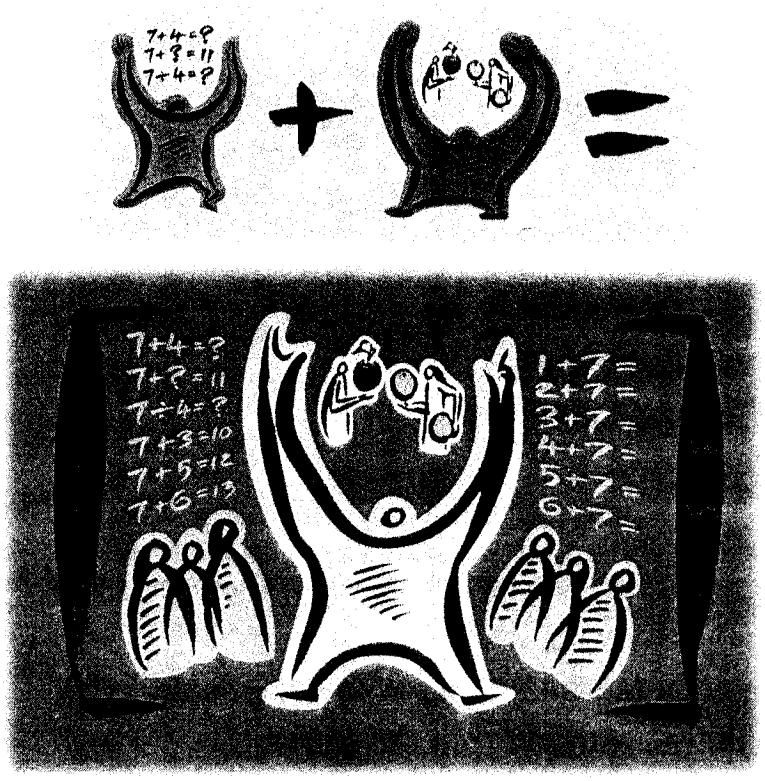

Peter Lui

Math Warriors, Lay Down Your Weapons

By Philip Daro

A recent analysis of mathematics performance yields some disturbing findings about U.S. student achievement. Although previous studies had suggested that American elementary students performed relatively well in mathematics, with older students doing less well, the new findings from the American Institutes for Research suggest that our 4th graders, too, are in the middle of the international pack. *(See Education Week, Nov. 30, 2005.)* Yet, even though our economic competitors outperform us, today's U.S. students do better than earlier generations of students. There has been a steady—but not steep—increase over the last two decades in mathematics performance, according to the National Assessment of Educational Progress. But we need to aim higher still. And we must look not to our own past for better results, but to our top competitors to understand how they have been able to outperform us.

Concern over previous international comparisons has prompted many educators and policymakers to launch ambitious efforts to strengthen mathematics instruction in high school. But some of the most popular solutions, such as instituting a requirement that all students take algebra in the 8th grade (and changing nothing else), may not solve the problem, and might make it worse.

The real math problem begins in elementary school, where too few students develop the foundations they will need to succeed in higher-level mathematics. It's clear from the new analyses of testing data that 4th graders have problems, and what they learn does not stick.

That's because of the way mathematics is taught in the early grades. Extensive research shows that American elementary schools teach arithmetic with a shortsighted focus on the problems within a chapter of a math book. Little thought is given to building the foundation for later chapters and grade levels. Children learn only specific procedures for specific problems, such as 7 + 4 = ___. Vary the problem slightly (7 + ___ = 11) and students do not know what to do. It is the relationships among problems (7 + 4 = ___; ___ + 4 = 11; 7 + ___ = 11; and 11 - ___ = 7) that lead to insights into arithmetic that will support, rather than undermine, learning algebra.

When students reach middle school, their teachers generally review the arithmetic learned in the early grades and teach it over again, in pretty much the same way. Then when students eventually get to algebra and geometry, their performance hits a wall because they don't understand the underlying concepts of arithmetic on which algebra and geometry are based. Students in the United States think of an equals sign as a form of punctuation: It marks the place to put the answer. They don't understand that the equals sign functions as a verb: It indicates that the quantity on the left has the same value as the quantity on the right. Teaching students how to solve the problem 7 + ___ = 11 lays the foundation for algebra, in which students

learn how to comprehend the equation 7 + x = y.

