

President's Message

Technology Is a Tool

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Calculators, computers, and a growing array of technological innovations are important tools for doing mathematics, joining the ranks of the compass, straightedge, pencil, slide rule, and trig tables. Technology is neither a panacea for improving the teaching and learning of mathematics nor the source of all the challenges facing teachers and students. It is a tool, and how teachers use that tool greatly affects how well students learn mathematics.

Computers and calculators were invented to save humans time and to allow us to solve more challenging problems more easily than we could otherwise do. Yet, some observers have noted that some school mathematics curricula seem designed to make technology obsolete. Rather than discussing whether technology is good or bad, we might discuss instead how we can capitalize on this powerful tool to help every student learn more mathematics, not less.

The Influence of Technology on Curriculum

Technology is here to stay, and it generates at least three important effects on the school mathematics curriculum. First, some mathematics is now *more important* than in the past because it plays a role in the design and use of technology. For instance, discrete mathematics topics such as matrices take on new importance in light of their use in optimization problems and the organization of data in rows and columns. The ability to translate data from one form of representation to another, such as from numbers and symbols to graphs and tables, or from graphs to tables, is more important now than ever, as well.

At the same time, technology makes some mathematics *less important*. This idea can be controversial because some fear that we will omit from the school curriculum all the computations that calculators can perform. It remains important for students to know how to add, subtract, multiply, and divide mentally and with a pencil and paper. But we must determine how much valuable instructional time we should devote to helping students become proficient with lengthy or tedious calculations. How long a divisor is long enough in the study of long division, for example, is now an important educational decision. In the typical American mathematics curriculum, often described as a mile wide and an inch deep, deciding what to leave out to make room for other topics is crucial.

The third and most important way in which technology affects the mathematics curriculum is that it makes some mathematics *possible* for the first time. Using technology, students at all levels can tackle real problems that might arise from planning a field trip or from a news story, even if the numbers involved might make the problem unwieldy with only a pencil and paper. Middle school students can analyze data using a wide range of statistical tools, developing quantitative reasoning abilities far beyond what was once possible. Graphing calculators allow students to see the connections between visual representations and symbolic ones, and we are

only beginning to scratch the surface of the potential of computer algebra systems. These are just a few examples of how technology can help us raise the level of mathematical knowledge and thinking that we can expect of all students.

Teaching with Technology

The teacher is a key decision maker in using technology in the classroom. The most important decision is when to use it and when not to. Students need to learn when to use technology, when to reach for a pencil, and when to do something in their heads. Using technology well, like making other instructional decisions about mathematics, calls for teachers to have a solid knowledge of mathematics and a working knowledge of the technologies available. There is nothing wrong with students knowing more than their teacher about how to use some features of a calculator or a piece of software. What is not acceptable is for a teacher to limit the use of technology because of the teacher's own discomfort or for a teacher to allow unlimited use of technology without first helping students master essential mental tools.

Providing appropriate access to technology should be the responsibility of the school and should not be left to students and their families. If we expect students to buy calculators that cost more than their shoes, society will surely face a digital divide greater and more dangerous than any economic gap we have yet seen in schools. The same can be said if some students have access to computers outside of school while others do not. This kind of economic imposition, and the disastrous inequity that would result, are unconscionable. Unfortunately, this means that math can no longer be the cheapest subject in the school budget. What was once done with little more than chalk or overhead pens now calls for a significant and ongoing investment in technology. In times of tight budgets, this is a real challenge, but one that must be faced head-on.

The question, then, is not whether to use technology, but how to use it in ways that support the mathematics learning of every student. If students do not learn appropriate ways to use technology in school, they will surely find inappropriate ways to use it outside of school.

What are the challenges that you face in using technology to support student learning? How have you addressed the financial challenge of providing students with technology or handled related management issues, like keeping equipment in working order and accounted for? What successes have you experienced in using technology to raise the level of mathematics your students learn? Join me for my next President's chat about these and related issues on March 21 at 4:00 p.m. EST or submit your comments beforehand by visiting www.nctm.org/news/chat.htm. Ω