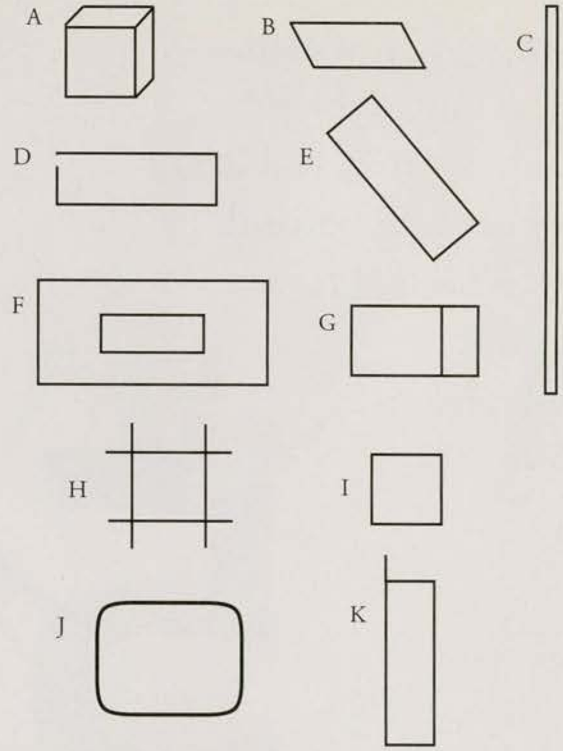


Figure 2. Candidate shapes: Which are rectangles?

In our data, we see repeatedly the need for teachers to have a specialized fluency with mathematical language, with what counts as a mathematical explanation, and with how to use symbols with care. In addition to continuing to probe the ways in which teachers need to understand the topics of the school curriculum, and the mathematical ideas to which they lead, we will explore in more detail how mathematical language—its construction, use, and cultivation—is used in the work of teaching.

Knowing mathematics for teaching demands a kind of depth and detail that goes well beyond what is needed to carry out the algorithm reliably.

Measuring Mathematical Knowledge for Teaching

Using the methods described above, we could have continued simply to explore and map the terrain of mathematical knowledge for teaching. Because such work is slow and requires great care, we examined only a fraction of the possible topics, grade levels, and mathematical practices teachers might know. However, we believe that *only* developing grounded theory about the elements and definition of mathematical knowledge for teaching is not enough. If we argue for professional knowledge for teaching mathematics, the burden is on us to demonstrate that improving this knowledge also enhances student achievement. And, as the current debates over teacher preparation demonstrate, there are legitimate competing definitions of mathematical knowledge for teaching and, by extension, what "teacher quality" means for mathematics instruction. To test our emerging ideas, and provide evidence beyond examples and logical argument, we developed (and continue to refine) large-scale survey-based measures of mathematical knowledge for teaching.

Our two main questions were: Is there a body of mathematical knowledge for teaching that is specialized for the work that teachers do? And does it have a demonstrable effect on student achievement? To answer these questions, we needed to build data sets that would allow us to test our hypotheses empirically. This required us to pose many items to a large number of teachers; to control for the many factors that are also likely to contribute to students' learning and detect an effect of what we hypothesized as "mathematical knowledge for teaching," large data sets were essential. Anticipating that samples of a thousand or more teachers might be required to answer our questions, however, we quickly saw that interviews, written responses, and other forms of measuring teachers' mathematical knowledge would not do, and we set out to try to develop multiple-choice measures, the feasibility of which others doubted and we ourselves were unsure.

Our collaborators experienced in educational measurement informed us that the first step in constructing any assessment is to set out a "domain map," or a description of the topics and knowledge to be measured. We chose to focus our initial work within the mathematical domains that are especially important for elementary teaching: number and operations. These are important both because they dominate the school curriculum and because they are vital to students' learning. In addition, we chose the domain of patterns, functions, and algebra because it represents a newer strand of the K-6 curriculum, thus allowing for investigation of what teachers know about this topic now, and perhaps how knowledge increases over time, as better curriculum and professional development become available and teachers gain experience in teaching this domain. We have since added geometry items and expanded our measures upward through middle school content.

Once the domains were specified, we invited a range of experts to write assessment items—mathematics educators, mathematicians, professional developers, project staff, and classroom teachers. We asked for items that posed questions related to the situations that teachers face in their daily work, written in multiple-choice format to facilitate the scoring and scaling of large numbers of teacher responses. We strove to produce items that were ideologically neutral; for example, rejecting any items where a "right" answer might indicate an orientation to "traditional" or "reform" teaching. Finally, we defined mathematical content knowledge for teaching as being composed of two key elements: "common" knowledge of mathematics that any well-educated adult should have *and* mathematical knowledge that is "specialized" to the work of teaching and that only teachers need know. We tried to capture both of these elements in our assessment.

To measure common knowledge of mathematics, we developed questions that, while set in teaching scenarios, still require only the understanding held by most adults. Figure 3 presents one such item:

> Ms. Dominguez was working with a new textbook and she noticed that it gave more attention to the number 0 than her old book. She came across a page that asked students to determine if a few statements about 0 were true or false. Intrigued, she showed them to her sister who is also a teacher, and asked her what she thought.

(Continued on page 43)

Mathematics for Teaching: Then and Now

In light of the current debate over how much and what kinds of mathematical knowledge teachers need, we thought it might be interesting to see how these questions were answered in years past. The problems below are from the State of California's teacher certification exam of December 1874. In addition to the three mathematics portions of the test, prospective teachers were examined in the areas of written grammar, oral grammar, geography, U.S. history, the theory and practice of teaching, physiology, natural philosophy, the constitutions of the United States and California, California school law, penmanship, natural history, composition, reading, orthography, defining, vocal music, and industrial drawing.

—EDITOR

ARITHMETIC

1. Divide 8,786,742 by the factors 7, 5, and 2. Explain the principle of obtaining the true remainder.

2. What is the greatest common divisor and the least common multiple of the numbers 18, 36, and 24? Explain the principle of obtaining each.

3. What is the difference between 2 miles, 5 furlongs, 6 rods, 3 yards, 2 feet, 7 inches, and 7 furlongs, 39 rods, 4 yards, 2 feet, 8 inches? Prove your work by subtraction in decimals.

4. Write in words and analyze the following fractions: ¾, 2⅓, .3, and .00007.

5. If ⅔ of 7 tons of coal cost $93⅓, what will ¾ of 5 tons cost? Work by analysis and prove by proportion.

6. What will it cost to build a wall 650 feet long, 8 feet high, and 2⅔ feet thick, at $9.75 per 1,000 bricks—each brick being 8 inches long, 4 inches wide, and 2 inches thick?

7. A grocer sold 4 barrels of sugar for $30 each; on two barrels he gained 20 percent, on the other two barrels he lost 20 percent; did he gain or lose on the whole?

8. A man received $16.12½ interest on a sum of money, which had been loaned 3⅓ years at 9 percent. What was the principal?

9. A flagstaff 75 feet high stands in the center of a square lot containing two acres; what is the length of a rope extending from one corner to the top of the staff?

10. Extract the cube root of $\frac{9}{21\frac{1}{3}}$

11. What are the names of the units used in the metric system for length, surface, solid, capacity, and weight?

MENTAL ARITHMETIC

1. Paid $2.50 for 5 yards of ribbon, at 12½ cents per yard, and 3 books at 37½ cents each. How much change did I receive back?

2. What percent of 60 is 12?

3. How many men can perform the same amount of work in 12 days that 6 men can in 4 days?

4. If a man travels 1 mile in 20 minutes, how many hours and minutes will it take him to travel 17 miles?

5. If A and B can do a piece of work in 4 days, and A can do it alone in 6 days, how long would it take B to do it?

6. A man being asked how many sheep he had, replied that if he had one and one half times as many more, and 2½ sheep, he would have fifty. How many had he?

7. A man after spending one half of his money and one third of the remainder, had $10 left. How much had he at first?

8. How many car tickets, at 6¼ cents each, can be purchased for $7.50?

9. How long will it take a man to clear $100 if he gets $1.50 a day, and pays $4 a week for board?

10. If you get 2½ credits each for 8 questions out of 10, what will be your percentage?

ALGEBRA

1. What is a reciprocal? Zero power? Negative exponent?

2. Find the prime factors of $6x^2 + xy - 9x - y^2 + 3y$.

3. Divide a by $\frac{x}{x+y} \times \frac{a}{x-y}$

4. What is the greatest common divisor and the least common multiple of x^2-4a^2, $(x+2a)^3$, and $(x-2a)^3$?

5. If B gives A $5 of his money, A will have twice as much as B has left; but if A gives B $5, then A will have but three fourths as much as B will have. How much has each?

6. Extract the square root of $a^4-a^3b+\frac{3a^2b^2}{4}-\frac{ab^3}{4}+\frac{b^4}{16}$

7. A merchant sold a piece of cloth for $39, and gained as much percent as it cost him. How much did it cost him?

8. Divide $7y^2$ by $\frac{10ax}{3by}$

9. Two houses standing on opposite sides of a street 84 feet in width, are respectively 67 and 54 feet in height. What length of rope will reach from the top of one house to the top of the other?

Note: 1 mile = 5,280 feet or *1,760 yards* or *8 furlongs; 1 furlong = 660 feet* or *220 yards* or *40 rods; 1 rod = 16.5 feet* or *5.5 yards; 1 acre = 43,560 square feet* or *4,840 square yards* or *160 square rods.*

Excerpted from the Sixth Biennial Report of the Superintendent of Public Instruction of the State of California, School Years 1874 and 1875, *published in 1875 by G.H. Springer, Sacramento, California.*

Circling "The Scourge"

The AFT has a long tradition of involvement in international affairs, working with teacher, healthcare, and public sector unions around the world to fight for workplace dignity and human and labor rights for all workers. Recognizing that the AIDS pandemic has decimated teaching forces and crippled school systems throughout sub-Saharan Africa, the AFT has developed partnerships with teacher unions in Kenya, South Africa, Zimbabwe, and other African countries to help them meet the challenges posed by HIV-AIDS. This article describes this initiative. For more information about the AFT-Africa AIDS Campaign, see the back cover of this magazine or visit the AFT Web site at ***www.aft.org/africa_aids****.*

—EDITOR

By Bess Keller

Lucy Barimbui is resolved to meet with the HIV-infected teachers—even when it means returning about 30 miles along a stretch of bone-shaking road that she has already traveled twice in three days.

Barimbui, who coordinates anti-AIDS education activities for the Kenya National Union of Teachers, plied her cellphone for hours trying to convene the meeting here. But, as she jounced along in the union's white van, losing phone service as often as finding it on the river-gouged foothills of Mount Kenya, about four hours north of Nairobi, she learned that while transportation cost is a problem for the teachers, fear is a bigger one.

True, they had taken the unusual step of publicly identifying themselves with the human immunodeficiency virus that causes AIDS, for which there is no immunization or cure. But they were not ready to be seen in Meru, the regional market town where most of them are known, let alone use the Meru offices of the union's local branch.

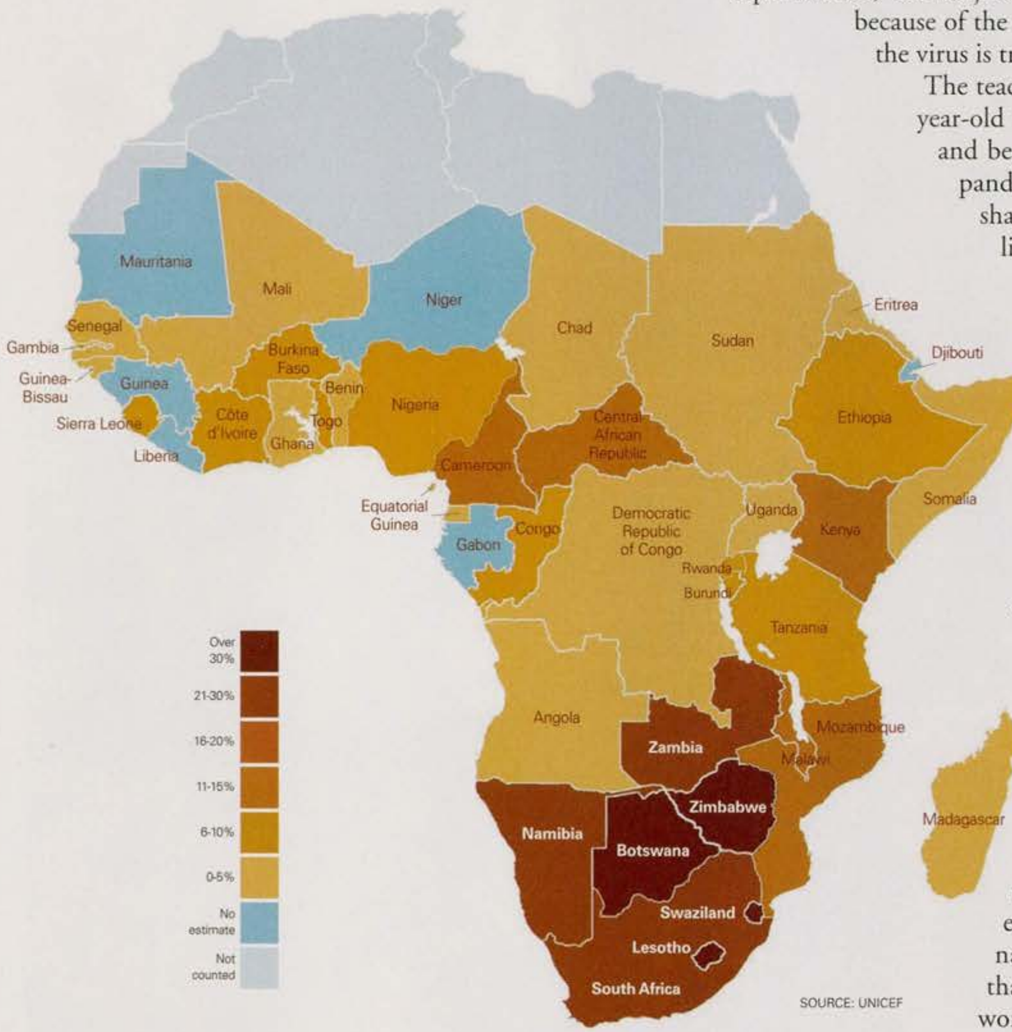
So the meeting is set for a cliff-top cafe in smaller Chuka, with the expenses of lunch and jitney fare paid by visitors from

Bess Keller is an assistant editor for Education Week. *This article is reprinted with permission from the March 16, 2005 issue of* Education Week. *Photos courtesy of Allison Shelley, former staff photographer for* Education Week.

