Early Detection Nips Math Problems in the Bud

A high school math testing program that started in Ohio shows that it's possible to improve math performance—and save money at the same time

AMID ALL THE ANGST ABOUT THE DISMAL state of science and math education in the United States, a program started by two Ohio educators 14 years ago is beginning to get a lot of attention. According to recent analyses, the program seems to be able to do the impossible: improve math achievement and save money while doing it. Small wonder, therefore, that the program, the Ohio Early College Mathematics Placement Testing Program (EMPT), has been spreading rapidly, mainly by word-of-mouth. It's now used in more than 600 high schools in Ohio, about 75% of the total, and has also been picked up by school systems in 15 additional states.*

EMPT uses an "early alert" test to warn junior year high school students of their math deficiencies in time for them to correct their shortcomings before graduation. Aimed primarily at college-bound students, the program has halved the need for remedial math courses in Ohio's major colleges and universities.

And it does this for peanuts, relatively speaking. The states spend about $2 to $3 for each student who participates in the program, and that is more than made up for by what they save in the cost of remedial mathematics courses.

EMPT dates back to 1977, a time when math educators already knew they had a problem on their hands. In Ohio and across the country, the scores on the math achievement tests administered to all high schoolers had been steadily plummeting since reaching a high in the mid-1960s. Concerned about the decline, the members of the Ohio state committee charged with running the tests the state used to assess the math skills of its high school students edged toward a classic squabble in a meeting held at the time. The university math contingent began blasting the secondary school teachers for failing to prepare their students adequately, and the high school teachers on the committee railed back that "ivory tower academicians" know very little about what it's like to teach math to adolescents.

Instead of fighting over the cause of the declining math abilities, however, two members of the committee had a better idea. Bert Waits, a mathematics professor at Ohio State University (OSU), and Albert Adcock, then chairman of the math department at Westland High School in Columbus, joined forces to develop a program—EMPT—that sought to correct the problem. At the heart of the program is a test that students can take, on a voluntary basis and usually during their junior year, to identify their math deficiencies. The test is typically given during a 1-hour English or history class to snare as many students as possible. It has sections on algebra, trigonometry, and geometry, which can be scored separately.

In the early days of the program, Waits used to deliver the test results to the participating schools himself. Now EMPT is so widely used, he can no longer give participants that kind of individual attention, but the program still has an important personal dimension: The results are given personally to students by their guidance counselors or math teachers, and, unlike the national standardized tests, EMPT defines inadequacies in terms of a student's own career goals.

A student who plans to major in history, for example, might be judged well prepared in math even though he or she does poorly on the trigonometry section of the test, while a prospective economics or engineering major with the same score might be judged in need of more training. Moreover, the school guidance counselors then advise students who have done poorly on one or more sections of the test on what high school math courses need to be mastered before graduation if they are to have a reasonable chance of success in their chosen college majors.

"The Ohio EMPT offers a good tool for informing high school students what to expect in college," says John Luker of the University of Illinois, who directs that state's program. "Most important," he adds, "it encourages students to enroll in senior-level high school math."

After the first group of juniors was tested

*Arizona, Illinois, Louisiana, Maryland, Michigan, Missouri, Nebraska, New Hampshire, New Mexico, Oklahoma, Oregon, Pennsylvania, Rhode Island, Washington, and Wisconsin.

How's your high school math?

1. If $\frac{2}{3} - \frac{1}{2} = \frac{y}{4}$, then y =

   (A) 3/2 (D) 2/3

   (B) 1/12 (E) none of these

   (C) 1

2. If the equations $2x + 2y = 9$ and $2x - y = -3$ are solved simultaneously, the value of x is found to be:

   (A) -1/2 (D) -2

   (B) 1/2 (E) none of these

   (C) 2

3. If $x^2 + kx + 10 = (x + 2)(x + 5)$, then k =

   (A) 2 (D) 7

   (B) 5 (E) 3

   (C) 10

4. In triangle ABC, angle C is a right angle with $a = 6$ and $c = 12$. What is b?

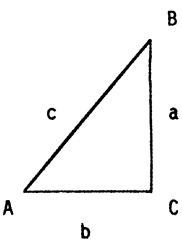
   (A) $6\sqrt{3}$

   (B) 6

   (C) $6\sqrt{5}$

   (D) $6\sqrt{7}$

   (E) 9



5. After a 15% reduction, the sale price of a knife was $5.09. Before the reduction the price was:

   (A) $5.85 (D) $6.21

   (B) $5.90 (E) $5.99

   (C) $4.32

Answers: (1.) B; (2.) B; (3.) A; (4.) D; (5.) E.

An EMPT sampler. *Try your skills on a selection of problems from an outdated test.*

in Ohio in 1977–78, they increased their math enrollment in the following year by 73% compared to senior math enrollment the year before. More recent surveys show that increased enrollment in senior-year math has been sustained at a level of 40% to 45%. Apparently, when the students have their deficiencies presented to them, with explanations of the potential impact on their college and career goals, they have a powerful motivation to take corrective action while still in high school.