What's needed is a new way of teaching mathematics. Unfortunately, reforming elementary mathematics has been hampered by the sound and fury of the so-called math wars, that long-smoldering conflict pitting those who advocate teaching mathematics through real-world problems (what their critics call "fuzzy" math) against those who prefer an emphasis on basic skills (what their critics call "drill and kill"). These wars have stifled well-meaning attempts to improve mathematics teaching and learning, and their collateral damage—on young people's educational opportunities—has been severe.

Overemphasis of skills or of problem-solving leads to the neglect of the other. More important, it aids and abets the neglect of conceptual understanding. Skills, problem-solving, and concepts are all necessary. Each depends on the other two. In the United States, we overlook conceptual understanding, in part because we have been so distracted by superficial, math-war arguments.

Partisans in the math wars disagree about the causes of the problem (some preferring to focus on blame), and they disagree about the remedies. But they also agree on much, and particularly on the need for change. Ironically, the "wars" hand victory to the status quo.

Evidence from countries that perform well in mathematics shows that the war is phony. What's needed in mathematics is not one paradigm or another, but common-sense—and carefully engineered—changes in what we teach. The countries that do well in international comparisons do not choose between skills or problem-solving; they teach concepts and skills *and* problem-solving.

Effective teaching could help students overcome many of the common misunderstandings they bring to each new math class. Often, such misunderstandings arise because students have learned well in the way they were taught. A particular concept may have worked effectively for problems in the grade in which they were taught it, but does not work for problems in higher grades. The dictum "when you add, subtract, or multiply, line the digits from the right" works fine until you have to add 3.75 to 12.5.

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Likewise, using shaded sections of a pie to teach part-whole ideas about fractions is a good start. But it will lead to misconceptions when a student has to add 3/4 to 2/4 and sees each fraction as a pie with parts, getting an answer of 5/8 (5 shaded parts and 8 total parts). To develop a more general idea of "whole," students should move on to rulers, where the whole is the unit (inch), and fractions are fractions of the unit (inch), no matter how many inches are involved (3/4 inches + 2/4 inches = 5/4 inches). This is a deeper and more general idea of fractions that readily supports ideas about fractions on the number line needed for algebra. Teaching fractions this way would support, rather than undermine, the teaching of algebra.

Redesigning mathematics instruction also requires intervened in many ways to help students at varying reading levels reach standards, elementary school mathematics programs have tended to treat all students the same, in a sink-or-swim design. In secondary school, tracking kicks in. But tracking students consigns too many young people, particularly minority students, to dead-end sequences of courses that fail to prepare them for the future. Tracking is a failed solution to a real problem, and has evil consequences. But untracking takes us back to the original, unsolved problem of how to manage differences in preparation among students.

Some students do well in the regular program. Others do well, but need a little extra help. For these students, a homework clinic before or after school can keep them from falling too far behind. As one teacher put it, "A lot of kids we thought were a year behind were only 15 minutes behind."

Still other students struggle because of misconceptions that hamper their ability to perform mathematics effectively. And some students are so far behind that they need serious intervention to get them back on course.

The answer, then, is an intervention strategy that can respond to varying student needs. Such a strategy would include before- and after-school clinics that provide homework help for these students who are "15 minutes behind," targeted assistance to students with specific misconceptions, and intensive interventions for students who are far behind.

Some schools have taken lessons from other countries and put in place practices such as frequent assessments to understand student needs, along with new pedagogies to help all students understand mathematics. And these schools have seen impressive results.

Claire Pierce, a math coach at Summerville Middle School, in Summerville, Ga., says frequent assessments, along with time for teachers to analyze student work, make a difference in how teachers address student needs. "Our teachers know more about what our students do and don't understand than they ever have," she reports. "There are lots of opportunities for them to look at student work, listen to student conversations, and consider explanations they've made of why they took a certain approach."

Debbie Menard, the principal of Twin Lakes Academy Elementary School, in Jacksonville, Fla., says that enabling students to understand the concepts they are learning has led to spectacular improvements in student achievement. The proportion of 3rd graders at the school performing at level 3 or above on the state mathematics tests (scored on a 5-point scale) shot up from 59 percent in 2004 to 83 percent in 2005. "When you and I took math, we got the right answer and that was the end," says Ms. Menard. "Now students have to think and explain their answers."

Teachers in these schools and others like them know that concepts, problem-solving, and basic skills are all important. Their success should convince combatants in the math wars to lay down their weapons. Our students deserve a truce. ■

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