(Left) Lucy Barimbui, AIDS education coordinator for the Kenya National Union of Teachers, talks privately with Muihuri Raiji's wife in the doorway of the couple's home in the Meru area. (Below) The 68 pupils at Nkumari Primary School in Kenya who have been orphaned, most by AIDS, stand outside the 670-student school.

Widespread Pestilence

The rates of people ages 15 to 49 living with HIV or AIDS in 2001 were highest in the southern part of the African continent.



the Kenyan capital, who include, besides Barimbui, a teachers' union official from the United States and a journalist.

Five members of the recently formed Kenya Network of Positive Teachers, known as Kenepote, show up—fewer than the local organizer expected, but then, Muihuri Raiji admits, "many of us are not comfortable" being open.

Amid the soft drink bottles they have emptied, the teachers—all in their 30s and early 40s—describe living with HIV. One reports the deaths of his wife and two young children from "the scourge," as Kenyans often call the AIDS pandemic in their musical English, the language used for much of schooling here. Another tells of his three suicide attempts, the last of which left him using a cane. A woman mentions that her boyfriend walked out on her rather than get tested for the virus.

The teachers sound inspirational themes, too, of family support and Christian rebirth in the face of despair.

Their professional reality is more shaded, though. Some bosses and colleagues are wary; a few are helpful. The silence around their personal experience with HIV or AIDS, which have been officially part of the national curriculum in Kenya since 2002, often causes the most pain.

"I wanted to let the students know my status, to know from me rather than anyone else," says Raiji, who teaches geography in a secondary school in the Meru area. The principal refused, but Raiji believes the students know anyway because of the questions they ask him about how the virus is transmitted.

The teachers' travails do not shock the 39-year-old Barimbui, who reached adulthood and began her teaching career just as the pandemic was beginning to spread its shadow over every aspect of Kenyan life. Still, nothing prepares the soul for misery heightened by ignorance. And since Barimbui left off teaching and took the AIDS-related post in Nairobi less than two years ago, that mix has become her daily fare.

A woman with a heart-shaped face and a ready laugh, given, in the Kenyan way, to wearing formal clothing—a two-piece suit and pumps—Barimbui addresses her work hopefully. The hope, though, is tempered by reality.

Her job exists because of a partnership between the KNUT, the Kenyan teachers' union, and the American Federation of Teachers. Active for decades on the international labor scene and mindful that Africa suffers from the world's worst poverty, the 1.3 million-member AFT has sought to collaborate with independent sub-Saharan teachers' unions on problems of their choosing.

In Africa, south of the Sahara desert, no education crisis looms larger than AIDS, which as a killer of young people, threatens both the teachers and the taught.

Seventy percent of those infected with HIV worldwide live in sub-Saharan Africa, where the disease has been spread mostly by sex between men and women. The infection rates are highest in the nations of southern and eastern Africa, reflecting the origins of the disease in the area west of Lake Victoria.

The pandemic has complicated every need in education—which many see as the best means of reducing poverty over the long haul—from planning how many teachers should be trained to engaging sick or grief-stricken children in learning.

In Kenya alone, where the infection rate is estimated to have reached 13 percent of the population, 27,000 teachers will die and more than 2 million children will lose one or both parents to AIDS in the next five years, by one projection. Even if those figures for the nation of 32 million prove to be high, as a result of an increase in the number of people taking antiviral drugs and a drop in the infection rate, the pandemic will not peak for at least another few years because of the years-long lag between infection and illness.

The AFT has raised some $170,000 from its members for its Africa campaign and used that money to leverage $3.8 million more from the President's Emergency Program for AIDS Relief, or PEPFAR, a fund launched by President Bush in 2003. With AFT's help, unions in Zimbabwe, South Africa, Swaziland, and Kenya are mounting responses to the pandemic.

Following a model the AFT helped craft in Zimbabwe, the Kenyan project uses "study circles," in which teachers learn together about HIV, script new sexual behaviors for themselves, and figure how better to care for those infected or affected by the disease. As teachers come to grips with AIDS in their own lives, which union officials in both countries view as the project's first priority, the leaders believe that educators will then be better prepared to help their students, their schools, and their communities.

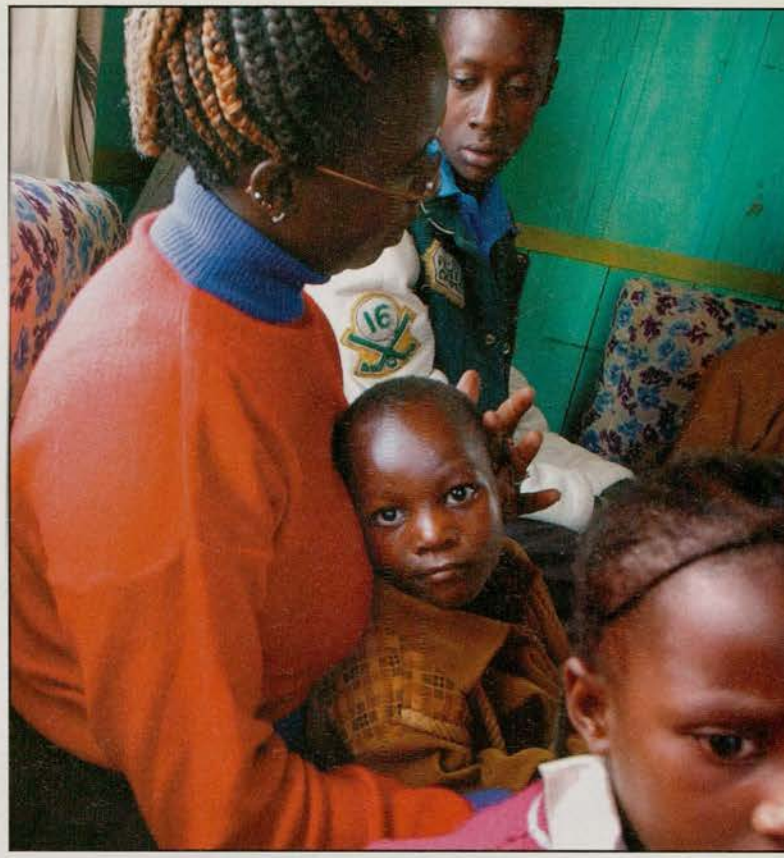
What's more, the project's leaders say they are struck by the drive of many teachers to translate their education and their stature into help for their neighbors.

More than 700 schools across Kenya are expected to convene circles in the next two years, each drafting a list of resources for those affected by HIV and AIDS, and 60 teachers are to be trained as counselors. The program also calls for an awareness and advocacy campaign to help transform schools into places where everyone feels safe from the prejudice and harassment those with the disease often encounter.

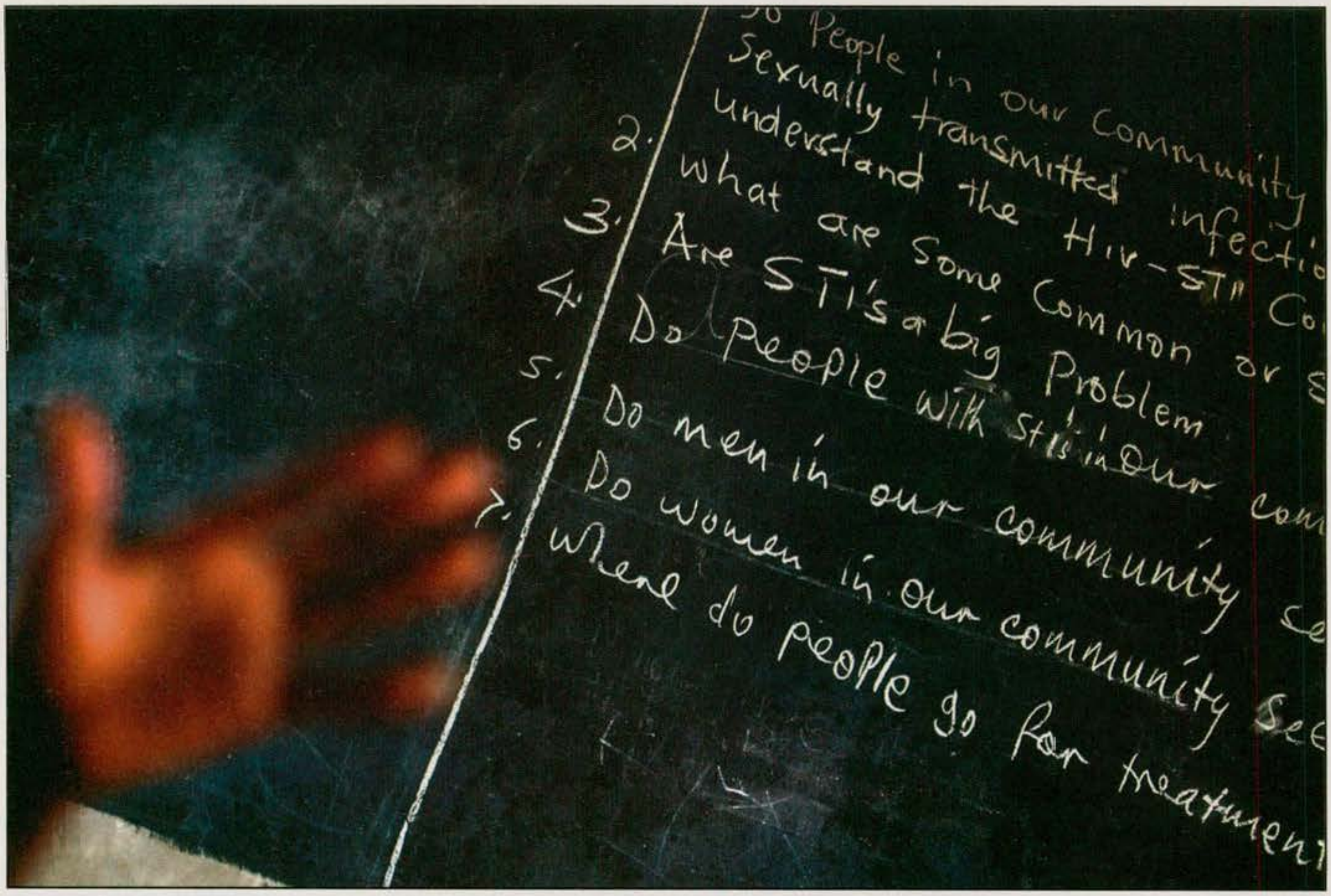
The AFT grant for the joint work underwrites Barimbui's salary, which, including benefits, comes to about $12,000 U.S. a year. The job brings with it a big office in the KNUT's Nairobi headquarters and a single, shared Internet connection—minus her own computer.

The human side of the work can require a combination of boldness and delicacy that is not easily compensated, even in developed nations.

After the gathering of Kenepote teachers breaks up, for instance, Raiji, the leader, stops Barimbui to talk about his family. He and his wife, who has tested negative for HIV, have two young children, who are also negative.



(Top) Susan Kagwiria, a teacher at Nkubu Primary School, visits HIV-positive children at home to monitor their progress on antiviral medicines. (Below) Cousins in Kenya eat sugarcane. At 9, the girl in the center is the size of her 5-year-old relatives because of AIDS.



(Above) Teacher Nelson Koome gestures during a "study circle" discussion of the causes and effects of HIV and AIDS at Nkubu Primary School, part of a member education project of the Kenya National Union of Teachers. (Top right) A sign in Meru, Kenya, warns of the dangers of AIDS. (Right) A mural painted on the side of Nkubu Primary School warns students of the dangers of rape.

