Recent Research on the Effects of Technology on Teaching and Learning

John Cradler and Elizabeth Bridgforth, WestEd

What does research and experience tell us about the benefits and the most appropriate uses of technology and telecommunications to support and expand teaching and learning?

A. National Perspective

In a 1993 forum sponsored by the Federation of American Research Networks (FARNET) and the Consortium for School Networking (CoSN), more than 70 educational decision-makers and practitioners from across the country and from all levels of the educational system participated in on-line discussions and then met for two days to prioritize benefits and issues related to educational networking. Forum participants concluded that networking technology is a powerful communications tool with the potential to facilitate educational reform. Properly implemented and supported, this tool can empower and excite students and teachers, while capturing the imagination of the community. Utilizing networking technologies in the classroom can encourage active learning, support innovative teaching, help relieve the professional isolation of teachers, and enable users to become active researchers and learners.

Network technology can also support site-based management by opening new lines of communication with outside information sources and by improving internal channels of communication among various decision-making levels. Many of the reports on the benefits of technology are derived from consensus statements from forums such as this.

B. Research Findings

This section summarizes major research findings from over 100 studies reviewed by Far West Laboratory, Software Publishers Association, Apple Computer Inc., the Office of Technology Assessment, the Monterey Model Technology Schools Project, and other sources as indicated.

The Office of Educational Research and Improvement (OERI) has funded numerous studies and projects that have documented the specific benefits technology can afford to education. These studies provide ongoing feedback to developers of technology-based programming to ensure alignment with high academic standards and interesting programming to meet the needs of diverse learning populations. The research also provides information needed by policy-makers, legislators, and educators in the development of legislation and state and local plans for the integration of technology into schools. Following are specific findings recently reported.

1. Student outcomes: The effectiveness of technology tends to vary as a function of the curriculum content and instructional strategy delivered by the technology. When content and strategies are determined to meet accepted education standards, research documents that technology can be a benefit. A recent review by Far West Laboratory (1994) of current research and evaluation findings from various studies has determined that the integration of technology and telecommunications into education:

- Increases performance when interactivity is prominent
- Increases opportunities for interactivity with instructional programs
- Is more effective with multiple technologies (video, computer, telecommunications etc.)
- Improves attitude and confidence -- especially for 'at risk' students
- Provides instructional opportunities otherwise not available
- Can increase opportunities for student-constructed learning
- Increases student collaboration on projects
- Increases mastery of vocational and work force skills
- Helps prepare students for work when emphasized as a problem solving tool
- Significantly improves student problem solving skills
- Improves writing skills and attitudes about writing for urban LEP students
- Improves writing skills as a result of using telecommunications
- Increases the preparation of students for most careers and vocations

A national survey by the Center for Technology in Education regarding telecommunications and K-12 educators (Honey, 1993) found that:

- Science, social awareness, and cultural exchange projects are perceived to be the most effective telecommunications activities to do with students.
- News services and scientific databases are rated as the most useful information retrieval activities for use with students.
- The most highly rated incentives for using telecommunications with students included expanded students' awareness about the world, accessing information that would otherwise be difficult to obtain, and increasing students' inquiry-based and analytical skills.
- The key factors that influence the success of non-technology-based shared learning activities also influence activities mediated by telecommunications. These are planning, cooperation, and well-defined and relevant project goals.

The Office of Technology Assessment (OTA) conducted a comprehensive nation-wide assessment at the request of the Senate and House

Committees on Education and Labor. The study showed that with adequate teacher preparation technology greatly facilitates:

- Teaching of abstract concepts and problem solving, as well as basic skills
- Independent work, teamwork and collaborative inquiry
- Adaptation of instruction to accommodate student learning styles and special needs
- Higher expectations of students and presentation of more complex materials
- Less teacher lecture, with more student-centered classrooms
- Opportunities for new learning experiences (OTA, 1995)

2. Educator outcomes: Research on technology's benefits for teaching is generally positive, with a shift from the traditional direct approaches to a more student-centered approach. Research specifically shows that educator-use of technology results in:

- Increased emphasis on individualized instruction
- More time engaged by teachers advising students
- Increased interest in teaching
- Interest in experimenting with emerging technology
- Increased administrator and teacher productivity
- Increased planning and collaboration with colleagues
- Rethinking and revision of curriculum and instructional strategies
- Greater participation in school and district restructuring efforts
- Increased teacher and administrator communication with parents
- Increased communications among teachers (OTA, 1995)

The national survey of telecommunications and K-12 educators by the Center for Technology in Education, (Honey, 1993) found that:

- More than two thirds of the educators surveyed report that integrating telecommunications into their teaching has made a real difference in how they teach.
- Conducting telecommunications activities with students enables teachers to spend more time with individual students, less time lecturing to the whole class, and allows students to carry out more independent work.

