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R&D Project on Algebra Software Seen to Show Promise

By ANDREW TROTTER

Computer software that shows students visual models of mathematical concepts—and lets them manipulate those models by doing math—has a certain intuitive appeal.

Now, recent research on SimCalc MathWorlds, one of the pioneering examples of such software, is providing some of the best evidence so far that the approach can lead to gains in student learning.

Data released last fall by the Menlo Park, Calif.-based nonprofit research organization SRI International, from a scientific study of 7th grade algebra students in Texas, show “large effects” from the use of SimCalc, when it is bolstered by professional development and a curriculum that are both geared to the state’s math standards, according to the researchers.

And the still-unreleased findings from the study’s second year, involving additional 7th graders and 8th graders, showed similarly positive results, they claim.

Data from a separate study of Massachusetts high school students that combined the use of SimCalc with graphing calculators linked by an in-class communication tool, published last week by the University of Massachusetts Dartmouth, also show benefits.

The university owns the software, which was originally designed by a professor there with funding from the National Science Foundation and has been worked on since by various researchers, including the principal investigators of both the Massachusetts and Texas studies. Neither study has yet appeared in a peer-reviewed journal.

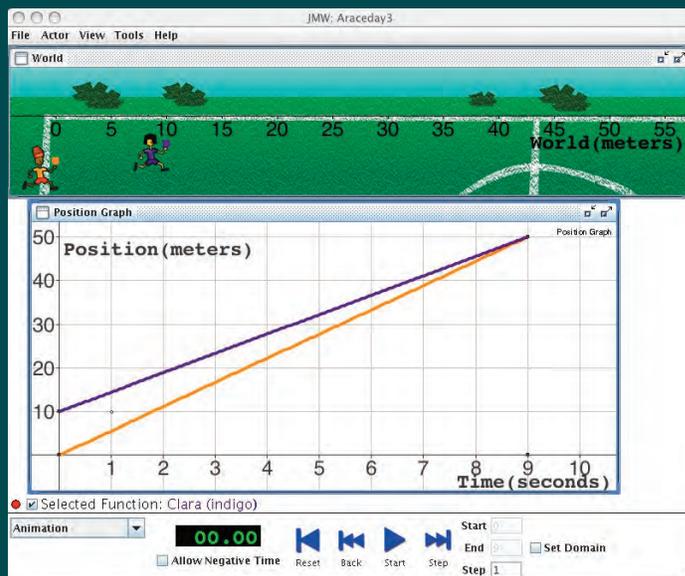
Still, based on the preliminary positive findings, the U.S. Department of Education has provided a \$2 million grant to the university to conduct a four-year longitudinal study starting this fall on the use of SimCalc with graphing calculators and computers linked via a wireless network.

Tested in Texas

SimCalc is designed to be used in Algebra 1 and 2, as well as precalculus, with students in middle and high school. The software is made available free to teachers, and different versions of it run on computers, graphing calculators, and other hand-held devices.

Francis “Skip” Fennell, the president of the National Council of Teachers of Mathematics, said he was “encouraged by the preliminary findings” on SimCalc.

Graphic Illustrations



Stephen J. Hegedus, the director of the James J. Kaput Center for Research and Innovation in Mathematics Education, works with 9th graders using SimCalc MathWorlds at Dartmouth High School.

In one 7th grade SimCalc activity, students control two runners by adjusting the slopes of the colored lines in the graph. By running the animation students see how slope relates to speed.

Kindra Clineff

But citing an upcoming survey of algebra teachers commissioned by the federal government's National Mathematics Advisory Panel, he said it was "very vexing" that more math teachers are not using the kinds of technology, such as graphing calculators, for which SimCalc was designed.

SRI's study of Texas 7th graders included 1,600 students and 95 teachers from 74 schools during the 2005-06 school year.

The schools were randomly assigned to use either SimCalc or their usual textbooks for a two-week unit on rate and proportionality, concepts fundamental to algebra and higher math.

