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ABSTRACT

This paper examines how technology was used to enhance instruction in schools that are viewed as "promising" in their technology use by individuals in state education agencies. Four elementary, three middle and two high schools from Arizona, California and Nevada were examined. Extensive document review and telephone interviews were conducted in preparation for two-person 1- to 2-day site visits. Four schools reported that teachers actively used technology in instructional delivery; minimal equipment included a computer, Video Cassette Recorder (VCR) and large video monitor in each classroom for multimedia presentations. A few teachers incorporated online telecommunications into their curriculum and instruction. Students used computers for learning keyboarding or practicing word processing and graphics; students at schools with Internet capacity used it for doing research for class projects. Five schools offered video production opportunities for students. In terms of technology integration, three trends were consistent: (1) using technology in project-based curriculum, (2) concerns with articulation issues between grade levels, and (3) an increased legitimation of "technology as curriculum" at upper-grade levels. Staff training and support depended on technology types, schools' equipment and availability of training personnel, the purposes and manner for which technology was going to be used, and the breadth and level of technology skills already held by the teachers. Schools used two additional strategies to provide support for technology use: access to a variety of technologies and use of technology beyond the school. Contains ten references. (AEF)

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Contents

Abstract

This paper provides a look at how technology was used to enhance instruction in schools that are viewed as "promising" in their technology use by individuals in state education agencies (SEAs). After a brief discussion of the methods used in the study, we look at how instructionally focused technology was implemented in the schools. The paper then focuses on how technology was integrated into curriculum and instruction. It concludes by discussing professional development and other aspects of school and district support for technology use.

In general, classroom integration of technology was uneven. Even at promising schools there is wide variation in the extent to which individual teachers use technology. Because our goal was to focus on experiences that could be helpful to schools beginning this process, we spent most of our classroom time with teachers who used technology. Schools provided a variety of types of support for technology use. In addition, technology was integrated differently at different grade levels. An increased focus on "technology as curriculum" was apparent at the upper grade levels.

Introduction

Technology is a cross-cutting educational reform tool, with the potential to provide opportunities previously unavailable and to expand the knowledge and learning experiences of both teachers and students (O'Connor, 1992; Polin, 1991). Ideally, technology programs in educational environments support current directions in curriculum and instructional reform. Technology helps engage students in complex and meaningful tasks and can change the interactions and structures related to learning. Belief that improved student learning and, thus, increased student achievement, results from these changes provides the impetus for reform.

However, the successful implementation of technology-oriented classroom practices relies on the acceptance and use of them by classroom teachers. Such acceptance cannot result from legislation and policy alone; technology must become part of teachers' classroom experiences. Technology can play an integral role in classroom management and organization (Collins, 1991; Herman, Heath, Valdés, & Brooks, 1991), be incorporated as a tool in the instructional process, or become the core of curricular instruction (Sheingold, 1991). As availability and use of technology continue to increase, its importance in the classroom and the educational environment has the potential to enhance the impact of many change efforts.

This paper provides a look at how technology was used to enhance instruction in schools that are viewed as "promising" in their technology use by individuals in state education agencies (SEAs). The paper is organized as follows. After a brief discussion of the methods used in the study, we look at how instructionally focused technology was implemented in the schools we visited. The paper then focuses on how technology was integrated into curriculum and instruction. It concludes by discussing professional development and other aspects of school and district support for technology use.

Methodology

This paper is based on extensive information obtained from nine schools that are considered exemplary in their use of technology three each from Arizona, California, and Nevada. The Southwest Regional Laboratory (SWRL) asked the heads of technology education in each state department of education to recommend schools that were well-known in the state for their use of technology, and to provide SWRL with names of key individuals to contact at each site. On the basis of preliminary interview information, we then selected a mix of schools representing a variety of technologies, length of time technology had been used, and grade levels being served.

Of the final group, four are elementary schools, three are middle schools, and two are high schools. One of the two high schools is a newly built technology magnet school. The other high school is located in a small district, so we visited the elementary and middle schools there as well to observe the spread of technology throughout the district. Finally, three of the schools are in the first year of their technology programs.

