Machine Dreams
Six Myths (and Five Promising Truths)
About the Uses of Educational Technology
Though their potential benefits are great, computers alone can't reform education or change the ways students learn
Terry Woronov

Computer technology is fast becoming an almost universal presence in education. Ninety-eight percent of U.S. schools now have at least some computers. The ratio of computers to students is increasing across the country, and continued growth is expected in purchases of hardware, software, and related equipment such as videodisk players and CD-ROM technology.

The push to get more and more computers into schools has been fueled in part by the belief that their mere presence will make good things happen (and by aggressive marketing by hardware and software manufacturers). A variety of studies, however, tell us that computers in themselves do not automatically change the nature of teaching and learning; rather, it is the way teachers integrate computers into classrooms, the content of technology-aided lessons, and quality of the software programs selected that determine whether and how computers in schools really benefit students.

Blaming teachers for the failure of technology to change education is a common historical theme.

Computers have proved valuable in supporting inquiry-based science teaching, inclusion of students with disabilities in regular classes, interdistrict collaboration, distance learning, and the dissemination of professional development materials (see below). At the same time, certain myths about the magic of technology persist. Six widely held beliefs, in particular, are worth examining closely:

Myth #1: Computers are here to stay, so we have to get as many of them as possible into classrooms, as quickly as possible.

Larry Cuban of Stanford University argues that computers are merely the most recent in a long line of technologies that have been promoted in schools, beginning with radio and television. As with these earlier technologies, decisions to integrate computers into education are often made without much thought about the reasons for doing so—that is, how they fit into the wider goals of education—and without a clear understanding of the benefits they are supposed to produce.

"Before technology can be used effectively," says Martha Stone Wiske of the Educational Technology Center at Harvard, "everyone involved in education—teachers, students, principals, school boards, parents, and communities—needs to think carefully about why we want to use technology, and what we hope to accomplish with it."

Myth #2: Educational technology would be used more widely, and more effectively, but for resistance from technophobic teachers.

A "phobia" is an irrational fear. But there is nothing irrational about teachers being afraid of looking stupid in front of students who know more about computers than they do; similarly, the difficulties of integrating computers into daily classroom practice with no system support are not imaginary.

Blaming teachers for the failure of technology to change education is a common historical theme, says Larry Cuban. The blame usually centers on the teacher's inability to integrate the technology into classroom practice. But many teachers face
formidable barriers in learning about computers. Relatively few pre-service programs for new teachers include more than a cursory introduction to technology. Neither is time generally available for inservice education about technology. Equipment and services that industry takes for granted—such as a computer and phone on every desk, access to a systems manager to help with problems and questions, and time on the job to learn new systems—generally do not exist in schools.

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**Just being engaged by computers doesn't mean students are learning anything important.**

Robert Hannafin and Wilhelmina Savenye of Arizona State University list many other reasons why teachers may resist technology. They cite research showing that some teachers are unhappy with the poor quality of the educational software available to them, or dissatisfied with the results of using computers in their classes. For example, some English teachers feel that students use word processors simply to make their papers look good rather than to improve the quality of their writing.

**Myth #3**: Using and programming computers teaches children “thinking” and “problem-solving” skills.

The research jury is still out on this claim. In 1992 Aqeel Ahmed reviewed 21 empirical studies on the effects of students having learned to program computers. Each of the studies attempted to measure the students' “cognitive abilities.” Ten of the 21 studies showed no effects on students' “cognition,” while the other 11 detected some benefits. But in every case, “cognitive abilities” was defined differently. Moreover, Ahmed found significant problems of methodology and reporting in all 21 studies.

Similarly, there is as yet no definitive evidence of the cognitive benefits of other uses of computers, such as multimedia, “edutainment” (computer games with nominally educational content, used at home), or hypertext (a computerized form of text that provides multiple options for calling up related texts and annotations). Indeed, researchers are still trying to determine what kinds of cognitive benefits may result from using new technologies and how to measure those benefits.

The authors of a longitudinal study of high school students enrolled in a "high access to technology" program conducted through Apple Classrooms of Tomorrow argue that, by using computers extensively in class, student acquire cognitive skills other than those measured by traditional indices. For example, they found that students had learned how to integrate graphics, animation, and hypertext into their written texts. The authors also assert that these students had improved ability to work in groups and to integrate large amounts of information, and had increased self-confidence. But did these activities and skills help the students to understand and reflect on important ideas, or to communicate clearly in speech and writing? No answer.

In another study, researchers at Purdue University looked at strategies used by college students to negotiate hypertext and found that most students wandered aimlessly through the material. Additional research is necessary to learn if hypertext reading is a skill that enhances learning, and if so, in what way.

**Myth #4**: Wider use of technological resources like the Internet will help remedy inequities in U.S. education.

While the Internet provides unprecedented access to information and resources around the world, only selected students currently have access to those computer tools. Henry Jay Becker's 1988-1991 study of computer use across the country found inequities based on race, gender, tracking, urban versus rural districts, and subject area. In an earlier study, Becker also found that students in lower tracks were often restricted to drill-and-practice work on computers, while "brighter" students were more frequently taught to use computers as tools for accomplishing other educational tasks.