Barimbui, though yearning at that moment to visit the hairdresser, responds as if she had no other concern but the teacher's and not a second to lose. In fact, as a wife, a daughter, the mother of 12- and 15-year-old sons and the highest-ranking female on the union's staff, she has a host of responsibilities, which she is the first to say she is learning to balance.

"Are you practicing safe sex?" she gently demands.

Raiji says that after praying over his choices, he has decided to refrain from intercourse, because using condoms is taking a chance. He adds that his wife, who is at home with an infant and a 5-year-old, is unhappy with the decision.

Barimbui thinks she knows why. "You are out and about, doing this and that, going around," she points out. "She is lonely, perhaps, and bored."

Maybe, Barimbui is saying in so many words, the decision should be rethought.

When Barimbui takes the American visitors through the sagging gates at Egoji Teacher Training College near Meru, it's a homecoming. The holder of a four-year degree in secondary education, she taught aspiring primary school teachers at Egoji, one of 26 such two-year institutions in the country, before being tapped for the job with the teachers' union.

At the time, she was wrestling with government policy for teachers at all grade levels to "integrate and infuse" discussion of HIV and AIDS into lessons. Rather than dismiss the jargon and stick to teaching English, Barimbui resolved to find ways to bring the continuing health crisis to the classroom and beyond. She and others organized a club for students, who perform songs and skits with anti-AIDS themes in public places. A Methodist who had taught at a secondary school in a nearby district, Barimbui was in high demand to speak in area churches of her denomination.

Meanwhile, the disease was exacting a personal toll. Two members of her department died, presumably of AIDS, although no no one said so. Then the woman who ran the school store confided in Barimbui: She was sick; her husband had died with the same ailment; it was witchcraft. In other Kenyan social circles, the cause might be ascribed to sin, AIDS-infected condoms, or even failing to eat enough fresh fish, while the cure might be having sex with a virgin.

Often, the woman came to Barimbui's house and wanted to talk. "The greatest challenge of my life was how to handle that," Barimbui recalls as the KNUT van rattles over the red-dirt hills, past a lushness of banana and mango trees, of coffee bushes and emerald green tea seedlings. The mystery book she is reading, *Morality for Beautiful Girls,* lays unminded on the seat beside her. Later, she will devour a book on personal time management.

The deaths magnified Barimbui's thoughts on what needed to be done: prevention education and counseling,

support for infected students and staff, an end to the secrecy and the shame.

She merely glimpsed those changes three years ago, when her energy led Joe Davis, the AFT's point person for Africa, to suggest that she be invited to join a group of otherwise all-male KNUT leaders and government officials studying anti-AIDS efforts in the United States.

Now, as part of the national project that Barimbui coordinates, former colleagues at the college have organized a half-dozen study circles among staff and students.

In one such circle for college staff on this particularly warm January afternoon, 10 women and six men are talking about which bodily fluids can transmit the immunodeficiency virus and which bodily orifices lend themselves to transmission. In a society where the worlds of the sexes are more sharply delineated than in the U.S., and the value put on sexual modesty is reflected in the long skirts that most women wear, it's not an everyday discussion.

"What about deep kissing?" asks Paul Kirema, the veteran science teacher or "tutor" who is leading today's session. He coaches the group to consider whether the word "saliva" should be moved from the "definitely infectious" to the "possibly infectious" column, both created by means of handwritten signs taped to the pale yellow wall.

"Pre-ejaculate" has already been moved the other way—from "possibly" to "definitely infectious." The word, defined in a businesslike way by Kirema as "the clear liquid that forms on the tip of a man's penis before ejaculation," eventually settles in the "possibly" column. "Saliva" is moved again to "not infectious."

Kirema notes that it is easier for women to get infected during condomless sexual intercourse than for men, a point not lost on a group that knows women now make up a majority of those infected in Kenya and elsewhere in sub-Saharan Africa.

In another study circle across the way, Joe Davis recalls later, the discussion centers on the sexual expectations men have of women. Wives should be sexually passive, though available anytime, according to the men. Prostitutes, on the other hand, ideally initiate sex and show pleasure, some of the men believe.

A wife who is uninterested in sex, the reasoning goes, will not seek pleasure outside the marriage, a threat that many African tribal groups have addressed by cutting female genitalia. That practice is slowly waning in the face of government and aid-donor opposition, though it is estimated that about half of local women, members of the Meru and Embu tribes, have undergone the procedure.

For reasons like those, many experts and the KNUT training manual argue that the pandemic cannot be arrested without a shift in power relations between the sexes, with women gaining new control over their lives.

Evidence suggests that teachers, though likely better informed on the subject of AIDS than the average Kenyan, do not in any way escape those patterns. Preliminary data from a recent survey conducted by the Washington-based Population Council and the Population Studies and Research Institute of the University of Nairobi show that of the more than 1,200 teachers answering a questionnaire, about 45 percent of the women and a little more than half the men disapproved of a married woman suggesting condom use.

Nor are teachers free of the fears or prejudices surrounding the disease, according to the survey results. More than 60 percent reported they were "very concerned" about being infected with HIV at work, and a third said they were "very afraid" of people who are infected. Four out of five teachers surveyed believed that their jobs might not be safe if school managers knew they had tested positive for the AIDS virus.

A few days after the trip to the teachers' college, Barimbui stops at Nkubu Primary School in the small town of that name south of Meru. The school, built by Roman Catholic missionaries, boasts a pillared portico and concrete lions at its entrance, though it is laid out along the same utterly simple lines and constructed of the same roughly mortared local stone as other public schools in the district.

Headmaster Bartholomew Njogu, a tall, serious man in spectacles, says that, for the most part, he does not know which children in his school are infected. Susan Kagwiria, the teacher who voluntarily functions as a counselor for many of the children affected by AIDS, keeps that information to herself for fear a child will be stigmatized. Disclosure of a student's HIV status, according to the policy recently approved by national education officials, is to be based on the best interests of the child.

Nonetheless, one boy is known to the headmaster because of the sores on his face. The visitors agree not to single out the orphan, but, somehow, with the buzz in the school about their interest in AIDS, other children laugh at him. The boy, who is about 11, begins crying. He is led to the staff room, where teachers huddle around him. So much for confidentiality, Barimbui recalls thinking in those moments.

When she arrives back in the headmaster's office, she is visibly agitated. "You must excuse my feelings," she blurts. "It's the handling of orphans."

Barimbui is, in one sense, all too aware of what she herself doesn't know. She has completed two counseling courses in Nairobi, but she thirsts for more. A standard reference book for therapists, the *Diagnostic and Statistical Manual of Mental Disorders,* is hard to come by. The library at Egoji Teacher Training College, for instance, does not have one.

Indeed, the library there has few materials on AIDS. Barimbui's husband, a secondary science teacher who lost a brother to the disease, has coached her on HIV biology, concerned she might suffer embarrassment with high-level officials.

Barimbui is among many teachers who hope for more knowledge of the field. Kagwiria, for example, who teaches the seventh grade at Nkubu Primary and has qualified as a master trainer for the KNUT's study-circle program, has completed a diploma in HIV management. But she wants a graduate degree in psychology. It would help in her volunteer work as a counselor.

On weekends and after school, Kagwiria goes to children's homes, where her first mission can be to persuade an often fearful and hard-pressed guardian to allow a child to be tested for the virus. If a child tests positive, the teacher urges drug treatment, which she then helps get and monitor.

The day after the incident that upset Barimbui, the cheery Kagwiria, in a bright red sweater and a pleated skirt, is visiting one of the students whose treatment she monitors, a 16-year-old boy who has lost his mother to AIDS. He sits as still as a rabbit in his aunt's low-ceilinged room, his smooth face expressionless as Kagwiria questions him:

"When do you take the medicine, before or after eating?"

"Before eating."

"You should be taking it after eating," she reminds him, "with lots of fluids."

But that's not the only problem. He has run out of the drugs, though it is two days until his next appointment at the hospital.

Later, she worries that the teenager could be infecting others. After all, he is 16.

That same day, Barimbui visits Raiji, the Kenepote leader. To get to his small peacock blue, metal-sheathed house, visitors must tromp up a track too muddy for the van, alongside garden plots of corn, past his parents' own small house. Raiji says his mother and father know of his illness, but they have never mentioned it.

The walk is less than a tenth of Raiji's hike to Kiangua Secondary School, even on the days when he can pick up a jitney—a *matatu*—for part of the journey. Then he spends an hour and a half on foot each way.

Sometimes, Raiji says, he feels dizzy. But he is not taking antiviral drugs. They cost 3,500 Kenyan shillings a month, and his salary is 10,000 in the same period.

The teacher is walking with the visitors back toward the van when his wife, Joy—"my Joy," he says when introducing her—calls to Barimbui. They talk in the askew doorway, under a philodendron vine carefully trained over a few nails.

"My wife needs counseling, and there is none around here," Raiji explains. "All she gets is from me."

When Barimbui climbs into the van later, toting a big sack of dried beans given to her by Raiji's wife, she says the young woman is concerned about her husband's temporary job status. More than that, communication between wife and husband is faltering.

There is weariness—and a grim determination—in Barimbui's voice as she recounts the conversation.

Not like the day she meets the teachers in the Chuka cafe, that afternoon, at their request, she closes the gathering with a prayer—of petition, of thanks for fellowship.

Afterward, in a reflective mood, she waits as men repair a flat tire on the van, and other men with nothing better to do watch. When she speaks, she looks past the milling figures, past an unfinished building adorned with two concrete tusks.

"Don't you think," she murmurs, "it's a very bad thing to have happened to mankind?" □

Opening the Door to a World of Possibilities

By Tony Stead

It is 3 P.M. and I am picking up my son, Fraser, from school. This is a rare occurrence for me. Normally I am away; my job as a consultant takes me to schools in parts of the United States I never knew existed. Waiting for Fraser, I am ready to ask him the usual question, "So what did you do at school today?" and expect the usual reply, "Nothing," even though I know his day has been packed full of exciting adventures that I will eventually hear about later that evening. Today, however, is different. Before I even have the opportunity to greet him, Fraser runs up to me with an enthusiasm akin to a child's first visit to Disneyland. "Papa," he shouts, "We're doing nonfiction writing, and I'm doing dogs, and Sharon lets me. I have to go and get some books and find out about them. I love dogs. Can you believe it? Dogs. My favorite!"

This kind of excitement over nonfiction research and writing around a topic of high interest I have seen many times before, with children in my own classroom. Fraser's teacher, Sharon Taberski, like many other teachers, has opened up a whole new world of possibilities in the writing classroom. The children's excitement is infectious and stays with them long after a unit is completed. Fraser's friend, Alexander, who was also fortunate enough to have had Sharon as his teacher the year before, still talks about his nonfiction report on cats and continues to compose nonfiction pieces at home. What is so refreshing is that these boys are in grades one and two. We are talking about young children who have already discovered the magic of nonfiction writing. Moreover, enthusiasm for nonfiction writing is not limited to boys (a common myth among many educators). In my many years of working with young children, I have found that girls become equally engaged in nonfiction writing when the subject matter is of interest to them personally. I believe that too often when we explore nonfiction writing in the early years, it usually focuses on topics such as frogs, spiders, bugs, and other creepy-crawlys that do little to turn girls on to nonfiction writing.

Tapping into the enthusiasm that writing nonfiction in-

Tony Stead is the senior national literacy consultant for Mondo Publishing and the facilitator for Boston Public Schools' Balanced Early Literacy Project. This excerpt is reprinted from Is that a Fact? Teaching Nonfiction Writing K-3, *with permission of Stenhouse Publishers. Visit the publisher at (800) 988-9812 or online at **www.stenhouse.com** to learn about Stead's new book,* Reality Checks: Teaching Reading Comprehension with Nonfiction K-5, *scheduled for release in November 2005.*

ILLUSTRATED BY GERARD DUBOIS

spires in both girls and boys is something that I believe we educators do not do enough, especially in the early years of schooling. I am reminded of an observation made by Donald Graves back in 1994. He wrote, "Unfortunately, little nonfiction, beyond personal narrative, is practiced in classrooms. Children are content to tell their own stories, but the notion that someone can write about an idea and thereby affect the lives and thinking of others is rarely discussed" (1994, p. 306).

Like Graves, I believe many teachers even today have not opened their doors to the possibilities beyond narrative when it comes to their writing programs. I know that for many years in my own classroom, my writing program revolved around the world of narrative and, in particular, fantasy. I would give my students many demonstrations of how to make their writing better. These demonstrations usually consisted of showing them how to plan, compose, edit, and proofread their writing, as well as how to publish their work and how to improve their spelling and grammar.

My students were engaged in their daily writing rituals and produced some wonderful pieces. They loved writing each day and were eager to publish their pieces so they could get their hands on all the wonderful markers and glitter that were strictly reserved for publishing. They became masters in the art of process and at times didn't even appear to need me to assist them with their pieces. I had taught them well how to get help from my daily demonstrations, from charts in the classroom, or by conferring with a peer. They eagerly shared their pieces with each other and their parents and looked forward to writer's workshop each day. Many even chose to write during free activity time, something unheard of in my beginning years of teaching.