Extensive document review and telephone interviews were conducted in preparation for two-person one to two-day site visits. Site visit activities included interviews with faculty and school and district administrators, and observations of technology use.

Although the sample schools are obviously not representative of technology use in the general population of schools, having been specifically selected for their outstanding efforts in this regard, their experiences can provide insights and lessons for all schools.

Implementation

Successful implementation and continued use of any educational innovation require commitment and change in users (Berman & McLaughlin, 1978), which, in turn, require support from others, for example, principals and colleagues in the setting. As schools implement technology—for example, distance learning programs—conditions at the site level strongly influence the success of implementation (Tushnet et. al, 1994). Consequently, we examined how teachers and students used technology for instruction and how schools supported their technology use.

Recent content standards and guidelines can be supported by technology use (Means et al., 1993). These standards advocate curriculum and instructional reforms that reflect constructivist theories of learning, which view learning as a process of student construction of knowledge through interaction with ideas, objects, and people. As students explore new concepts and experience dissonant events, new and deeper understandings are developed. Learning is viewed as an active process involving reflection and collaboration.

Technology can provide challenging, authentic tasks and hands-on activities to engage students in self-constructed learning. Using technology, students can create sophisticated and professional-looking products, communicate across distances, generate complex calculations, and work in a variety of real-life contexts and situations. Not surprisingly, math and science standards, among others, incorporate technology use as a goal (National Council of Teachers of Mathematics [NCTM], 1989; National Committee on Science Education Standards and Assessment [NCSESA], 1993).

Delivery of Instruction

Four schools reported that teachers actively used technology in instructional delivery. Minimal equipment included a computer, VCR, and large video monitor in each classroom for multimedia presentations. For instance, an art teacher projected computer-generated designs through the classroom television monitor so students could see how changes in texture created by different draw and color options on the computer changed the overall look of a design. At another school, the principal described one teacher's lesson on how the media uses technology to sway an audience. This teacher showed students stills and clips from different original news programs and documentaries to stimulate analysis and student discussion of how sensationalism was created through the flow of sound, phrasing, and pictures.

In addition, some teachers used technology in teaching by customizing computer applications for student use in learning activities. For instance, as part of a curriculum unit on percentages, one elementary school teacher adapted a spreadsheet application so his students could make mock stock market investments and follow them over time. A computer support person helped him change the software and, although the teacher spent extra time and effort, he reported feeling energized and planned to use the software again the following year.

A few teachers incorporated on-line telecommunications into their curriculum and instruction. For instance, one was following the International Arctic Project, an educational on-line network involving a team of Arctic explorers traveling over the North Pole, as part of a unit on science. This project allows the explorers to communicate over the Internet with schoolchildren, although not in real time. For this teacher, a 10-hour per month limit on connect time for the school led to breaks in instruction because, at times, students were unable to access the Internet without the teacher making other arrangements.

Student Learning Activities

When technology becomes part of students' learning experiences, teachers choose technology applications that support their instructional goals to enhance learning. Basic computer applications like word processing and graphics can be used as tools for academic work, instructional software can be used to reinforce acquisition of basic and problem-solving skills, and a variety of technologies can be integrated into student-centered activities.

Students had access to and used computer technology at all promising schools. They used instructional software in classrooms and computer laboratories. Programs varied in formats. Some, such as "The Oregon Trail," were game-like. Others focused on learning concepts rather than practice of skills. For example, at one school a computer program for learning geometry allowed students to construct figures and then move lines and angles according to different parameters. The teacher believed her students learned geometry concepts faster and easier when using the program.

Students also used computers for learning keyboarding or doing word processing and graphics. For instance, at one elementary school, students made books by creating their own captions for computer graphics scanned in from popular children's books. After printing and binding their books, students read them aloud before they took them home to share with their parents. Other general applications included database programs, especially with third grade and up. At one school, third graders generated a database of their classmates' names, birthdays, and related personal information.

Students at schools with Internet capacity used it for doing research related to classroom projects. However, such use was usually limited to one or two classrooms.