3. Conditions for technology to be effective. The findings of these and other studies generally and consistently show that technology alone does not have a significant effect on teaching and learning. Technology is a tool that when used with tested instructional practices and curriculum can be an effective catalyst for education reform (Cradler, 1992). The following are the major factors necessary to support the effective application of technology to learning:

- Staff development that is individualized to the needs of the teacher
- Technical assistance that is available when needed

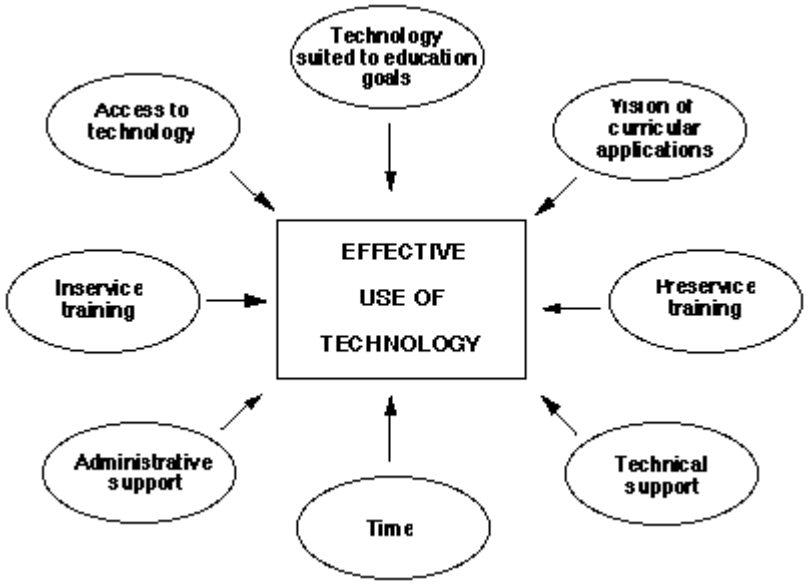
- Time for teachers to plan, learn about, and implement technology applications
- Long term staff development to support the integration of technology into instruction
- Understanding of ways to integrate technology into education reform
- Teacher-access to technology while planning
- Involvement of teachers in planning statewide, school, and classroom uses of technology

The Far West Laboratory study of the impact of educational technologies from 1984 to 1991, and research on the California Model Technology School Projects show that technology alone does not have a significant effect on teaching and learning unless certain conditions exist, such as the following:

- Teachers must integrate technology and telecommunications applications into the ongoing program.
- Technology and networking should offer opportunities for students to solve problems and construct solutions.
- Technology must give students more control over learning while teachers serve as facilitators.
- Teachers and administrators must jointly plan for the use of technology and networking.
- Government must promote educationally sound applications of technology and development of software and video programs that meet educational content standards.
- Telecommunications is especially effective when combined with other technologies and linked to high education standards.
- Student access to telecommunications increases opportunities and incentives for students to construct and invent their own learning.

The OTA suggests minimum requirements for the effective use of technology in education, as indicated in the following list and chart.

- Suiting technology to education goals and standards
- Having a vision for the use of technology to support curriculum
- Providing for both inservice and preservice training
- Ensuring access to appropriate technology
- Providing for administrative support for technology use
- Providing time for teachers to plan and learn how to integrate technology
- Providing for ongoing technical support for technology use



4. Features of effective learning technologies. Research on teaching and learning identifies critical features of technology-based resources for effective applications in education. Developers of educational technology programming should make efforts to incorporate the following elements into programs:

- Immediate adjustment of task difficulty in relation to student responses
- Instant feedback on correctness of responses
- Ease of use by students and teachers
- Sustained interest and use by students
- Simulations of tasks not possible in the classroom or from books
- Student control of pacing the educational programming
- Opportunities for individualized problem solving
- Opportunities to use multiple technologies
- Built-in assessments and procedures to matched technology resources with learner needs
- Field testing of technology-based resources with a variety of students in a variety of settings
- Teacher involvement in the development of educational technology programs
- Alignment with curriculum frameworks and/or existing instructional resources

5. State and federal program support factors: A survey of the research and review of 20 state plans, conducted by Far West Laboratory (1994), documented particular state and federal program elements that promote effective technology use. The following factors have been

found to be directly or indirectly related to the effective and sustained integration and use of technology and telecommunications in education.

- Careful planning that involves all stakeholders in education and technology
- State leadership to support sustained funding for the planned use of technology
- Technology incorporated into existing and emerging education initiatives
- Incorporation of technology applications into state curriculum frameworks and standards
- Coordination of education, business, and other relevant governmental agencies
- Business involvement in planning and implementing technology in education
- Increased involvement between community agencies and education agencies
- A statewide interoperable electronic information highway accessible by all classrooms and learning environments
- An interagency governance structure to secure and coordinate resources across agencies for technology
- Funding for school and district technology use plans that meet local and state criteria
- Site-level planning as a pre-requisite for receiving technology-based resources
- Guidelines for local planning that promote funding allocations for staff development
- Incentives for identification and dissemination of proven programs and practices
- A statewide educational technology clearinghouse with electronic distribution capabilities
- Incentives for the development and validation of technology-based resources
- Provisions for regional and local technology use training and technical assistance
- Both formative and summative evaluation of all programs
- Technology uses incorporated into program review and assessment guidelines
- A process to communicate program accomplishments and problems to stakeholders
- Informing policy-makers about cost-benefits of technology applications in education

C. Summary

Technology is related to increases in student performance when interactivity and other important features of instructional design are applied to its use. Teacher preparation, follow-up staff development, and technical assistance are critical prerequisites for effective technology applications. Planned integration of technology in education that directly involves teachers consistently allows teachers to engage students in meaningful educational experiences and allows more time for individualized instructional opportunities.

Effective application of technology to support education involves careful review and re-planning of the classroom and school-level program. Research generally suggests that effective technology use is a complicated and involved process of planning and ongoing support with serious consideration of the current and emerging research findings on its use.

Support for national research and development for technology applications in education is critical to keep pace with emerging technologies. However, less than one percent of federal funding for technology research and development is dedicated to educational applications of

technology. Evidence is mounting that there are still many unanswered questions about educational uses of technology, and therefore, more research is needed to inform educators and software developers about the most effective and needed uses of technology.

 Return to Education Resources Table of Contents

 Return to WestEd/Far West Laboratory CAETI Homepage