However, something was missing. There was too little variety in what my students chose to write about. Typically, my kindergartners would write, "I love my mom" every day or would tell what had happened at home last night—"I played with my toys." "I went to a party." The entries by my first- and second-graders varied little from those of the kindergartners. They usually concerned home or school

experiences. Although it was only natural that the children's voices be governed by what was happening to them in their day-to-day lives, I knew that nonfiction should have been a key element of their writing experience, and sadly it was not. What I needed to do as their teacher was tap my students' experiences and create new ones so that they could discover different purposes and formats for writing.

I began by reading nonfiction material to my children as part of my daily read-aloud and shared reading routines. One book I read was *Chickens* by Diane Snowball. Before reading the book, I asked the children to look at the cover and make predictions about the book's content. They thought that the little chicken on the right was going to run away from home and all his friends were talking about how to stop him from doing so. It quickly became evident to me from such comments that they expected this book to be a story. After all, what I usually read to them was fiction.

I opened the cover and read them the first page: "This is a rooster." Then I asked them if they thought their prediction about the book's content was correct. "Yes," they answered in unison. "That's the father chicken," remarked Carlo, "and he is the one who told the baby chicken off and that's why the baby chicken is running away." I accepted this and moved on to the next page: "This is a hen." "That's the mother chicken and she told the baby chicken off, too, because he wouldn't eat his dinner!" exclaimed Renee. It was obvious from these comments that my children were going to hang on to their prediction about a runaway chicken for as long as they could. However, the next page—"Roosters and hens mate to have chickens"—threw all their predictions to the wind (and me with it as well: I had a lot of careful explaining to do regarding that page, but that's another story).

After the reading, we talked about how this text was a different kind of book because it told us true things about chickens. We discussed how authors write these types of books to tell people facts about certain animals. I also alerted them to the labels in the book, and we discussed the way writers of nonfiction often use tags to assist their readers. One week later, one of my second-grade students, Laura, proudly produced a story she had been working on. Laura was an avid writer. We were only four months into the school year and she had already produced five stories, all of which revolved around her being a princess and her many adventures. I don't know how many times she'd been rescued by a prince in her many stories. I really thought this could be the next Danielle Steele or Barbara Cartland sitting in front of me. But Laura's new piece was different. I was both surprised and delighted when I read it. This piece was nonfiction and, like Diane Snowball's book, it centered around the topic of chickens.

Laura had discovered a new purpose for writing: to report facts about animals. She used some of the traditional ways authors relay their information, including diagrams, labels, and arrows to describe the cycle of the chickens losing and growing new feathers. Laura was very excited about her latest piece of writing and informed me that she wanted to write more—on all the other animals she had information about.

I realized then that for too long I had kept my students in a world of personal narrative and fantasy by providing demonstrations of these writing forms almost exclusively. When I looked through my classroom library I found that 90 percent of the books were fiction stories. My read-alouds and shared readings were limited to the world of make-believe or personal narrative. No wonder my children wrote the same things every day and had become masters of these few forms. While I still believed that fiction and personal narrative were important, I realized they were only part of the bigger picture.

* * *

Some time ago, I recorded all the types of reading, writing, listening, and speaking my son Fraser was engaged in over the course of one Saturday. I wanted to see just how important it was for him to engage in language forms apart from narrative and fiction. Almost 90 percent of his world was nonfiction—from trying to figure out how to win the game on his Game Boy to instructing me on which clothes he needed to wear and why it was so important for him to wear his Pokémon sweater even though the temperature had just hit 90 degrees. His questions were constant: How? When? Where? And of course the one that haunts us all as teachers and parents—Why? Why? Why? It became evident to me that this little boy, like millions of other children, wanted to know how this big, wide, wonderful world works and what he could get out of it. He was also eager to teach me what he had already learned and was adamant that the rules for a particular game were as he told me, not as I tried to instruct him, because he had played this once before and what would I know about it anyway, even if I did have the rules in hand. He certainly had the oral language to explain, instruct, and persuade; what he needed was the ability to translate this knowledge into written form.

When I think about my years as a teacher, although fairy tales and fantasy always engaged my students, it was when rain or snow was pelting down on the classroom windowpanes or a bug happened to walk across one of the children's tables that excitement and engagement were at their peak. I think of Sylvia Ashton Warner's timeless classic *Teacher* and Albert Cullum's *The Geranium on the Window Sill Just Died, but Teacher You Went Right On.* These books remind us to seize the moment and harness children's natural curiosity about themselves and their world to classroom instruction. What we need to do as teachers is tap this excitement, seize upon it, and help children discover that when they write they can do far more than simply record what they did last night. They can write for the purpose of instruction in the form of rules of a game to let novices such as myself learn how to play. They can write for the purpose of scientific explanation, to let readers know why it snows, or simply to describe chickens and dogs, or in Dorothy's words from the *Wizard of Oz*, "lions and tigers and bears."

What we as teachers must do is help children discover what the types of nonfiction writing look like and the structures and features that competent writers use when writing for specific purposes. Children write personal narratives and stories, not because this is the limit of their experiences, but because they don't know how to write outside of these forms. Their writing demonstrations, expectations, and engagements are limited by us, their teachers.

Children need to be introduced to the different purposes of writing. They need to know how to plan, compose, revise, and publish text types apart from narrative. We teachers are not unlike our students when it comes to an overemphasis on narrative. We, like they, feel comfortable with the structure and associated language forms of story. Our own limited knowledge of different writing genres and how they work has made us poor models and guides for our children. We need to do more of what Sharon Taberski has done for Fraser and the other children in his class: open the door to a wide world of possibilities. □

References

Cullum, A. (1971). *The Geranium on the Window Sill Just Died, but Teacher You Went Right On.* London: Harlin Quist.

Graves, D. (1994). *A Fresh Look at Writing.* Portsmouth, N.H.: Heinemann.

Snowball, D. (1995). *Chickens.* New York: Mondo Publishing.

Warner, Sylvia Ashton. (1963). *Teacher.* New York: Simon and Schuster.

The Power of Place

By James Oliver Horton

Over 4 million people visited Independence Hall in 2004. Nearly 600,000 visited Martin Luther King, Jr.'s childhood home. And about 350,000 visited the Little Bighorn Battlefield. They went not just to learn history, but to feel the power of place and experience the deeper understanding that comes from standing exactly where historical figures have stood, soaking in the sights, sounds, and scents of the environment.

To help teachers (and parents) expose children to the power of place, there is a beautiful new series of books, American Landmarks. *Here, as a small taste of the series, we share the introduction by Editor James Oliver Horton, as well as excerpts from two of the books,* Landmarks of the American Revolution *and* Landmarks of African-American History.

—*EDITORS*

Few experiences can connect us with our past more completely than walking the ground where our history happened. The landmarks of American history have a vital role to play in helping us to understand our past because they are its physical evidence. The sensory experience of a place can help us reconstruct historical events, just as archaeologists reconstruct vanished civilizations. It can also inspire us to empathize with those who came before us. As philosophers of the Crow Indian nation have reminded us, "The ground on which we stand is sacred ground. It is the blood of our ancestors." It is the history owed to our children. They will remember that history only to the extent that we preserve the places where it was made.

Historical sites are some of history's best teachers. In the early 1970s, when I was a graduate student working on a study of the 19th-century black community in Boston, I walked the streets of Beacon Hill imagining the daily lives of those who lived there a century before. Although I had learned much about the people of that community from their newspapers, pamphlets, personal letters, and official records, nothing put me in touch with their lives like standing in the places where they had stood and exploring the neighborhood where they lived.

I remember walking along Myrtle Street just down Beacon Hill from the rear of the Massachusetts State House in the early morning and realizing that Leonard Grimes, the black minister of the Fugitive Slave Church, must have squinted into the sun just as I was doing as he emerged from his home at the rear of number 59 and turned left on his way to his church. Walking up Joy Street in December added new meaning to descriptions I had read about the sound of children sledding down its slope during the particularly snowy winter of 1850. And twisting my ankle on irregular cobblestone streets made clear the precarious footing for fugitive slaves fleeing at full run from slave catchers empowered by the Fugitive Slave Law of 1850.

Any historical event is much better understood within the context of its historical setting. It is one thing to read the details of the Battle of Gettysburg. It is quite another to stand on Little Round Top, with its commanding view of the battlefield to the north and west, and contemplate the assault of the 15th Alabama Confederates against the downhill charge of the 20th Maine Volunteer Infantry. Standing at the summit, taking the measure of the degree of slope and the open area that afforded little cover to advancing armies, is an unforgettable experience. It bears irrefutable testimony to the horror of that battle and to the sacrifice of the more than 50,000 men during four days in the summer of 1863.

The *American Landmarks* series has emerged from this belief in the power of place to move us and teach us. It was with this philosophy in mind that in 1966 Congress authorized the establishment of the National Register of Historic Places, "the nation's official list of cultural resources worthy of preservation." These enduring symbols of the American experience are as diverse as the immigration station on Angel Island in San Francisco Bay, which served as the U.S. entry point for thousands of Asian immigrants; or Sinclair Lewis's boyhood home in Sauk Centre, Minn., the place that inspired the novelist's Nobel Prize-winning descriptions of small-town America; or the Cape Canaveral Air Force Station in Florida, launch site of Neil Armstrong's historic trip to the moon. Together, such places define us as a nation.

The historic sites in this series are selected from the National Register and the books are written by some of our nation's finest historians—based at universities, historic museums, and historic sites. For them, historic sites are not just places to visit on a field trip, but primary sources that inform their scholarship. Not simply illustrations of history, they bring the reality of our past to life, making it meaningful to our present and useful for our future. □

James Oliver Horton is the Benjamin Banneker Professor of American Studies and History at George Washington University, director of the Center for Public History and Public Culture, and recipient of the "Living Legend Award" from the Afro-American Museum of Boston. These excerpts from American Landmarks *are published with permission of Oxford University Press.*

ILLUSTRATED BY NENAD JAKESEVIC


CHARLESTON
HARBOR

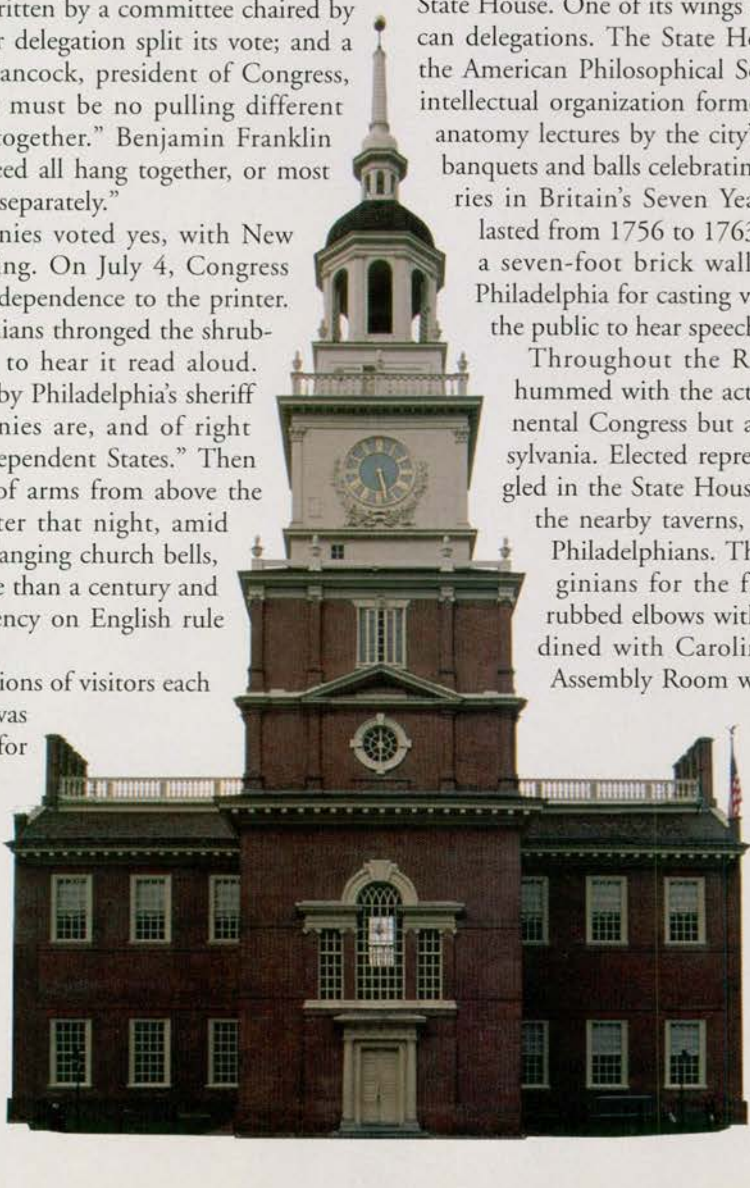
Independence Hall

By Gary B. Nash

"This morning is assigned for the greatest debate of all," noted John Adams, a Massachusetts delegate to the Second Continental Congress, which was meeting in the Pennsylvania State House in Philadelphia on July 1, 1776. At the end of that day, the delegates from nine of the 13 colonies rose from the long table in the handsomely paneled room to vote for the Declaration of Independence. The delegates of two colonies voted against the Declaration, written by a committee chaired by Thomas Jefferson; another delegation split its vote; and a fourth abstained. John Hancock, president of Congress, urged unanimity: "There must be no pulling different ways; we must all hang together." Benjamin Franklin concurred: "We must indeed all hang together, or most assuredly we shall all hang separately."