One use of technology that particularly reflected activity-based learning was student-created news programs using video technology. Five schools offered video production opportunities for students. Two schools broadcast daily video news and announcements; two schools broadcast longer news programs on a weekly basis; and one school occasionally broadcast student-created videos featuring special events. One school anticipated adding the capacity for student-produced videos in the near future. Video production was offered as an elective class at some schools and was considered an extracurricular activity at others.

Integration Into Curriculum and Instruction

In a sense, the challenge of integrating technology into educational environments is more human and organizational than technological (Sheingold, 1991). Even though technology is used, it may not be used in ways that support the conceptions of teaching and learning expressed in the new subject matter standards and guidelines. The promising technology schools offered a glimpse of how teachers and schools integrate technology into curriculum and instruction in ways that support educational reform. We noted three trends consistent with this focus: (a) using technology in project-based curriculum, (b) concerns with articulation issues, and (c) technology as a legitimate curriculum at upper-grade levels.

Within Schools

Seven of the schools we visited were working toward integrating a variety of technologies into classroom instruction, mainly through the use of project-based curriculum. Teachers assigned a variety of long- and short-term individual and group student projects as a focal point for curriculum units. For instance, at one school, as part of a history/social science unit, eighth-grade students created a video presentation about Stonehenge as a classroom report. They copied photographs from a book, put them on videotape, then wrote a script that was audio-dubbed onto the tape. These students participated in a national competition and eventually took their project to Washington, DC.

At another school where the curriculum focused on developing student expertise in technology applications, an ongoing project used the Internet to involve students in collaboratively creating a virtual reality tour of the school. The tour eventually will be accessible via the school's home page on the World Wide Web. The teacher mapped the school in 19 different sections and small groups of students each work on one section. The sections will be combined into an integrated program, pressed into a CD, and uploaded onto the Internet.

Four of the schools we visited changed scheduling to accommodate curriculum and instructional changes and the use of technology. One school reported teachers informally teamed up and arranged extended blocks of time for students to work on projects. Another school formally scheduled extended periods on Tuesdays and Thursdays for project work. This school offered teachers the option of further extending their periods into a double extended block so there would be "a really long time to get into some project." One school reorganized scheduling so that interdisciplinary teams of teachers could work on curricula that integrated technology. At this school, Monday was a reduced school day for students while teachers spent the morning learning about technology or developing curricula.

Between Levels and Schools

Articulation between grade levels is frequently an issue in school districts. Students cannot progress at their grade level if they have not acquired the skills necessary to master current content. The need for articulation is likely to be exacerbated in the case of technology because some schools will be ahead of others in technology adoption and implementation. If students entering the "advanced" schools are assumed to have prerequisite computing skills but do not, they may be disadvantaged in learning the curriculum.

Three promising technology schools directly dealt with articulation issues. For one high school, the need to complete certain prerequisites before proceeding in their coursework meant that students had difficulty transferring between programs or into the school after their freshman year. Those students who did so attended summer school and extra classes to make up necessary prerequisites. In another district, the high school did not plan to offer keyboarding classes any more. As technology became available at the middle school, most students entered with keyboarding skills. Independent study opportunities will be made available for those students who lack or transfer in without computer skills.

Many districts start by upgrading the high school and send older equipment to the lower grade levels. In contrast, one elementary school was the most advanced technologically in the district. At this school, teachers were concerned about accomplished hi-tech students moving into schools with neither equipment or opportunities for further learning about technology. Staff worried that students would lose both interest and skills.

Between School Levels

Among the nine exemplary technology schools, an increased legitimation of "technology as curriculum" was notable at upper grade levels. As students progressed in school, technological skills gained more attention in curriculum and instruction.

At the elementary school level, school staff stressed that technology was primarily used as a tool for learning academic curriculum. Cognitive development and attainment of concepts were considered more important than computer literacy. As the computer teacher at one elementary school shared, "It isn't just keyboarding." At this particular school, students in preschool and kindergarten classes worked on computers with a focus on preliteracy and development of fine motor skills. The computer teacher told the following story to illustrate how development of the concept of proper nouns and computer skills intertwined, "I got a picture of a little boy actually writing his name [on the computer]. It was really neat because his name was Casey, and here he was with his capital C, and that's a big step for them."

