

Research Implications for Preparing Teachers to Use Technology

This is the third in a series of articles addressing critical and frequently asked questions about the effective use of technology as an instructional resource, as determined by the Center for Applied Research in Educational Technology (CARET). This article provides a review of the research findings and implications related to preparing teachers to effectively integrate technology into curriculum and instruction.



By John Cradler, Molly Freeman, Ruthmary Cradler, and Mary McNabb

Subject: Research on professional development

Audience: Teachers, technology coordinators, library/media specialists, teacher educators

Grade Level: K–12 (Ages 5–18)

Standards: NETS•T I, V (www.iste.org/standards)

Supplement: www.iste.org/L&L

The Problem

A growing challenge in education is establishing and implementing strategies to develop the skills and knowledge necessary for teachers to effectively use technology as an instructional tool. The importance of professional development for teachers is emphasized in the No Child Left Behind Act, which requires that 25% of state federal technology funding be allocated for professional development and that such professional development be research based. This act also states that the im-

pact of professional development on the effective integration of technology into curriculum and instruction be documented.

Surveys consistently show that teachers are interested in technology, but need increased opportunities to develop their capacities.

- Only 20% of teachers consider themselves well prepared to use technology in their classes. A 1999 report from the National Center for Education Statistics (NCES) reports

that 66% of teachers who received more than 32 hours of technology-related training felt well to very well prepared to use technology in their classrooms (NCES, 2000a). The percentage who felt well to very well prepared to use technology dropped to 34% for those who received from 9 to 32 hours and to 24% for those who received less than 9 hours of technology-related professional development.

- Technology in schools is a rapidly increasing education resource. Computers are available in almost every classroom in the United States, with 98% of schools and 77% of classrooms connected to the Internet. Teachers are consistently reporting an increased need for professional development to enable them to effectively use this resource to improve student learning (NCES, 2000b).
- At least 84% of teachers believe that computers and access to the Internet improve the quality of education, but two-thirds report that the Internet is not well integrated into their classes (NetDay, 2001).

Research-Based Solutions

CARET has assigned a high priority to the challenge of informing educators about the most effective strategies for planning and delivering professional development to teachers. This is based on a survey and focus group of educators who identified and ranked 9 topics and 45 related questions for CARET to address. The second highest ranking topic, after student learning, was professional development related to the use of technology. (Student learning was discussed in *L&L 29*[8].)

A careful review of studies shows that more than the specific technology or software used, the context in which technology is applied is critical to the educator. The extent to which teachers

are prepared to infuse technology into curricula and instruction is a major contextual factor. This finding is consistent over the past 15 years and is the major reason the U.S. Congress is requiring that states allocate at least 25% of federal technology funding to professional development.

Currently, CARET has reviewed and summarized 26 studies, surveys, and reports related to professional development. As new studies emerge, CARET reports will be updated. The questions addressed in this review are:

- Which models or strategies are effective for preparing new teachers to integrate technology?
- How can national, state, and local teacher technology standards be met?
- Which strategies build teacher confidence and interest in technology?
- What can school leaders do to enable teachers to make effective use of technology?

(Editor's note: See the Checklist of Indicators online supplement at www.iste.org/L&L for a list of indicators to consider when planning, implementing, and evaluating professional development programs.)

Research Findings and Implications for Educators

Question 1: Which models or strategies are effective for preparing new teachers to use and integrate technology?

Answer: Demonstrate infusion of technology into instructional practices. Require that college faculty use technology in their courses as a learning and teaching tool.

A careful review of studies on the effects of technology shows that more than the specific technology or software used, the context in which the technology is applied is most critical to the educator.

- Preservice elementary teachers learn technology integration strategies by working with and observing practicing teachers and students while they use technology (Abbot & Faris, 2000).
- Technology use in K–12 classrooms increases if preservice teachers use technology in their own learning, for example, in preservice course assignments and activities (Goldberg & Sherwood, 1983; Willis & Raines, 2001).
- Schools of education can model best practices for new teachers by preparing their faculty to infuse technology throughout the curriculum (International Society for Technology in Education [ISTE], 2000).
- Education faculty should integrate technology applications into preservice teacher assignments and field activities so that new teachers have opportunities to acquire technical skills and practice instructional strategies (CEO Forum, 1999; Goldberg & Sherwood, 1983).
- For their practice teaching assignments, preservice teachers should be placed with teachers who are exemplary users of technology (Abbot & Faris, 2000).
- Courses in teaching methods can incorporate content from general education courses to promote technology infusion across the curriculum (ISTE, 2000).
- Schools of arts and sciences can incorporate technology to model teaching with technology in content areas (ISTE, 2000).

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Question 2: How can national, state, and local teacher technology standards be met?

Answer: Integrate technology standards with professional development at state, regional, and local school sites.

The research provides a spectrum of practices for enabling teachers to meet technology proficiency standards:

- Technology standards can be met by integrating them with school-site professional development (ISTE, 2000; U.S. Congress, Office of Technology Assessment [OTA], 1995).
- Incorporation of the ISTE NETS Performance Indicators for Teachers into professional development of practicing teachers as well as into teacher-preparation courses may increase the probability of meeting educational technology standards (ISTE, 2000).
- Use of technology standards in the classroom is supported when teachers are provided with information and professional development on how to analyze and select electronic learning resources that align with and support state and national instructional content standards (Beuthel & Cradler, 2000).
- Opportunities for teachers to develop their own computer skills correlates with enhanced student achievement (Mann, Shakeshaft, Becker, & Kottkamp, 1999).
- Intensive and ongoing staff development that provides opportunities for modeling, practice, and reinforcement of technology use with curricula should be linked to curriculum goals and objectives from the onset of technology implementation

efforts (Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

- A school's capacity to change can increase when technology training is embedded in an overall reform effort (Roschelle et al., 2000).
- Visual literacy skills should be modeled for preservice teachers so they learn to decode and encode images for selecting, designing, and evaluating digital resources, and to model and teach these skills to their own students (Mann et al., 1999; Roblyer & Bennett, 2001).
- Education faculty can benefit from reduced course loads in order to learn to integrate technology into preservice teacher activities and assignments (Slowinski, Anderson, & Reinhart, 2001).