The next day, 12 colonies voted yes, with New York's delegation abstaining. On July 4, Congress sent the Declaration of Independence to the printer. Four days later, Philadelphians thronged the shrub-dotted State House yard to hear it read aloud. They cheered the reading by Philadelphia's sheriff that "these United Colonies are, and of right ought to be, free and independent States." Then they tore the king's coat of arms from above the State House door and later that night, amid more cheers, toasts, and clanging church bells, hurled this symbol of more than a century and a half of colonial dependency on English rule into a roaring bonfire.

Cherished today by millions of visitors each year, Independence Hall was not known by that name for a long time. Rather it opened as the Pennsylvania State House in 1756, when the American colonies were firmly attached to England. Construction of the hall began in 1732 on a gently sloping piece of land five blocks from the Delaware River on the outskirts of the small seaport town, where visiting Native Americans had earlier camped.



Gary B. Nash is professor of history at the University of California, Los Angeles, director of the National Center for History in Schools, and author of numerous award-winning books. Excerpted with permission from Landmarks of the American Revolution.

All business of the colony, in the hands of the Assembly, the Council, and the Supreme Court, was conducted in this State House. One of its wings lodged visiting Native American delegations. The State House also hosted meetings of the American Philosophical Society, the first scientific and intellectual organization formed in the American colonies; anatomy lectures by the city's eminent doctors; and fancy banquets and balls celebrating the king's birthday or victories in Britain's Seven Years War with France, which lasted from 1756 to 1763. Its yard, later enclosed with a seven-foot brick wall, was also the main site in Philadelphia for casting votes and a gathering place for the public to hear speeches from colonial politicians.

Throughout the Revolution, the State House hummed with the activities not only of the Continental Congress but also the government of Pennsylvania. Elected representatives in each body mingled in the State House, in the streets outside it, in the nearby taverns, and in the salons of wealthy Philadelphians. There, Pennsylvanians met Virginians for the first time; Connecticut men rubbed elbows with Georgians; Rhode Islanders dined with Carolinians. In June 1775, in the Assembly Room where Congress met, the delegates appointed George Washington as commander in chief of the newly authorized Continental Army. Another 13 months later, on July 15, 1776, delegates from every Pennsylvania county—many of them farmers and artisans—convened here to draft a constitution for Pennsylvania. In 1779, Pennsylvania leg-

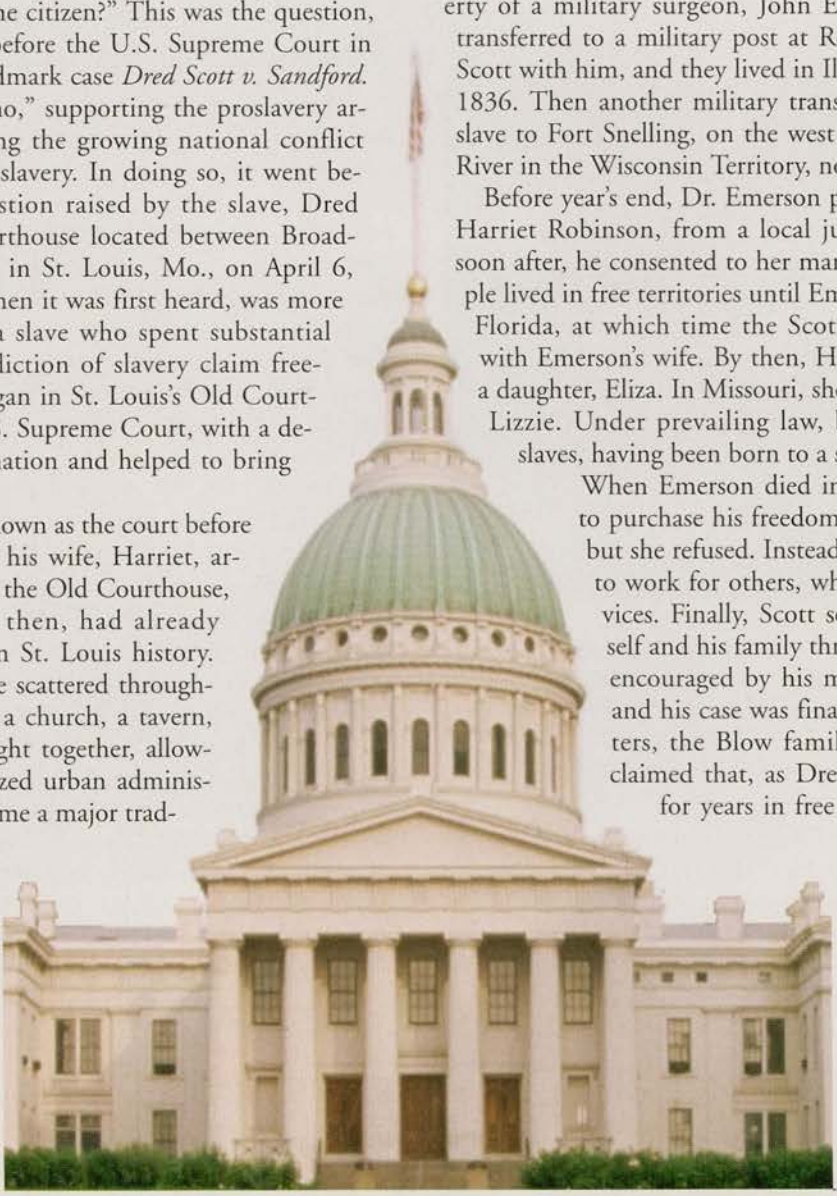
(Continued on page 40)

The Old Courthouse

By James Oliver Horton

"The question is simply this: Can a [N]egro whose ancestors were imported into this country and sold as slaves, become a member of the political community formed and brought into existence by the Constitution of the United States, and as such become entitled to all the rights, and privileges, and immunities guaranteed by that instrument to the citizen?" This was the question, not at all simple, put before the U.S. Supreme Court in March 1857 in the landmark case *Dred Scott v. Sandford.* The Court answered "no," supporting the proslavery argument and intensifying the growing national conflict over the institution of slavery. In doing so, it went beyond the original question raised by the slave, Dred Scott, in the Old Courthouse located between Broadway and Fourth Street in St. Louis, Mo., on April 6, 1846. The question, when it was first heard, was more straightforward: Can a slave who spent substantial time outside the jurisdiction of slavery claim freedom? The case that began in St. Louis's Old Courthouse ended in the U.S. Supreme Court, with a decision that shook the nation and helped to bring on the Civil War.

Although it is best known as the court before which Dred Scott and his wife, Harriet, argued for their freedom, the Old Courthouse, as it was called even then, had already played a pivotal role in St. Louis history. Here, city offices—once scattered throughout the community in a church, a tavern, and a fort—were brought together, allowing for a more centralized urban administration. As the city became a major trading center, the courthouse was expanded so that its original building became a wing of the new, larger structure. It was in its old west wing that the first Dred Scott trial was held.



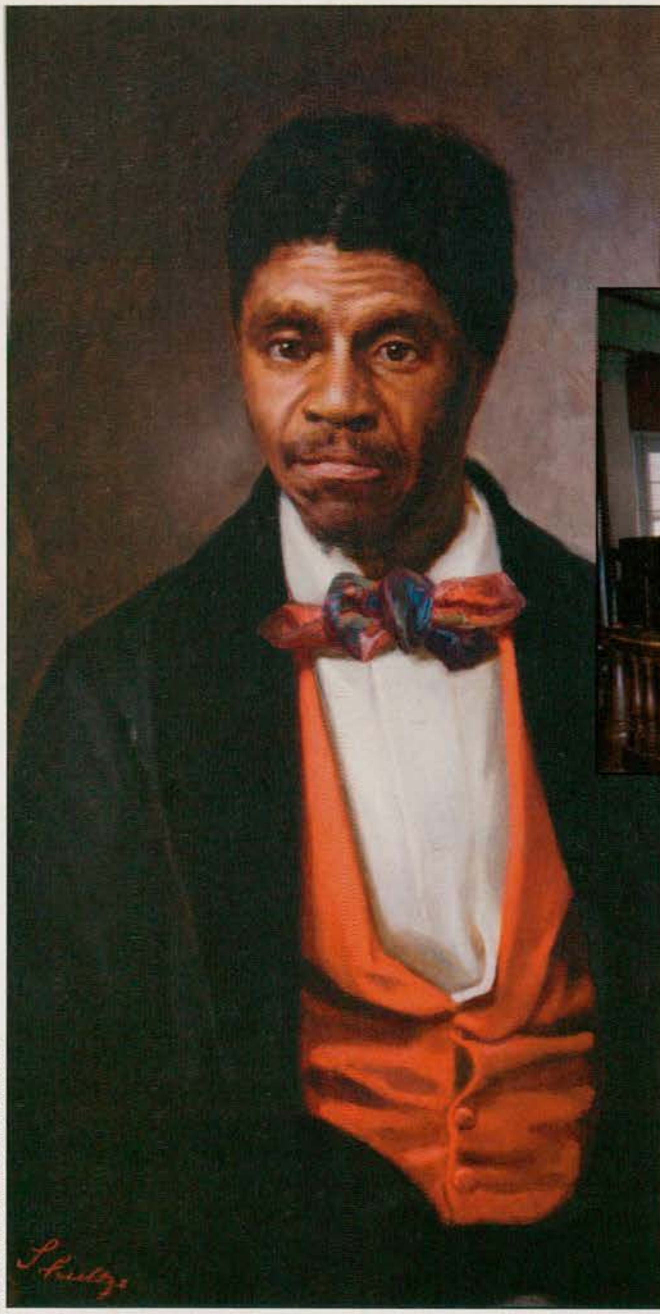
Scott was born a slave in Virginia about 1799. He was the property of Peter Blow. When the Blow family relocated to St. Louis in 1830, they brought Dred Scott with them. Shortly after the move, economic pressures forced the family to sell some of its property, including Dred Scott. That sale changed Scott's life, as sales often did for those bound in slavery. He became the property of a military surgeon, John Emerson, who was soon transferred to a military post at Rock Island, Ill. He took Scott with him, and they lived in Illinois until the spring of 1836. Then another military transfer brought master and slave to Fort Snelling, on the west bank of the Mississippi River in the Wisconsin Territory, now Minnesota.

Before year's end, Dr. Emerson purchased a female slave, Harriet Robinson, from a local justice of the peace, and soon after, he consented to her marriage to Scott. The couple lived in free territories until Emerson was transferred to Florida, at which time the Scotts returned to Missouri with Emerson's wife. By then, Harriet had given birth to a daughter, Eliza. In Missouri, she had a second daughter, Lizzie. Under prevailing law, both the children were slaves, having been born to a slave woman.

When Emerson died in 1843, Scott attempted to purchase his freedom from Emerson's widow, but she refused. Instead she hired the Scotts out to work for others, who paid her for their services. Finally, Scott sought freedom for himself and his family through the courts. He was encouraged by his minister, John Anderson, and his case was financed by his former masters, the Blow family. The Scotts' attorney claimed that, as Dred and Harriet had lived for years in free territory, they and their children had the right to freedom. There was precedent for this argument. At the time, Missouri courts recognized a policy of "once

---

Excerpted with permission from Landmarks of African-American History.



MISSOURI HISTORICAL SOCIETY, ST. LOUIS

Dred and Harriet Scott were slaves who had lived in a free state and in free territory when they decided to sue for their personal freedom under Missouri state law in 1846. Earlier Missouri court decisions had emancipated slaves who had traveled to free states or territories, and Scott expected his suit to be quick and successful. Eleven years later, however, the U.S. Supreme Court declared him a slave with no right to bring suit before the court.

JEFFERSON NATIONAL EXPANSION MEMORIAL/ NATIONAL PARK SERVICE

This courtroom inside the Old Courthouse is one of the two restored rooms on the second floor. Originally, the building held seven to 12 courtrooms for use by the county and city courts.

free, always free," and in similar cases, other slaves had attained their freedom using this argument. The case came to trial in June 1847 and was heard in the first-floor, west-wing courtroom of St. Louis's Old Courthouse. The Scotts lost their case on a technicality, but were granted a second trial in 1850, held in the same courtroom. This time the jury granted the Scotts their freedom. Unfortunately, however, this was not the end of their struggle.

By the mid-1840s, when a slave successfully sued for his freedom, it was viewed by most in the South as a dangerous attack on the institution of slavery that had come to define the South and its way of life. Having lost at the local level, there was pressure on Mrs. Emerson to appeal her case, retain her slave, and safeguard slavery from these kinds of freedom suits. Her appeal was successful. The case moved beyond the Old Courthouse to the Missouri Supreme Court, which reversed the lower court decision, arguing that "times now are not as they were when the previous decisions on this subject were made." The court ordered that the Scotts be re-enslaved. Ironically, Scott had lost on another technicality.