The middle schools began to introduce technology itself as a legitimate curriculum. Two of the four middle schools visited offered applied technology classes. These classes exposed students to a variety of technologies over the course of a semester or year. For example, one class included flight simulation, bridge building, aerodynamics, and video production. Other classes included modules on laser communications, car building, solar energy, computer-aided design, and small engines. In these classes, the concern was less with integrating technology use into academic curriculum to further student achievement than with introducing students to technology uses in applied settings.

Applied technology commanded greater attention in high schools with year-long courses offered for one area. At the two high schools we visited, one school offered, among other technology classes, a computer-aided design (CAD) course to train students for work. The other high school was a technology magnet that offered an introductory applied technology class similar to the middle school classes, as well as advanced curricula in seven areas of technology studies. Five of these areas focused on advanced technology applications: computer design, computer science, management information systems, systems technological support, and technology applications. Graduating students received certification in their area of focus and interned for further training during their senior year.

Regardless of grade level, technology curriculum became important as schools connected to the Internet. These schools increased focus on skills for information retrieval and the ethics of information use. For instance, one school planned a semester-long information retrieval course using the Internet for students. At another school, conflict over whether students should freely access the Internet or be shielded from inappropriate information led to the development of user guidelines and plans for curricula that focus on social ethics and personal responsibility in technology use.

Professional Development and Support

Professional development and support are critical dimensions of integrating technology into classroom instruction. The type, level, and location of initial and subsequent training activities at the schools we visited were dependent on several factors:

- the type of technology being introduced;
- the manner in which technology was being introduced to the school (as a full package or with elements being gradually integrated over time);
- the manner in which teachers were expected to use technology (in their classrooms, in special computer laboratories, or both);
- whether the school will have a technology specialist available to train and troubleshoot during the school year;
- whether the school had a laboratory that could be used for staff training purposes;
- the technology that would be available in individual classrooms;
- the purposes for which technology was initially going to be used (i.e., teaching computer and other technologic skills, enhancing instruction in all areas, or improving administrative functions—e.g., grading, scheduling, between-staff communications);
- if a particular school or district had a computer laboratory dedicated to staff and faculty development; and
- the breadth and level of technology skills already held by the teachers.

Each of the above factors helps determine overall staff training needs and approaches to meeting them. For example, two schools had dedicated teacher laboratories, in which both large- and small-group training and individual practice (with assistance on call) could take place. Another school installed computers in each of several class preparation rooms for small-group sessions.

Two of the schools provided individual teachers with one free class period per day to serve as technology support personnel. In one of those schools, the teachers had been extensively trained, so this time was sufficient. At the other, training had been less intense and needs were greater. Because the support person was able to respond to only very few, typically urgent, requests for assistance, an approach through which he could meet the broader needs of the entire staff was needed. In response, one hour of every other week was dedicated to schoolwide technology development, and attendance at training sessions comprised of equal parts of didactic instruction and laboratory practice was required of all faculty. These sessions were scheduled weekly during regular school hours, and the student school day was reduced.

The technology magnet school provided teachers with 500 hours of training, and had several technology specialists among the school's teachers, who were able to provide ample assistance to their colleagues during the school year. At the other end of the training and support spectrum, one school did not even have a release time technology specialist who could work with the teachers. As a result, that school relied on district technology personnel for training on an "as needed" basis, and the staff used each other *and students* as resources to help them learn new techniques and to resolve computer "glitches" during the school day.

Technology Expertise and Instruction

In addition to teacher training, schools used two mechanisms to ensure that teachers either had sufficient expertise or access to it to implement technology. Schools selected staff and provided technical support to enhance teachers' capacity for technology use.

Staff selection. Five of the nine schools selected staff specially for their technology programs. Whether or not schools preselected staff appeared unrelated to either grade level or location of the school. When targeting potential staff members, schools sought people with knowledge and experience with technology, or who were willing to learn about technology. In addition, one school looked for teachers who were supportive of student-centered learning strategies and another looked for those with a history of using innovative or creative instruction.