"Raw scores don't have the impact of this type of personalized information," says Joan Leitzel, who participated in the early development of EMPT when she was on the OSU faculty, but has since become division director for education and human resources at the National Science Foundation. "Even though students are inclined to relax during their senior year of high school, they don't like the thought of spending the first year of college taking noncredit courses. And their parents don't like paying for it."

Indeed, EMPT graduates do better on college placement exams than students who haven't participated in the program and, consequently, they need fewer remedial courses. At OSU, for example, about 25% of students from non-EMPT schools need remedial math compared to only about 13% of the program's participants. Largely as a result of EMPT, the percentage of freshman taking the remedial courses at OSU has declined from 47% in the late 1970s to 20% now, says Waits.

And that's saved money for the state. During the late 1970s, says Waits, "The [state] legislature was spending $10 to $12 million annually on remediation at the university level." But the annual cost of EMPT in Ohio is only about $200,000. Although the program was originally funded by OSU and a local Columbus foundation, the Ohio legislature, gratified by the declining need for remedial math, now picks up the modest costs.

The program has other, more intangible benefits as well. One of these is the establishment of a friendly, ongoing dialogue among high school math teachers, guidance counselors, and college math faculty—a marked improvement over the tensions of the 1970s. "Now, university staff tend to look upon high school staff as professional colleagues," says Adcock, still a math teacher at Westland High. "The success of the program has a lot to do with the personalities of the people involved. The OSU people respect the experience of the high school staff."

Although the EMPT focused strictly on math assessment at first, in recent years it has moved on to develop courses and other means of upgrading the abilities of high schoolers. The most recent effort in this regard is a "Calculus Readiness Course," which relies on computers and graphics to encourage problem-solving and give students a more intuitive sense of math. The course helps the students to anticipate the demands of higher math, says Waits.

Kenneth Wilson of OSU, a Nobel laureate in physics, is among those enthusiastic about EMPT's new direction. The program's earliest efforts, which focused on the students in trouble, did nothing, he says, to spur enrollment in graduate level sciences. "But," he predicts, "the latest developments, which encourage interest in precalculus in high school, could generate new majors in the sciences." ■ ANNE SIMON MOFFAT

And the Winner: Cetus Does Own PCR

Round 1 in a David and Goliath struggle between Cetus Corp. and DuPont over the polymerase chain reaction (PCR) is over and the winner is: biotech small fry Cetus. Last week in U.S. District Court in San Francisco, a six-member jury upheld two Cetus patents on the revolutionary technique for amplifying rare DNA sequences that was developed at Cetus in the mid-1980s. The jury failed to buy DuPont's claim that PCR was already in the public domain because it was outlined in papers by a Massachusetts Institute of Technology professor a decade before Cetus developed it.

Now that that verdict is in, Round 2 is coming up: a second trial to determine whether DuPont has been infringing the patents by selling kits and reagents based on the chemical reaction that underlies PCR. If they have, DuPont may have to cough up damages based on its income from the kits.

> ***"PCR has always belonged to Cetus. The jury's verdict completely vindicates our position."***
>
> —RONALD CAPE

Last week's decision promises to be a big financial shot in the arm for Cetus. Sooner or later PCR is likely to generate a market worth hundreds of millions of dollars—income Cetus badly needs after the Food and Drug Administration failed last summer to recommend approval for its other promising revenue generator, the recombinant cancer drug interleukin-2.

DuPont's case rested on the argument that PCR had been described in a series of papers from the lab of H. Gobind Khorana in the early 1970s (*Science*, 15 February 1991, p. 739). Although some big-name scientists, including Arthur Kornberg (who won a Nobel Prize for work on the class of enzymes that power PCR), went to bat for DuPont, many biotech analysts felt DuPont had little chance. One reason is that last summer the U.S. Patent Office reexamined the PCR patents and found that the Khorana papers did not invalidate them.

"We still feel the patent office is wrong," says DuPont attorney George Frank. He says DuPont had a particularly "hard row to hoe," since it bore the burden of proof and its arguments were based on highly technical papers that even experts in the field can't agree about.

Cetus, on the other hand, is celebrating a success it says it expected all along. "PCR has always belonged to Cetus," says the company's CEO, Ronald Cape. "The jury's verdict completely vindicates our position."

No date has yet been set for the next trial—on infringement—and Cetus attorney Peter Staple declined to speculate on how large any award for damages might be, although he did note that the amount could be tripled if Cetus can prove DuPont willfully infringed a patent they knew to be valid. In the meantime, Cetus has requested an injunction to keep DuPont from selling its DNA amplification products.

And if two rounds aren't enough for these punch-drunk opponents, there may be yet another rematch—on an aspect of PCR technology not covered in the first trial. In January Cetus filed a suit claiming that DuPont had infringed a recent PCR patent on the use of heat-stable enzymes to streamline DNA amplification. Although the suit was put on hold while the first one went to trial, Staple said, Cetus now expects to push it forward if they have to. ■ MARCIA BARINAGA