Dred and Harriet were not ready to relinquish the freedom that had seemed so close at hand. Their case attracted the attention of the antislavery movement, and a team of abolitionist lawyers took action on Scott's behalf. The team filed suit in St. Louis Federal Court in 1854 against John F.A. Sanford, Mrs. Emerson's brother, who acted for her estate. (John Sanford's name was misspelled in the Supreme Court records, and the case has been know since as *Scott* v. *Sandford*.) As Sanford was a resident of New York, the case could be moved out of the Missouri court system and heard by the federal courts. The trial took place not in the Old Courthouse but in the Papin Building, near St. Louis's present-day Gateway Arch. The court decided in favor of Sanford, prompting Dred Scott and his team of lawyers to appeal to the U.S. Supreme Court.

Dred Scott's legal drama, begun in the Old Courthouse, was a significant part of a much larger national debate, older than the country and dangerous to the Union. Although the Founding Fathers never specifically mentioned slavery in the Constitution, the shadow of that institution hung heavily over the proceedings that brought the document to life.

The 13 British colonies and all the original states in the Union had sanctioned slavery, but, starting with Vermont in 1777, most northern states set about abolishing the institution in the decades after the Revolution. The Georgia and South Carolina representatives at the 1787 Constitutional Convention in Philadelphia, however, flatly refused to be a part of any national union that denied protection to slavery. Although South Carolina's representative, Charles Cotesworth Pinckney, did not get the explicit constitutional guarantees protecting slavery that he demanded, representatives from more moderate southern states, such as Virginia's George Mason, agreed that the federal government should not hinder the maintenance and growth of slavery. Even most northern representatives believed that the Constitution needed to protect slaveholders' right to their human property and thus prohibited Congress from interfering with the importation of slaves into the country for at least 20 years after the passage of the Constitution.

By the time Dred Scott stood before the St. Louis court, there were more than three million slaves in the United States, and slavery was an important and well-established institution in America life. Even as slavery dwindled in state after state in the North, the institution expanded in the South. It became critical to the southern economy and so significant nationally that the entire country felt its power. Cotton, the major slave crop, played a large role in America's foreign trade. By 1840, it was, in fact, more valuable than all the nation's other exports combined. And the value of the slave population was a major part of the national wealth, greater in value than all of America's banks, railroads, and factories put together. Thus, when Dred Scott asked that the court grant freedom for himself and his family, his request might well have been seen as a threat to an important economic foundation of the nation.

Any challenge to slaveholding in the South was further complicated by the rise of the militant abolition movement then causing a great stir in many regions of the North. The white abolitionist William Lloyd Garrison, editor of the radical newspaper *The Liberator,* joined forces with black abolitionists to attack slavery and lobby the North on behalf of freedom. Although most white people in the northern states were not ready to support the antislavery argument, a few legislatures—Massachusetts and Pennsylvania, for example—passed regulations in the 1840s, called personal liberties laws, prohibiting state officials or facilities from participating in the enforcement of the 1793 Fugitive Slave Law, under which slaveholders attempted to recapture their property.

Missouri was a part of this debate even before it became a part of the United States. It entered the nation in 1821 as the 12th slave state, balancing the previous year's admission of Maine, the 12th free state. Slavery was central to the state's economy and to that of its major city of St. Louis, where slave trading was big business and slave auctions were sometimes conducted from the front steps of the Old Courthouse. Often these sales were conducted to settle slaveholder estates or to pay debts and fulfill business contracts between local merchants. For the Scotts, as for slaves generally, the courthouse was not simply a hall of legal justice.

By the mid-19th century, the increasing hostility between abolitionist and proslavery activists had become a national concern that some in the Congress hoped to cool with the passage of major compromise legislation. The Compromise of 1850, as the series of bills was called, offered the antislavery advocates the admission of California as the 16th free state and the abolition of the slave trade in the District of Columbia. To slavery's supporters, the Congress offered a new, stricter fugitive slave law that did not give an accused fugitive the right of legal counsel, a jury trial, or even the right to speak in self-defense. The new law also required all citizens to assist in the capture of fugitives on penalty of fine and arrest. Black and white abolitionists vowed to resist this law at all costs, and President Millard Fillmore, bent on showing resolve to the South, vowed to enforce it.

Meanwhile, Kansas erupted. In 1854, Congress passed legislation that allowed the fate of slavery in that territory to be decided by the will of a majority of its settlers. Almost immediately, friction became hostility that gave way to open warfare as proslavery forces and abolitionists rushed to claim political control of the territory. The violence of "Bleeding Kansas" spilled over into northern cities where abolitionists fought to protect fugitive slaves, and even into the hall of Congress, where Preston Brookes, a proslavery South Carolina congressman attacked Massachusetts antislavery Senator Charles Sumner in the Senate Chamber. Sumner had derided an elderly senator from South Carolina, a relative of Brookes, for his support of the proslavery forces in Kansas. Brookes' attack on Sumner was a part of the sectional violence and, because it occurred on the floor of the U.S. Senate, it shocked the nation. By the mid-1850s, America seemed to be moving toward a major confrontation between pro- and antislavery forces. It was in this atmosphere that Dred Scott and his lawyers came before the U.S. Supreme Court to make their argument.

In 1857, when the high court considered Scott's case, five of its nine justices, including Chief Justice Roger B. Taney, were sons of the South. Two of the northern judges were strong advocates of states' rights policies that favored the South, and a third was on record as being proslavery. Only the remaining northern judge was opposed to slavery. In the political heat of the era, the Court's findings took on immense political significance. It went far beyond ruling on the freedom of one African-American family. On March 6, 1857, 80-year-old Justice Taney read aloud the lengthy majority opinion in the *Dred Scott* case. Seven of the nine justices—all of the southerners and two of the northerners—agreed that Dred Scott should remain a slave, but the majority opinion did not stop there. The Court also ruled that, as a slave, Dred Scott was not a citizen of the United States, and therefore had no right to bring suit and "no rights which the white man was bound to respect." In a direct slap at the new Republican Party, established in 1854, and its free soil platform, which declared the party's opposition to the expansion of slavery into the free territories, the Court argued that the federal government had no right to prohibit slavery in the western territories. This judgment was a central point of contention in the political powder keg of the 1850s.

The *Dred Scott* decision had, by the late 1850s, moved the country to the brink of civil war. Dred Scott did not live to see the war that finally ended slavery. He and his family were freed in the spring of 1857, after Mrs. Emerson remarried, this time to an antislavery congressman. A year later, on September 17, 1858, Dred Scott died of tuberculosis and was buried in St. Louis. □

Independence Hall

(Continued from page 36)

islators drafted the first state law abolishing slavery, although gradually.

Two years into the war, the State House suffered all the indignities of an occupying army. When the British defeated the Americans at Brandywine, southwest of the city, the Continental Congress and state government fled, hauling off the State House bell (better known today as the Liberty Bell) to Allentown to keep the British from melting it into metal for ammunition. When British troops led by General William Howe occupied the city between September 1777 and June 1778, the first floor of the State House became a hospital and its second floor a jail for American officers. The dead carried from its bloodied chambers were buried in the Strangers' Burial Ground diagonally behind the State House or were thrown into an open pit dug just outside the building. When the British evacuated the city, they left behind a building "in a most filthy condition and the inside torn much to pieces," according to Josiah Bartlett, a member of the Continental Congress. So foul was the air inside the State House that the returning delegates to the Continental Congress had to meet elsewhere until the building was scrubbed down from top to bottom.

Better times returned to the State House after the British withdrew, but it sometimes became a place of protest as well as a site for celebration. Here Philadelphians rushed in October 1781 to celebrate news of Lord General Charles Cornwallis's surrender at Yorktown to Washington's army and his French auxiliaries. Less than two years later, angry Pennsylvanian soldiers surrounded the State House and demanded back pay so vociferously that the Continental Congress fled to the sleepy town of Princeton, never to return to Philadelphia. In 1787, fifty-five delegates from 12 states redignified the old State House when they arrived to spend a hot, muggy summer there writing the Constitution that the states would ratify in the next year. Pennsylvania's ratifying convention met in the State House for several weeks in 1788, and two years later a state convention met there to revise Pennsylvania's constitution. On its heels, the U.S. Congress arrived from New York in December 1790. It would direct the nation from the State House in Philadelphia for 10 years.

In the early 19th century, the State House, with its spacious yard, remained the prime site for celebrating the nation's independence and the birthday of its first President, although it was not yet known as Independence Hall. Even before George Washington died in 1799, Philadelphians were gathering around the State House to toast the President, conduct civic feasts, and display illuminations and transparencies honoring the Founding Fathers. Sometimes the civic festivals bordered on what one proper Quaker lady, Elizabeth Drinker, described in her diary in 1798 as "a little mob fashion."

After Congress declared the Fourth of July a national holiday in 1799, it became the nation's principal patriotic celebration. But it took only a few years for Philadelphia's State House yard to yield to "mob fashion"—with grave results. By 1805, Independence Square had become a place not so much to memorialize the past as to lay down a color line. When black Philadelphians came to celebrate the nation's birthday, white roughnecks drove their fellow citizens from the square with a barrage of rocks and curses.

A few years later, the city's leading African-American sail maker, James Forten, who had fought in the American Revolution as a 15-year-old powder boy on Stephen Decatur's

Slavery and Independence Hall

Independence Hall has been a symbol of American founding principles, including freedom, equality, and justice. Yet it has been a contested place where Americans divided sharply over how fundamental rights would be made operational. This was clear in the 19th century, when the building was no longer Pennsylvania's State House but became the nerve center of Philadelphia's government.

The Compromise of 1850 included a tough new Fugitive Slave law that permitted Southern slave owners or their agents to come north to seize runaway slaves. These alleged fugitives were denied a jury trial; rather, their fate was determined by federal judges or special commissioners. Independence Hall became the scene where accused fugitives were detained in the U.S. Marshal's office, received hearings, and learned their fates.

LIBRARY OF CONGRESS

In this dramatic print published by abolitionists to deplore the Fugitive Slave Act of 1850, six white men fire on ambushed black men in a cornfield.

In 1851, after a Maryland slave owner was killed at a farm in Christiana, near Lancaster, Pa., while trying to capture his escaped slaves, several dozen African-American and white "conspirators" were charged with treason for interfering with the Fugitive Slave Law. The prisoners were tried in court on the second floor of the State House. Philadelphians were bitterly divided on the issue. Some agreed with Mr. Aaron of the Pennsylvania Antislavery Society that the black Pennsylvanians at Christiana "were only following the example of Washington and the American heroes of '76." Others rallied at a mass meeting in Independence Square "to prevent the recurrence of so terrible a scene upon the soil of Pennsylvania, to ferret out and punish the murderers." If Independence Hall was becoming sacred ground, it also remained a contested ground.

John Adams Writes to His Wife about Signing the Declaration of Independence

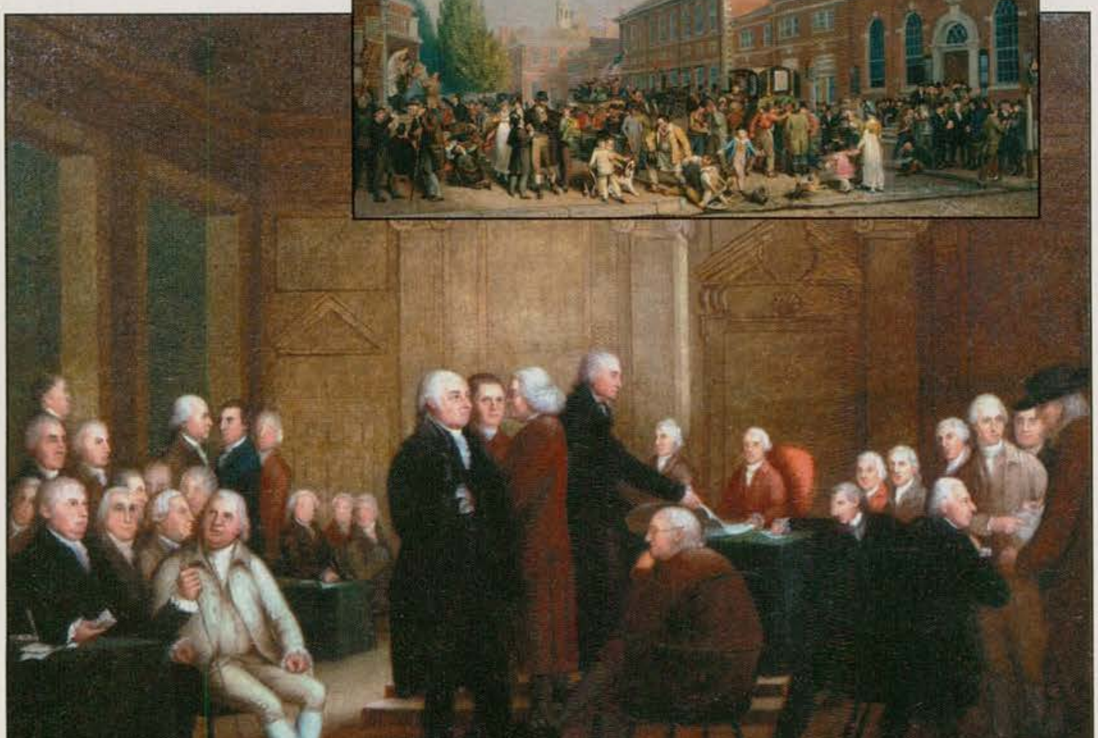
John Adams, who was to become the second president of the United States, served as one of the Massachusetts delegates to the Second Continental Congress and a leader in moving the Congress toward accepting the Declaration of Independence. On July 3, 1776, Adams fervently wrote his wife Abigail about the vote of 12 colonies for independence—only New York abstained—in the Assembly Room of what would become known as Independence Hall.