At one elementary school, the technology program was implemented in an older facility that had no technology prior to receiving a technology grant. Teachers were given an option to stay at the school and use student-centered learning strategies and technology in their classrooms, or transfer to another school in the district. When new teachers were hired, the primary criterion for selection was their interest in using technology and focusing on student-centered learning. Newly hired teachers were not expected to be more than technology novices; however, they were expected to be willing to learn something new about it every day.

For the technology magnet school, knowledge and willingness to learn were important. Noncredentialed teachers from the business sector were hired to teach specialized advanced technology classes in their area of expertise. The district granted special credentials to those instructors for specific subject areas, such as banking and finance.

Technical support. Regardless of whether formal training is offered, direct support can help promote positive teacher experiences and attitudes toward technology use. Previous research on technology implementation suggests that designating an experienced resource person at each site helps provide ongoing support for teachers who are integrating technology in the classroom (Means et al., 1993).

Of the nine exemplary technology schools, all but three designated a specific well-trained person for computer support. At the three schools that did not, teachers reported negative experiences or perceptions in relation to technology. Negative experiences included loss of faith in computer software due to "glitches" in its operation, fears that students were only learning computer skills, not curriculum; and an unwillingness of teachers to participate in training and in-services.

Some schools reported that teachers also relied on students for direct computer support. Often students have fewer fears about and more experience in technology use than adults. Teachers and peers ask experienced students for help with computers and applications. In fact, two schools officially used students as aides in computer labs. One principal reported that being selected for technology support had positive consequences for students' self-esteem. Rather than being branded "nerds" for their skills and expertise, students felt appreciated and were within the mainstream.

Additional Approaches to Support

Schools used two additional strategies to provide support for technology use: (a) access to a variety of technologies and (b) use of technology beyond the school.

Access to technology. Access is critical in implementing technology programs and integrating technology into instruction. Students and teachers cannot be expected to learn about and use technology unless it is available and suitable to meet their needs.

Computer laboratories were available for both drop-in use and scheduled classes. In addition, all but one school had at least one computer in every classroom, which made it easier to access for instruction, but not for independent student use. The magnet school did not have problems accessing computers in the classroom with some of the classrooms having a computer for every student.

Teachers not only accessed their classroom computers, but shared computer laboratories with students. Schools with limited equipment increased teacher access by devising systems for sharing. For instance, one school bought mobile carts so that equipment could be moved from room to room. Additionally, two schools invested in classroom telephone access to a few centrally located VCR units.

Two schools also opened technology facilities for community access. One school opened the computer laboratory to college students and the community for a small fee. The other school planned to start "Family Nights" for parents and community members following a successful opening of the computer laboratory during open house.

Scaling up. Promising schools contribute to the spread of technology by moving technology adoption and use into other schools or gearing up to a districtwide focus. Four schools demonstrated some evidence of scaling up in relation to technology. Construction of a high-tech computer laboratory at a small district's high school led to the addition of a computer laboratory and new course offerings at the middle school. Advanced technology at one elementary school triggered formation of a district-level technology committee to examine efficient methods of sharing cabling and relay capabilities and networking of all administrative systems. Two schools indicated their districts planned to provide districtwide electronic-mail (e-mail) or voice mail following successful implementation on their individual campus.

Summary

In general, classroom integration of technology was uneven. Even at promising schools there is wide variation in the extent to which individual teachers use technology. Because our goal was to focus on experiences that could be helpful to schools beginning this process, we spent most of our classroom time with teachers who used technology. Schools provided a variety of types of support for technology use. All but three promising schools designated a specific support person on site and two schools provided release time when that person was a classroom teacher. In addition, technology was integrated differently at different grade levels. An increased focus on "technology as curriculum" was apparent at the upper grade levels. Schools involved their communities through long-term district plans for technology integration and school reform and by opening up school technology facilities for community use. In this way, their community was kept informed about progress and outcomes were visible for continued community support.

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