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# Winning Equation: How Technology Can Help Save Math Education

**A national panel recommends technology to fix a broken system. Here's how some teachers are using math tech.**

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Math education in the United States is a broken system. So says a national panel of experts convened by President Bush, which warned of the disastrous effects this run-down system will have on individual and national success -- unless we introduce markedly different teaching strategies.



Credit: Corbis

During most of the twentieth century, the United States dominated the math field with its output of important mathematicians and its great strides in engineering, science, and finance. But the depth of the country's decline is apparent in some frightening statistics: Less than one-third of eighth-grade students and fewer than one out of four seniors now test as proficient or better for math, according to recent National Assessment of Education Progress reports.

The number of U.S.-educated people prepared to take on technologically challenging jobs is dwindling due to a stuffy education system, but it may be that tech tools are just what we need to help turn things around.

In its final report, "Foundations for Success," the National Mathematics Advisory Panel recommended technology to freshen up a tired curriculum, noting that "technology-based drill and practice and

tutorials can improve student performance in specific areas of mathematics." The report also said student achievement is higher in classes that use instructional software than in those that do not. And the report cited studies that show teaching computer programming to students can support the development of particular mathematical concepts, applications, and problem-solving skills.

The panel didn't recommend specific technologies, but for the past few years, nonprofit organizations, learning labs, and academia have been providing math teachers with a steady stream of high tech toys.

## Personalized Practice

Every other week, Judy Murphy, math department head at Burncoat Middle School, in Worcester, Massachusetts, takes her students to the computer lab to use the Assistment system, an online program that provides students with one-on-one tutorials. Teachers can tailor the program to fit specific curricula, and Murphy's students use it to practice the state's math-assessment test questions.

If students answer a problem incorrectly, the program may give them a review session, and afterward, it tests them on a similar question to gauge whether they've learned the material. For students who answer multiple questions correctly on the first try, the program may skip tutorials to move them on to a more challenging lesson.

"What the technology can do is track the different approaches students are taking and give them guidance," says Ken Koedinger, director of the Pittsburgh Science of Learning Center, who likens Assistment to Cognitive Tutor, a program with a similar concept. Koedinger notes that although students are getting focused attention from the computer, the teacher is free to spend more time with those who need extra help.

But the most helpful aspect of the Assistment system and Cognitive Tutor, teachers say, is their ability to track the strengths and weaknesses of individual students and the class as a whole. "I can get a report that shows me how many students got a certain problem wrong, and now I can bring that back into my classroom and use that to guide my instruction," acknowledges Murphy. "Being able to see how many students ask for help is key. It lets me zone in on what students really need help with."

## Help Solve for X

And what students most need help with, according to the panel, is algebra. The report highlights algebra as a "demonstrable gateway to later achievement" and says completion of Algebra II "correlates significantly with success in college and earnings from employment." Students who complete Algebra II are more than twice as likely to graduate from college as students with less mathematical preparation, the report says.

One technology that jump-starts algebraic thinking for middle school students is SimCalc, a program that uses computer-based graphs, animation, symbols, and tables to make difficult concepts, such as mathematical rates of change and accumulation, easier for students to learn.

In one SimCalc tutorial about a soccer team, students can control the players' movements by manipulating a graph with a mouse. In another tutorial, changing the graph allows students to choreograph a rap routine for a group of avatars, or online characters. "The really unusual thing is its ability to shape a graph to let you see its meaning in motion," says Jeremy Roschelle, director of research institute SRI International's Center for Technology in Learning. "It can then relate that to

algebraic equations, and the kids get to tell stories about it."

SimCalc also incorporates a motion detector, which can graph students' velocity or acceleration as they move. "It's making the reading of graphs, and the area of them, second nature to middle school kids," explains George Collison, consultant for the Concord Consortium, a nonprofit educational research and development organization that focuses on technology. "These are skills they would normally get, if they ever got to them, in the senior year of high school."

## Less Can Be More

The graphing calculator is a piece of technology simpler than a computer that consultants and teachers nevertheless say not to overlook. Such calculators now come equipped with software that allows students to draw shapes and plot points on the screen.

"I love computers, but often it's difficult for teachers to schedule the labs, and graphing calculators are less expensive, so everyone can have one," says Diane Carluccio, mathematics and technology consultant for the Stevens Institute of Technology's Center for Innovation in Engineering and Science Education. "You can draw shapes and then learn all the postulates and theorems. The possibilities are endless."