Yesterday the greatest question was decided which ever was decided in America, and a greater, perhaps, never was nor will be decided among men. [Britain had been] filled with folly, and America with wisdom; at least this is my judgment. Time must determine. It is the will of Heaven that the two countries should be sundered forever.... [Independence day will be observed as a holiday,] the most memorable epoch in the history of America [and] will be celebrated by succeeding generations as the great anniversary festival.... [It should be commemorated by] a solemn act of devotion to God Almighty.... It ought to be solemnized with pomp and parade, with shows, games, sports, guns, bells, bonfires, and illuminations, from one end of the continent to the other, from this time forward forevermore.

NATIONAL PORTRAIT GALLERY, SMITHSONIAN INSTITUTION/ART RESOURCES, NY

warship, wrote bitterly in his *Letters from a Gentleman of Colour,* "Is it not wonderful that the day set apart for the festival of liberty, should be abused by the advocates of freedom, in endeavoring to sully what they profess to adore?" The landmark of American ideals had become a staging ground for racial conflicts. For years thereafter, black Philadelphians would celebrate January 1, the day that the horrific slave trade ended in 1808, rather than July 4, as their Independence Day.

After the war, few people felt inspired to honor the nation's birthplace. In fact, the old State House slowly decayed, especially after the Pennsylvanian government relocated to Lancaster in 1799, and the federal government left Philadelphia for Washington, D.C., the following year. Pennsylvania's legislature had so little regard for what we now esteem as a national shrine that in 1816, seeking money to build a new capitol in Harrisburg, it approved the sale



(Inset) John Lewis Krimmel, an immigrant from Württemberg, Germany, depicted election day revelry in front of Independence Hall and its flanking buildings in 1815. All classes of people appear in this rare street scene from the period. (Left) In 1784, English immigrant Robert Pine started a painting of the Second Continental Congress voting for independence, which was completed by Edward Savage about 1801. The portrayal of the State House Assembly Room is historically accurate.

ATWATER KENT MUSEUM OF PHILADELPHIA, THE HISTORICAL SOCIETY OF PENNSYLVANIA COLLECTION.
INSET: MUSEUM PURCHASE WITH FUNDS PROVIDED BY HENRY FRANCIS du PONT

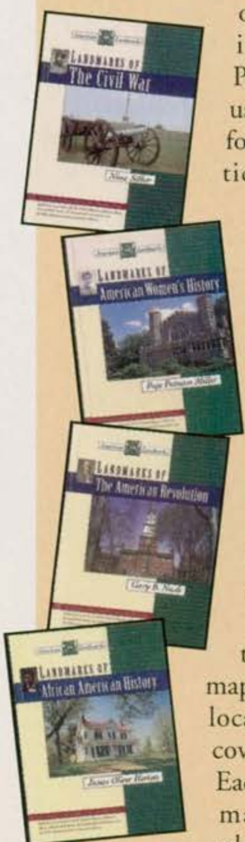
of the State House yard behind the building. The spacious yard, now a restful tree-shaded park in bustling Philadelphia, was to be divided into house lots after streets were run through the yard. The State House itself, along with its now-famous Liberty Bell, was to be sold as surplus property to the highest bidder. In 1802, Charles Willson Peale installed his museum of natural history and curiosities, and his menagerie munched quietly on the State House lawn.

In 1818, the city of Philadelphia came to the rescue of the State House. For $70,000, the city purchased the building and its large yard, but Philadelphians did not truly become interested in the building until 1824. This new affection arose from plans to celebrate the arrival of Marquis de Lafayette, who was on his first visit to the United States since he had fought with the American army nearly a half-century before. Planners for the celebration made the old State House the main site for welcoming the aging French compatriot and rushed to decorate the room where the Declaration of Independence and the Constitution had been drafted, debated, and signed.

Lafayette's visit made it clear that the State House was a precious bridge between the past, the present, and the future. Responding to the mayor's welcome, Lafayette referred to "this hallowed Hall" and to the "Birthplace of Independence," noting that "here within these sacred walls ... was boldly declared the independence of these United States," and "here was planned the formation of our virtuous, brave, revolutionary army, and the providential inspiration received that gave the command of it to our beloved, matchless Washington." Now this room acquired a new name—the Hall of Independence—and the timeworn State House acquired a new name—Independence Hall. With a new lease on life, Independence Hall was on its way to becoming a national icon. □

How To Use This Series

The *American Landmarks* series is designed to tell the story of American history from a unique perspective: the places where history was made. In every book, each chapter profiles a historic site listed on the National Register of Historic Places, and each site is used as the centerpiece for discussion of a particular aspect of history—for example, the Woolworth store in the Downtown Greensboro Historic District for Martin Luther King, Jr.'s role in the civil rights movement. This series is not intended as an architectural history; it is an American history.



In each book, there is a regional map of the United States locating the main sites covered in the volume. Each chapter contains a main essay that explains the site's historical importance; a fact box (explained next); and one or two maps that locate the site in the region or show its main features. Each chapter also contains a box listing sites related to the main subject. For each related site, the box includes the official name, address, phone number, Web site, whether it is a National Historic Landmark or part of the National Parks Service, and a short description. As much as possible, the related sites are geographically diverse and open to the public.

Many of the chapters feature primary sources such as letters, journal entries, legal documents, and newspaper articles. Each primary source is introduced by an explanatory note or a caption, indicated by the symbol (as shown on p. 41).

In the back of each book is a timeline of important events mentioned in the text, along with a few other major events that help give a chronological context for the book's theme. A list of further reading includes site-specific reading, along with general reading pertinent to the book.

Fact Boxes

Each chapter has a fact box containing reference information for its main site. This box includes a picture of the site; the site's official name on the National Register; contact information; National Register Information System number (which you can you use to obtain more details about the site); whether the site is a National Historic Landmark or part of the National Park Service; and important dates, people, and events in the site's history.

Oxford University Press partnered with the National Park Service, the National Register of Historic Places, the National Park Foundation, and the Gilder Lehrman Institute of American History to develop the American Landmarks *series. The complete series is listed below. Currently, four of the books—on the American Revolution, the Civil War, women's history, and African-American history—are available. The rest will be published over the next few years. The books are $30 each, but until December 31, 2005, AFT members can receive a 20 percent discount by calling Oxford University Press at (800) 451-7556 and mentioning the promotional code 24848.*

Landmarks of African-American History
Landmarks of American Immigration
Landmarks of American Indian History
Landmarks of American Literature
Landmarks of the American Presidents
Landmarks of American Religion
Landmarks of the American Revolution
Landmarks of American Science & Technology
Landmarks of American Sports
Landmarks of American Women's History
Landmarks of the Civil War
Landmarks of Liberty
Landmarks of the Old South

(Continued from page 22)

Which statement(s) should the sisters select as being true?
(Mark YES, NO, or I'M NOT SURE for each item below.)

	Yes	No	I'm not sure
a) 0 is an even number.	1	2	3
b) 0 is not really a number. It is a placeholder in writing big numbers.	1	2	3
c) The number 8 can be written as 008.	1	2	3

Figure 3. Item measuring common content knowledge

To measure the more specialized knowledge of mathematics, we designed items that ask teachers to show or represent numbers or operations using pictures or manipulatives, and to provide explanations for common mathematical rules (e.g., why any number is divisible by 4 if the number formed by the last two digits is divisible by 4).

Figure 4 shows an item that measures specialized content knowledge. In this scenario, respondents evaluate three different approaches to multiplying 35×25 and determine whether any of these is a valid general method for multiplication. Any adult should know how to multiply 35×25 (see our earlier example), but teachers are often faced with evaluating unconventional student methods that produce correct answers, but whose generalizability or mathematical validity are not immediately clear. For teachers to be effective, they must be able to size up mathematical issues that come up in class—often fluently and with little time.

Imagine that you are working with your class on multiplying large numbers. Among your students' papers, you notice that some have displayed their work in the following ways:

Student A	Student B	Student C
35	35	35
× 25	× 25	× 25
125	175	25
+ 75	+ 700	150
875	875	100
		+ 600
		875

Which of these students is using a method that could be used to multiply any two whole numbers?

	Method would work for all whole numbers	Method would NOT work for all whole numbers	I'm not sure
a) Method A	1	2	3
b) Method B	1	2	3
c) Method C	1	2	3

Figure 4. Item measuring specialized content knowledge

The claim that we can measure knowledge that is related to high-quality teaching requires solid evidence.

Although students are mentioned in this item, the question does not actually tap respondents' knowledge of students, or of how to teach multiplication to students. Instead, it asks a mathematical question about alternate solution methods, which represents an important skill for effective teaching.

Based on our study of practice as well as the research base on teaching and learning mathematics, analyses of curriculum materials, examples of student work, and personal experience, we have developed over 250 multiple-choice items designed to measure teachers' common and specialized mathematical knowledge for teaching. Many dozens more are under development. Building a good item from start (early idea stage) to finish (reviewed, revised, critiqued, polished, pilot-tested, and analyzed) takes over a year, and is expensive. However we regarded this as an essential investment—a necessary trade-off for the ease, reliability, and economy of a large-scale multiple-choice assessment.

Our aim is to identify the content knowledge needed for effective practice and to build measures of that knowledge that can be used by other researchers. The claim that we can measure knowledge that is related to high-quality teaching requires solid evidence. Most important for our purposes is whether high performance on our items is related to effective instruction. Do teachers' scores on our items predict that they teach with mathematical skill, or that their students learn more, or better?

Is There Knowledge of Mathematics for Teaching? What Do Our Studies Show?

We were fortunate to be involved in a study that would allow us to answer this question. The Study of Instructional Improvement, or SII, is a longitudinal study of schools engaged in comprehensive school reform efforts. As part of that study, we collected student scores on the mathematics portion of the Terra Nova (a reliable and valid standardized test) and calculated a "gain score"—or how many points they gained over the course of a year. We also collected information on these students' family background—in particular their socioeconomic status, or SES—for use in predicting the size of student gain scores. And importantly, we also included many of our survey items—including those in Figures 3 and 4—on the teacher questionnaire. Half of these items measured "common" content knowledge and half measured "specialized" content knowledge. Teachers who participated in the study by answering these questions allowed us to test the relationship between their knowledge for teaching mathematics and the size of their students' gain on the Terra Nova.

The results were clear: In the analysis of 700 first- and third-grade teachers (and almost 3,000 students), we found that teachers' performance on our knowledge for teaching questions—including both common and specialized content knowledge—significantly predicted the size of student gain scores, even though we controlled for things such as student SES, student absence rate, teacher credentials, teacher experience, and average length of mathematics lessons (Hill, Rowan, and Ball, 2005). The students of teachers who answered more items correctly gained more over the course of a year of instruction.

Comparing a teacher who achieved an average score on our measure of teacher knowledge to a teacher who was in the top quartile, the students of the above-average teacher showed gains in their scores that were equivalent to that of an extra two to three weeks of instruction. Moreover, the size of the effect of teachers' mathematical knowledge for teaching was comparable to the size of the effect of socioeconomic status on student gain scores. This was a promising finding because it suggests that improving teachers' knowledge may be one way to stall the widening of the achievement gap as poor children move through school. The research literature on the effect of SES on student achievement indicates that there tends to be a significant achievement gap when students first enter school and that many disadvantaged children fall further and further behind with each year of schooling. Our finding indicates that, while teachers' mathematical knowledge would not by itself overcome the existing achievement gap, it could prevent that gap from growing. Thus, our research suggests that one important contribution we can make toward social justice is to ensure that every student has a teacher who comes to the classroom equipped with the mathematical knowledge needed for teaching.

This result naturally led us to another question: Is teachers' mathematical knowledge distributed evenly across our

Teachers' performance on our knowledge for teaching questions—including both common and specialized content knowledge—significantly predicted the size of student gain scores.

sample of students and schools, regardless of student race and socioeconomic status? Or, are minority and higher-poverty students taught by teachers with less of this knowledge? Our data show only a very mild relationship between student SES and teacher knowledge, with teachers of higher-poverty students likely to have less mathematical knowledge. The relationship with students' race, however, was stronger. In the third grade, for instance, student minority status and teacher knowledge were negatively correlated, at $-.26$. That is, higher-knowledge teachers tended to teach non-minority students, leaving minority students with less knowledgeable teachers who are unable to contribute as much to students' knowledge over the course of a year. We find these results shameful. Unfortunately, they are also similar to those found elsewhere with other samples of schools and teachers (Hill and Lubienksi, in press; Loeb and Reininger, 2004). They also suggest that a portion of the achievement gap on the National Assessment of Educational Progress and other standardized assessments might result from teachers with less mathematical knowledge teaching more disadvantaged students. One strategy toward narrowing this gap, then, could be investing in the quality of mathematics content knowledge among teachers working in disadvantaged schools. This suggestion is underscored by the comparable effect sizes of teachers' knowledge and students' socioeconomic status on achievement gains.