Question 3: Which strategies build teacher confidence and interest in technology?

Answer: Being mentored by an experienced teacher who is proficient with technology, sufficient time for collaborative learning and practice with technology, active participation in professional meetings, and use of computers at home by teachers.

Twelve studies reported similar trends in the effectiveness of strategies for increasing teacher confidence and motivation to use technology:

- Preservice and practicing teachers and education faculty benefit from observing and working with mentors who are experienced using technology with standards-based curricula (Abbot & Faris, 2000).
- Mentors who can help teachers adapt technology applications to their classroom needs are important

to the success of innovative uses of technology (Zhao, Pugh, Sheldon, & Byers, 2002).

- Considerable time for collaborative learning and practice is required for teachers to gain confidence in using technology (Coley, Cradler, & Engel, 1997; Cradler & Cradler, 1995; OTA, 1995).
- Participation in professional associations and sharing with colleagues within and beyond one's school contribute to increased confidence and motivation for using technology and correspond with increased use of learner-centered instructional strategies (Becker & Riel, 2000).
- Home computer use builds teacher motivation and confidence for infusing technology into the classroom (Becker, 1999).
- Preservice teachers should be clustered in groups of 8 to 12 to conduct course assignments and to review practice teaching experiences (Abbot & Faris, 2000).
- Teachers need ready access to technology while they plan, along with flexible scheduling for team teaching and for learning to use technology during the school day (Honey & McMillan, 1996).
- Teachers need long-term professional development to adapt and infuse curricula with technology (Wetzel, 2001a, 2001b; Wetzel, Zambo, Buss, & Padgett, 2001).
- The frequency, breadth, and depth of collaboration with colleagues influences the instructional context and the quality of technology use (Becker & Riel, 2000).

Teachers should be encouraged to use computers at home to learn at their own pace, pursue their own interests, and gain an understanding of the range of technology applications that can be used in the classroom.

Question 4: What can school leaders do to enable teachers to make effective use of technology?

Answer: Customize professional development programs to address teacher's needs, allocate needed computers and connectivity in the classroom, use technology in their own work and in communication with teachers, and commit funds to support teacher involvement in decision making.

Five studies identify strategies for school leaders to support and reinforce the exemplary use of technology with curricula:

- School leaders can support on-site, just-in-time learning by tailoring professional development to the perceived needs and curriculum goals and objectives of individual teachers (Cradler & Cradler, 1995).
- School leaders can allocate resources for at least four networked and Internet-connected computers in each classroom (Becker, 1999).

- School leaders need to model the use of technology in their work in order to encourage and reinforce the classroom infusion of technology by teachers (CEO Forum, 1999).
- School leaders need to support technology policies that provide teachers easy access to technology resources and professional development opportunities (Zhao et al., 2002).
- School leaders can enable teachers to observe practices in other districts and states and to make recommendations for new practices based on their observations (OTA, 1995).

Future Directions

This article has summarized and offered conclusions for a limited amount of formal research on professional development. Much of the information used to guide professional development is based on the experience of educators and has not been formally tested through research. CARET staff are

finding that most research addresses very specific questions but does not test aspects of major initiatives, such as the application of standards for both teachers and students. CARET has not found any studies that actually measure the differential affects of specific professional development strategies on specific changes in teaching and learning, and we believe this is an important area to study. We welcome input from anyone on this and other topics related to technology in teaching and learning and encourage readers to access <http://caret.iste.org> and provide such input.

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John Cradler is the co-director of the CARET project and president of Educational Support Systems (ESS). He first became involved with technology when working with the South San Francisco Unified School District. In 1974, while looking for a more efficient way to provide reading tutoring for special education students, he discovered a Stanford University project on computer-assisted instruction, which was adapted to support a phonics tutoring project called Success Controlled Optimal Reading Experience (SCORE).

Molly Freeman, PhD, currently conducts research with ESS and, since 1996, has consulted with the Internet Institute of Santa Clara County Office of Education. Molly's experience with technology began with punch-card coding responses to interviews of children for one of the first studies of school integration in Riverside, California. As Chairperson of the Division of Education and Human Development at Holy Names College from 1980 to 1986, Molly participated in the early stages of computer integration with teacher preparation programs.

Ruthmary Cradler works as a consultant, specializing in evaluation of educational technology program implementation and development. She is a member of the PT³ national advisory committee for program evaluation. She holds an MA from San Francisco State University. Thirty years ago she was excited about the electric (versus hand-cranked) ditto machine. She was also excited about her first Cuisinart food processor, which had a greater long-term effect on her life than the ditto machine.

Mary McNabb, EdD, works as a consultant focusing on investigating effective uses of technology for teaching, learning, and assessment purposes. She began using networked computers to teach English in 1993, which fostered her interest in earning a doctorate in educational technology in 1996. She worked at the North Central Regional Educational Laboratory (1996-2000) and has served on several Preparing Tomorrow's Teachers to Use Technology (PT³) grant projects, including ISTE's NETS for Teachers leadership committee and the PT³ core group of evaluators.

What are your experiences with integrating technology?
 How do you find research-based solutions to your problems?
 What questions do you need answered?
 Send a letter to L&L editor, Kate Conley at letters@iste.org.