The panel's report neither confirmed nor negated evidence suggesting graphing calculators help students learn, but teachers say such calculators help with what the report termed "math anxiety." That's because a teacher can ask students to write a particular equation on their calculators and then project their answers anonymously onto a screen in the front of the room. "You're not signaling out kids who are good or bad. You're showing what's right or wrong, so you're decreasing anxiety," explains SRI's Jeremy Roschelle. "It gets them much more engaged and creates an environment that's proactive."

## Make Abstractions Accessible

Still, not everyone is sold on high tech math tools, as some teachers and parents fear technology will take the place of students actually learning the skills themselves.

Technology proponents respond that these tools can be more than a crutch: They can turn the abstract into something more concrete, helping students understand concepts, like those in algebra, that are far removed from the physical world.

"A graph becomes the surrogate for the motion of an avatar," says the Concord Consortium's George Collison. "One manipulates the graph and finds the avatar moves. It's making the abstract an object of discourse. Students can explore dynamic relationships, which is simply not possible without these machines."

And in the end, advocates say it's not just about how technology can enhance understanding but also about a need to keep classes current. "We have kids sitting in rows in the classroom, and they're bored to tears. It's just not the way they live," notes Carluccio. "Teachers and parents need to understand that this is the life of children today. They have to really understand that it's important for kids to be engaged, and it's important for us to change with the times."

If teachers can continue to find ways for technology to help their students acquire key math skills and understand difficult concepts -- as promoted in the panel's report -- then keeping pace with the times can

mean the triumph of good, old-fashioned learning, too.

**Lauren Smith, a freelance writer for education-focused publications, has reported for the *Chronicle of Higher Education*, the *Bangor Daily News*, and the *Scripps Howard News Service*.**

## Advice for Educators: Start Using Math Tech

The National Mathematics Advisory Panel points out that technologically driven tutorials are successful when they're designed to help specific populations of students meet specific goals. For this reason, it warns teachers to be careful that the software they use has been proven successful for students like theirs.

"Educators should critically inspect individual software packages and the studies that evaluate them," the report cautions. In the following responses, the heads of educational companies and nonprofit organizations offer advice on how to get started using technology to bolster math classes:

"Do some professional development. Seeing Math is available from Teachscape and PBS's TeacherLine, which has a lot of online professional-development tools.

"Generally, the big problem is funding the actual computers. And that's where the Texas Instruments graphing calculators, which cost \$80-\$100, come in. Almost every state has funds available for supporting technology and supporting things that go with it. It's never enough, but schools that have a "Go get 'em" attitude can do it."

-- *Robert Tinker, president of the Concord Consortium*

"There's so much out there to try, but be careful about what's been done with technology before. Find out what works and what doesn't work, and build off of best practices. There's plenty of room for creativity in doing it your own way. Copy from the best, and then you can put your stamp on it."

-- *Ken Koedinger, director of the Pittsburgh Science of Learning Center*

"There are a couple of good places to start. One is Drexel University's Math Forum. It has an excellent collection of support and advice for teachers. I recommend that teachers look at what the National Science Foundation has researched. But be cautious about some of the commercial messages, because some of the technologies are not proven. Get professional-development help. It's all about how you use the technology, and you need to feel comfortable with it.

-- *Jeremy Roschelle, director of SRI's Center for Technology*

"First, go to workshops. Attend events such as the National Council of Teachers of Mathematics conferences, many of them technology based, which are held several times during the year.

"Also, school districts need to do a better job providing for their teachers' professional development in using technologies. In some cases, districts just bring in someone for a onetime workshop, and that's it. That won't work. It needs to be ongoing."

*-- Diane Carluccio, consultant at the Center for Innovation in Engineering and Science Education, Stevens Institute of Technology*

"I am suspicious of using games as a way for computers to teach math. I'm fond of saying that kids pay a lot of attention to ice cream and like ice cream, but we wouldn't use it to teach them math. I think that there is potential with games, but it's much harder than people think. Teachers should start with technology that's important to them. Find good lesson plans. Start with things that matter to you as a teacher. Then look at what technology would be good for your students."

*-- Larry Berger, CEO of Wireless Generation*

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