Another arena for testing our ideas is in professional development. If there is knowledge of mathematics for teaching, as our studies suggest, then it should be possible for programs to help teachers acquire such knowledge. To probe this, we investigated whether elementary teachers learned mathematical knowledge for teaching in a relatively traditional professional development setting—the summer workshop component of California's K-6 mathematics professional development institutes—and, if so, how much and what those teachers learned (Hill and Ball, 2004). We explored whether our measures of teachers' content knowledge for teaching could be deployed to evaluate a large public program rigorously. We found that teachers did learn content knowledge for teaching mathematics as a result of attending these institutes. We also found that greater performance gains on our measures were related to the length of the institutes and to curricula that focused on proof, analysis, exploration, communication, and representations (Hill and Ball, 2004). In addition to these specific findings, this study set the stage for future analyses of the conditions under which teachers learn mathematical content for teaching most effectively.

One of the most pressing issues currently before us is whether specialized knowledge for teaching mathematics exists independently from common content knowledge—the basic skills that a mathematically literate adult would possess. Analyses of data from large early pilots of our surveys with teachers (Hill and Ball, 2004) suggest that the answer may be yes. Often we found that results for the questions representing "specialized" knowledge of mathematics (e.g., Figure 4) were separable statistically from results on the "common" knowledge items (e.g., Figure 3). In other words, correctly answering the kind of question in Figure 4 seemed to require knowledge over and above that entailed in answering the other kind correctly (e.g., Figure 3). This suggests that there is a place in professional preparation for concentrating on teachers' specialized knowledge. It may even support a claim by the profession to hold a sort of applied mathematical knowledge unique to the work of teaching. If this finding bears out in further research, it strengthens the claim that effective teaching entails a knowledge of mathematics above and beyond what a mathematically literate adult learns in grade school, a liberal arts program, or even a career in another mathematically intensive profession such as accounting or engineering. Professional education of some sort—whether it be pre-service or on the job—would be needed to support this knowledge.

Conclusions

Our work has already yielded tentative answers to some of the questions that drive current debates about education policy and professional practice. Mathematical knowledge for teaching, as we have conceptualized and measured it, does positively predict gains in student achievement (Hill, Rowan, and Ball, 2005). More work remains: Do different kinds of mathematical knowledge for teaching—specialized knowledge or common knowledge, for example, or knowledge of students and content together—contribute more than others to student achievement? The same can be said for building a knowledge base about effective professional development. Historically, most content-focused professional development has been evaluated locally, often with perceptual measures (e.g., do teachers *believe* that they learned mathematics?) rather than true measures of teacher and student learning (see Wilson and Berne, 1999). Developing rigorous measures, and having significant numbers of professional developers use them, will help to build generalizable knowledge about teachers' learning of mathematics. We emphasize that this must be a program of research across a wide sector of the scholarly community; many studies are required in order to make sense of how differences in program content might affect teachers, teaching, and student achievement.

These results represent progress on producing knowledge that is both credible and usable. In the face of this, the negative responses we have received from some other education professionals are noteworthy. Testing teachers, studying teaching or teacher learning, at scale, using standardized student achievement measures—each of these draws sharp criticism from some quarters. Some disdain multiple-choice items, claiming that nothing worth measuring can be measured with such questions. Others argue that teaching, and teacher learning, are such fine-grained complex endeavors that large-scale studies cannot probe or uncover anything worth measuring. Still others claim that we are "deskilling" or "deprofessionalizing" teachers by "testing" them. We argue that these objections run counter to the very core of the critical agenda we face as a professional community.

Until and unless we, as educators, are willing to claim that there is professional knowledge that matters for the quality of instruction and can back that claim with evidence, we will continue to be no more than one voice among many competing to assert what teachers should know and how they might learn that, and why. Our claims to professional knowledge will be no more than the weak claim that we are professionals and deserve authority because we say so, not because we can show that what we know stands apart from what just anyone would know. Isolating aspects of knowing mathematics different from that which anyone who has graduated from sixth grade would know, and demonstrating convincingly that this knowledge matters for students' learning, is to claim *skill* in teaching, not to *deskill* it. Making these arguments, too, is part of the challenge we face as we seek to meet the contemporary challenges to our jurisdictional authority.

Our research group's experience in working from and with problems of professional practice, testing and refining them with tools that mediate the power of our own convictions and common sense, is one example of the work of trying to build knowledge that is both credible and useful to a range of stakeholders. Many more examples exist and can be developed. Doing so is imperative in the current environment in which demands for education quality are made in a climate of distrust and loss of credibility. Meeting this challenge is a professional responsibility. Doing so successfully is essential to our survival as a profession. □

Unless we, as educators, are willing to claim that there is professional knowledge that matters for the quality of instruction and can back that claim with evidence, we will continue to be no more than one voice among many competing to assert what teachers should know.

Endnote

The research reported in this paper was supported in part by grants from the U.S. Department of Education to the Consortium for Policy Research in Education (CPRE) at the University of Pennsylvania (OERI-R308A60003) and the Center for the Study of Teaching and Policy at the University of Washington (OERI-R308B70003); the National Science Foundation (REC-9979863 & REC-0129421, REC-0207649, EHR-0233456, and EHR-0335411), and the William and Flora Hewlett Foundation, and the Atlantic Philanthropies. Opinions expressed in this paper are those of the authors, and do not reflect the views of the U.S. Department of Education, the National Science Foundation, the William and Flora Hewlett Foundation or the Atlantic Philanthropies. We gratefully acknowledge helpful comments by Daniel Fallon, Jennifer Lewis, and Mark Thames on an earlier draft of this paper.

References

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal, 93*, 373-397.

Ball, D. L. and Bass, H. (2003). Toward a practice-based theory of mathematical knowledge for teaching. In B. Davis and E. Simmt (Eds.), *Proceedings of the 2002 annual meeting of the Canadian Mathematics Education Study Group* (pp. 3-14). Edmonton, AB: CMESG/GDEDM.

Ball, D. L., Lubienski, S., and Mewborn, D. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematics knowledge. In V. Richardson (Ed.), *Handbook of research on teaching*, 4th edition (pp. 433-456). New York: Macmillan.

Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers.* Providence, R.I. and Washington, D.C.: American Mathematical Society and Mathematical Association of America.

Dewey, J. (1902/1956). The child and the curriculum. In *The child and the curriculum: The school and society* (pp. 3-31). Chicago: University of Chicago.

Hill, H.C. and Lubienski, S.T. (in press). Teachers' mathematics knowledge for teaching and school context: A study of California teachers. *Educational Policy.*

Hill, H., Rowan, B., and Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Education Research Journal, 42(2)*, 371-406.

Hill, H. C. and Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education, 35(5)*, 330-351.

Kilpatrick, J., Swafford, J., and Findell, B. (Eds.) (2001). *Adding it up: Helping children learn mathematics.* Washington, D.C.: National Academy Press.

Lampert, M. (2001). *Teaching problems and the problems of teaching.* New Haven, Conn.: Yale University Press.

Loeb, S. and Reininger, M. (2004) *Public policy and teacher labor markets: What we know and why it matters.* East Lansing: Education Policy Center, Michigan State University.

Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Wilson, S. M. and Berne, J. (1999). Teacher learning and the acquisition of professional knowledge: An examination of research on contemporary professional development. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of research in education* (Vol. 24). Washington, D.C.: American Educational Research Association.

Letters

(Continued from page 2)

kinesthetic learners was not very meaningful. Most of the measures that are purported to assess what sort of learner you are have no reliability or validity (in the psychometric sense). So the likely resolution of this puzzle is that, in the first phase of the experiment, the 25 percent of subjects who were categorized one way or another may have had a high score on one of the tests merely by chance. As I mentioned in the article, the determined theorist can always find a way to rework the theory so that it hasn't been disproved. This would be one way: to claim that an effective way of identifying visual, auditory, and kinesthetic learners has not yet been developed. Nonetheless, there's a large body of evidence indicating that all students learn more when content drives the choice of modality.

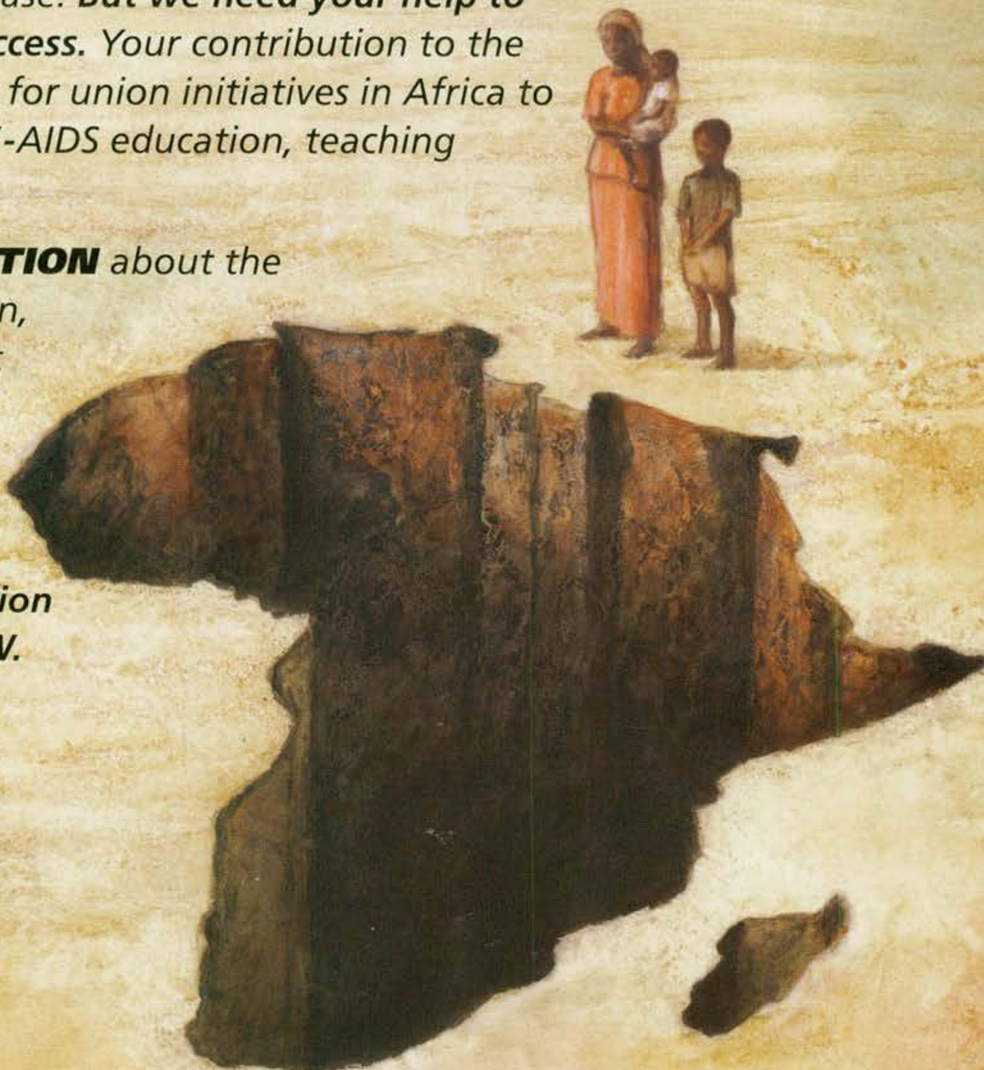
—Daniel T. Willingham

Let us know what you think!

We welcome comments on *American Educator* articles. Address letters to Editor, *American Educator*, 555 New Jersey Ave. N.W., Washington, DC 20001 or via e-mail at **amered@aft.org**. Letters selected may be edited for space and clarity and must include your complete address and phone number or e-mail address so we may contact you if necessary.

THIS YEAR IN SOUTH AFRICA, MORE THAN 1,000 TEACHERS WILL DIE OF AIDS. *In Zimbabwe more than 30 percent of the country's teachers carry HIV. Hundreds of thousands of schoolchildren have lost a parent to the epidemic. Throughout Africa, the statistics tell a similar story—**teachers' lives lost and whole education systems endangered**.*

THE AFT HAS LAUNCHED *a multi-year, multi-country campaign in partnership with African teacher unions to provide resources to fight the spread of this deadly disease. **But we need your help to make this campaign a success.** Your contribution to the campaign will go directly for union initiatives in Africa to provide resources for HIV-AIDS education, teaching materials, and supplies.*



FOR MORE INFORMATION *about the AFT-Africa AIDS Campaign, visit the AFT's Web site at* ***www.aft.org/africa_aids*** *or write to us at*
AFT-Africa AIDS Campaign
AFT Educational Foundation
555 New Jersey Ave., N.W.
Washington, DC 20001.