The latest data show that the hardware gap is closing, with minimal differences in numbers of computers and student-computer ratios in schools across the country—except in Hispanic-majority schools. The new equity gap, according to Becker, is in the use of telecommunications and in computer expertise. Poorer school districts and black-majority schools have largely been "left out of the loop" when it comes to telecommunications, he says. And the need for bilingual computer-literate teachers is acute.

Gender equity is a contentious issue in educational computing, with most researchers finding that boys dominate computer use in classrooms and far outnumber girls in computer science classes. Other studies note that the majority of computer-using teachers are male; few female role models exist for young women who develop an interest in technology. Three times as many men as women currently earn degrees in computer science, according to the National Science Foundation, and the gap is growing.

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**There is as yet no definitive evidence of the cognitive benefits of multimedia or hypertext.**

**Myth #5**: Increased use of technology in the classrooms will inevitably bring about systemic school reform.
Many advocates of educational computing claim that computer use will, by itself, cause a dramatic change in teaching and learning by promoting critical thinking and inquiry-based problem solving. But simply putting a computer in a classroom does not necessarily change anything. Computers are commonly used in traditional, unconstructive ways—for drill and practice, as electronic worksheets, and as rewards for good behavior.

Computer skills are also taught largely as ends in themselves. An advanced-level math teacher at a large public high school near Boston summarizes the problem: "I would like to have my students use the computer lab to experiment with statistical analysis, but the lab is reserved all day for teaching typing and for other vocational classes." There's nothing wrong with using computers to teach vocational skills, but that won't change the nature of teaching and learning in schools.

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**Students in lower tracks were often restricted to drill-and-practice work on computers**

Some innovative schools are using technology to support efforts to re-examine the purposes and potential of education, but it is a mistake to assume that the technology itself is driving the process of change. Michael Eisenberg, director of the ERIC Clearinghouse for Information and Technology, warns educators not to have unrealistic expectations for technology. "Schools are complex institutions," he says. "Learning and teaching are complex processes. Technology is essential because it pervades our society. But it is only a means. Technology itself will not change or reform education."

**Myth #6: Kids love to use computers—so they must be learning.**

Until relatively recently, most adults assumed that serious learning in school had to be unpleasant. Only in recent decades have educators come to believe that learning can and often should be fun. Computer use in schools is sometimes justified because students enjoy it. But just being engaged by computers doesn't necessarily mean that students are learning anything important from them.

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**Five Promising Truths**

- **Computers and new standards.** New national standards in math and science call for students to engage in active, inquiry-based, hands-on learning, which can be facilitated by computer-based laboratories and simulations.
- **Entrepreneurial schools.** A few highly technologically literate schools around the country are beginning to produce their own educational materials and distribute them to others. One project at Thayer Junior-Senior High School in Winchester, New Hampshire, produces professional development materials on videotape and distributes them via satellite to 600 schools around the country.
  
  Elliot Washor, the program's director, says that technology is not its primary goal: "This is a restructuring project. The technology is what makes it possible." Other schools will soon be learning Thayer's video production techniques; as the technology becomes cheaper and more accessible, Washor predicts, more schools will be writing, producing, and disseminating their own materials and curricula.
- **Statewide Initiatives.** More than 40 states have set up organizations to provide telecommunication links or technology support to school districts. The Massachusetts Corporation for Educational Technology (MCET) provides courses for students of all ages, including adult education and professional development, through a national satellite network, and also operates a computer network that provides Internet access. Having a statewide mandate, with state and federal funding, gives MCET and other such organizations access to resources and expertise beyond what is usually available to individual school districts.
  
  Like Elliot Washor, MCET staff emphasize that the technology itself is not the goal of their services to schools: "Content is at the heart of what we do," says Beverly Simon, MCET's director of communications. "What's communicated is far more important than the vehicle we use. The technology itself is of vital interest, but what is most interesting is what we can contribute to schools through technology."
- **Inclusion of students with disabilities.** Technology has enabled students with a wide range of disabilities to participate fully in mainstream classes and to develop skills previously considered beyond their capacities. (See "Assistive Technology for Literacy," page 6.)
- **Distance Learning.** This is a broad term, encompassing technology that "extends the learning community beyond the classroom walls," says Purdue University's Ernest McDaniel. Courses offered via satellite by MCET's Mass LearnPike and Los Angeles's TEAM's project give teachers and students access to materials and expertise not otherwise available to them.
  
  Teachers and students are increasingly using electronic mail to communicate with peers and experts around the globe. Popular programs like National Geographic Kids Network and TERC's Global Lab enable students to share experimental data they
have gathered. Growing numbers of schools are hooking into the Internet, a huge international network that provides access to a vast amount of information and resources (see box, page 8).

For Further Information

A. Ahmed. "Learning to Program and Its Transference to Students' Cognition." Available from the ERIC Clearinghouse (ED352261, 1992); 800-443-3742


C. Martin and E. Muchi-Beyma (eds.). In Search of Gender Free Paradigms for Computer Science Education. International Society for Technology in Education, 1787 Agate St., Eugene, OR 97403.

MCET (and the Mass LearnPike Satellite Network). 38 Sidney St., Cambridge, MA 02139; 617-621-0290.

TEAMS Distance Learning, Los Angeles County Office of Education, 9300 Imperial Highway, Room 250, Downey, CA 90242.

TERC, 2067 Massachusetts Ave., Cambridge, MA 02140; 617-547-0430.


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