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FOCUS ON: CURRICULUM & ASSESSMENT

Technology Helps Teachers Home In on Student Needs

Test scores have risen since middle schools started using system

BY SEAN CAVANAGH
Canton, Ohio

Like many teachers, Jim Pukys is accustomed to posing a fundamental question to students at the end of each algebra lesson: Did you understand?

Unlike most teachers, though, he believes he has a reliable way of knowing whether his students are telling him the truth. It begins when he writes out a function and asks students to find its value. He then collects their answers, which they send electronically from calculators at their desks. Within seconds, an image appears on a screen at the front of the class, showing how many students picked the right answer: about two-thirds of them on one recent occasion.

Not good enough, he decides. He goes over the problem again, in greater detail.

That interplay has become routine in the Canton city school district, and it is becoming increasingly common in mathematics classrooms across the country, as teachers turn to interactive technology that provides them with instant information about student progress.

Technologies like TI-Navigator, sometimes called "personal response" systems, enable teachers to gauge whether students—not just as a group, but also individually—have grasped a math concept. Teachers then can adjust their lessons in midstream when problems persist.

"As a teacher, you find that in any class there are two or three kids who can get every answer, and those are the kids you hear from," Mr. Pukys said last month during a break from his 8th grade algebra class at Crenshaw Middle School. "I have a class of 25 students," he said, and with the technology, "I can hear answers from all 25, rather than just two or three of them."

The approach seems to be showing results. Two years ago, this 11,000-student, largely working-class district launched a program in its middle schools to use graphing calculators in combination with TI-Navigator, both designed by Dallas-based Texas Instruments. Graphing calculators, sold by a number of companies, have been fixtures in math classes since the early 1990s. Texas Instruments officials estimate TI-Navigator is used in 2,300 of the nation's nearly 15,000 districts; other companies have developed similar technologies, industry experts say.

Since schools here began using the technology, Canton's math scores in the 6th, 7th, and 8th grades on the Ohio achievement test, which previously lagged well below state standards, have risen, nearly doubling at some schools. Canton officials were sufficiently encouraged by those results to add TI-Navigator in the district's two high schools.

Quick Feedback

Educators have long debated the proper role of calculators and technology in math classes. A federal advi-

Courtesy of Texas Instruments

Tech Trend

The proportion of students scoring at or above "proficient" on Ohio's 8th grade achievement test has risen in Canton's middle schools since they began using technology and graphing calculators in classes.

	2004-05	2005-06
Crenshaw Middle School	45.8%	62.7%
Hartford Middle School	22.0	48.3
Lehman Middle School	31.7	57.1
Souers Middle School	47.8	52.9

SOURCE: Ohio Department of Education

Texas Instruments puts out one line of "personal response" systems and graphing calculators that teachers can use to gain quick access to students' understanding of math concepts. Teachers can then tailor instruction accordingly.

sory panel commissioned by President Bush this year is discussing calculator use as part of a broader review of effective strategies for improving teaching and learning in the subject. *(See Education Week, Feb. 15, 2006.)* Critics have complained that schools promote those tools, especially at earlier grade levels, at the expense of cultivating students' basic computational skills and their ability to solve problems using paper and pencil. A 2005 report by the Washington-based Thomas B. Fordham Foundation, for instance, concluded that students' ability to graph linear functions by hand are "easily camouflaged by the obsessive use of graphing technology."

Teachers in Canton, however, believe technology is sharpening students' skills. The district introduced TI-Navigator and graphing calculators in the 2004-05 school year as part of a broader attempt to change the way math is taught, aimed at making teachers less reliant on textbooks and more focused on addressing crucial math concepts found in Ohio's state standards. Those standards in turn serve as the basis of the state's achievement test.

A central change was the desire to test students skills' more often—not necessarily through graded exams at the end of courses or units, but rather through smaller, ongoing quizzes and problems to help teachers determine whether students were learning. That smaller-scale testing is sometimes called "formative assessment"—an approach that has drawn increased interest from educators nationwide in recent years as a way to raise student test scores.

"Teachers always used to tell us in school, 'Show your work,' " said Elliot Soloway, a professor of computer science at the University of Michigan, in Ann Arbor. Mr. Soloway, who also owns a school technology company, once worked as a paid consultant to Texas Instruments, though his work was unconnected to the Navigator system.

"They did that for one reason," he said, "to see if you understood the material. Unfortunately, they might not know that until four days later. Moment-by-moment assessment is a very new capability."

Technological innovation does not come cheap. TI-Navigator costs about $9,500 per class in Canton, when

the price of all equipment is included, said Pam Bernabei-Rorrer, the district's math coach. The district launched the technology with a combination of about $360,000 in federal funding. That support was essential in a district that has seen its enrollment steadily decline over the years, as job losses in the steel industry and manufacturing have ground away much of this midsize city's economic engine. Today, 70 percent of the district's students receive free or reduced-price lunches.