The concept of rate, for example, is used in two related concepts, one representing position or accumulation and the other the degree of change, speed, or interest, said Jeremy Roschelle, who led the study and worked on SimCalc at the University of Massachusetts Dartmouth in the 1990s before joining SRI. "Understanding those as separate and related mathematical entities is extremely challenging for students," he said.

Both versions of the unit were targeted to meet the state's math standards, and teachers in both groups received three days of professional development.

On tests before and after the unit, the students using SimCalc on average increased their scores by 46 percent, the study says. By contrast, students using the typical Texas curricula on average increased their scores by 19 percent.

The average SimCalc student moved from the 50th percentile to the 80th percentile on a test of proficiency in those math concepts.

Gains in understanding of rate and proportionality were particularly pronounced in questions involving more-advanced, conceptually difficult mathematics, the researchers said.

Since those findings were released in May, SRI has compiled second-year results from the 7th grade classrooms with 1,199 students and the first-year results from a parallel 8th grade study of 825 students, with similar positive findings, the researchers said.

Janis Whitehead, a 7th grade teacher in the Texas study, said students in her accelerated, regular, and "success program" for struggling students all benefited from using the software.

"My accelerated kiddos—by the second week, they were picking up on slope," she said. "The lower kids—proportionality, they finally got it."

Ms. Whitehead, who teaches at Big Spring Junior High School, in Big Spring, Texas, said she was lucky because she had 10 laptop computers in her classroom. "That's probably the reason I was sold on it," she said of using SimCalc. "I didn't have to make arrangements to go to a lab and didn't have to go to a lab."

Douglas H. Clements, a professor at the University of Buffalo in New York who was not involved in SimCalc's development, said the experimental study in Texas had positive features, in that it involved "lining up professional development and curriculum, and embedding the software within a curriculum that is consistent with that software's approach."

"The whole notion of this multiple representation and linked representation really does have power," said Mr. Clements, who is a member of the National Mathematics Advisory Panel. "These things are really important."

The Massachusetts study focused on Algebra 1 classrooms in high schools in districts in southeastern Massachusetts. Classes used the SimCalc software on graphing calculators connected to their teachers' computers via a wireless communication system called TI Navigator, by Texas Instruments Inc..

The arrangement let students create and manipulate visual models in SimCalc and allowed them to engage in a sort of digital mathematical dialogue that complemented class discussion, according to Stephen

J. Hegedus, an associate professor of mathematics at the University of Massachusetts Dartmouth, who was the principal investigator in the study and has helped develop SimCalc over the past 10 years.

Students often worked individually or in small groups, making graphical representations of math concepts, but the teacher could use the Navigator system to collect their work and combine it with that of other students and project it on a screen for the entire class.

Students Motivated

Mr. Hegedus said the Navigator system "transforms the ways students can communicate." In a traditional class, "most of the interaction is teacher-student," he said.

For the unit, which could last from three to six weeks, the classes focused on core algebra ideas, such as linear functions, simultaneity, and slope. In all those areas, the study found improvements in the SimCalc group beyond those made by the comparison group that did not use the technology, the researchers said.

Cathleen A. Marchessault, a math teacher involved in the Massachusetts study, has used the combination of SimCalc with calculators and the TI Navigator system for five years, with grades 9-12.

Ms. Marchessault, who teaches at the 1,200-student Dartmouth High School in Dartmouth, Mass., said she had seen the school's lowest level of algebra students grasp "that second set of differences for quadratic functions, which is the rate, or the position versus time; that's something that a calculus student might struggle with."

She has also observed that students are motivated by being able to show their work anonymously to the class. "They don't want to be the guy who is not there," she said. "They want to contribute something."

Researchers on both studies said they are now trying to spread their findings to the wider community of math educators, while pushing the research further.

In the upcoming federally funded study led by Mr. Hegedus, the software curriculum materials will replace from eight to 12 weeks of standard Algebra 1 materials and six to eight weeks of Algebra 2 materials. The study will involve eight Massachusetts school districts.

The researchers, who will be advised by Mr. Roschelle of SRI, will examine whether the students who use the technology are more intrinsically motivated to further their study of math in the 11th and 12th grades than students who don't use it.

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