"The teachers believe in it," Ms. Bernabei-Rorrer said of the technology. "They have a sense of ownership."

Mr. Pukys, in his 16th year in the district, is one such convert. He and other teachers went through extensive training sessions led by Ms. Bernabei-Rorrer, who, along with a few Canton teachers, was coached on TI-Navigator by Texas Instruments' staff in Dallas.

During the recent class, Mr. Pukys directed students through a lesson on functions and graphing with the help of the Navigator, standing alongside a white screen at the front of his class, occasionally tapping commands into a laptop computer at his side.

Students worked on graphing calculators at their desks, which connected to "hubs," or small gray boxes, that collect data and send it to the teacher's laptop and the white screen. In Mr. Pukys' class, the hubs hung from the ceiling, with wires connecting to students' calculators below, like IVs in a hospital room.

Checking Progress

Mr. Pukys displays an image of the x- and y-axes on the big screen, with a line crossing through them, then asks: Is the line a function, yes or no? Students respond by clicking buttons on their calculators, through a Navigator program called Quick Poll.

From her seat near the back, Samantha Knisely, 13, enters "yes" on her calculator. A moment later, Mr. Pukys collects the results, which he displays on the overhead screen. All 24 students gave the same answer as Ms. Knisely—the correct response.

The next task is tougher. The teacher gives the students four separate questions on functions and graphing, then asks them to respond, through a Navigator device called Learning Check. Mr. Pukys could have sent them the questions electronically, but instead hands them out on a piece of paper, asking the students to write down their work, then enter their answers into their calculators.

When the responses have come in, Mr. Pukys takes the class through each problem, answering questions, correcting mistakes. He then posts students' scores on the four-question quiz on the screen. Students are identified by user names, rather than their real names. (Last year, Samantha's user name was "Sam"; this year she has a new one.) A few of her friends know her user name, though mostly students are paying attention to their own scores. Mr. Pukys keeps a list of students' screen names.

"It's better this way," Ms. Knisely says of the pseudonyms. "People get excited when they get a good score, …[but] if I do badly, I don't want people to know."

Mr. Pukys sometimes enters students' scores from Learning Check in their course grades. He can also have the students type their homework answers into the Navigator system and score the results.

TI-Navigator allows students to see their mistakes and correct them, he says. Mr. Pukys likes to put a computer image of the St. Louis Gateway Arch on the screen, then ask students to write a quadratic equation describing its shape. Students' individual answers appear as separate, colored arches on the wide screen. He then asks students whose arches are off to modify their equations until they have the correct arch.

Like many Canton teachers, Mr. Pukys uses a touch-screen designed by SMART Technologies Inc., which can connect with the Navigator. Some teachers use a more basic projector screen.

Some students try to buck the system, of course. An 8th grader in another math class, when asked to complete an algebra problem, types "IDK, IDC" into his calculator, which shows up on the class screen—shorthand for "I don't know, I don't care."

Those challenges aside, teachers like Sam Studer, at Souers Middle School, say the technology has made it easier to identify struggling students quickly and set up a plan to help them. "I'll make time after class," he said, "or I'll pull five or six of them and get them together."

When Mr. Pukys' class ends, students return their calculators to numbered pouches hanging at the front of his room. Some school officials used to worry that the devices—which sell for $70 to $140, depending on the model—would be lost or stolen, but so far that hasn't happened, Ms. Bernabei-Rorrer said.

"The kids don't want to lose this equipment," she said. "There's been that peer pressure."

Costly Endeavor

Canton received separate grants for $250,000 and $110,000 to launch the TI-Navigator and calculator program, both from the U.S. Department of Education. Melendy Lovett, the president of educational and productivity solutions for Texas Instruments, said her company has helped other districts find grants from public- and private-sector sources.

After the initial purchasing costs, the district has had to spend little money on the system, Ms. Bernabei-Rorrer said. Texas Instruments provides free upgrades of all the equipment, she noted. Even so, cost would be

a major obstacle for many districts, particularly cash-strapped ones thinking of buying the technology, she said.

"To take away from the bare bones of a district to pay for it would be difficult," Ms. Bernabei-Rorrer said. "That's why you have to look for grant funding."

Most math teachers—even the least tech-savvy ones—would be willing to embrace technologies like the TI-Navigator, because of such potential benefits, Mr. Pukys believes. He cites his own technological journey as an example. He graduated from high school in the mid-1980s without ever having used a computer in class. When he began using TI-Navigator in the classroom, he kept a cheat sheet at his side, listing the functions of his laptop's various buttons; after a few days, he found he didn't need it.

"Three years ago, all the [technology] I had was an overhead projector in my class," he said. "Now, I've got $10,000 worth of equipment."

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