Helping Teachers Learn About and Use Technology Resources

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SUMMARY OF KEY FINDINGS

- Most teachers have not had suitable training to prepare them to use technology in their teaching. A majority of teachers report feeling inadequately trained to use technology resources, particularly computer-based technologies. Although many teachers see the value of *students* learning about computers and other technologies, some are not aware of the resources technology can offer them as professionals in carrying out the many aspects of their job.
- In a majority of schools, there is no onsite support person officially assigned to coordinate or facilitate the use of technologies. Even in schools where a technology coordinator exists, most of the time is spent supervising students, or selecting and maintaining software and equipment. Very little time goes directly to training or helping teachers use technologies.
- To use technology effectively, teachers need more than just training about how to work the machines and technical support. To achieve sustained use of technology, teachers need hands-on learning, time to experiment, easy access to equipment, and ready access to support personnel who can help them understand how to use technology well in their teaching practice and curriculum.
- Schools and school districts are using a number of different approaches for training teachers and implementing technology. These include developing "technology-rich" model schools; training a cadre of teachers who train and help their colleagues; providing expert resource people; giving every teacher a computer; training administrators alongside teachers; and establishing teacher resource centers. Data do not confirm that any one strategy is more effective than another; often they work in

combination. Districts may be well advised to use multiple training and support strategies tailored to the educational goals of the local site.
- Lessons from experienced implementation sites suggest that those who wish to invest in technology should plan to invest substantially in human resources. Currently most funds for technology are spent on hardware and software. Increasingly experienced technology-using sites advocate larger allocations for training and support.
- Support for technology use from the principal and other administrators, from parents and the community, and from colleagues can create a climate that encourages innovation and sustained use.
- Schools should avoid acquiring technology for technology's sake. Developing a technology plan—thinking through the goals for technology use at the local site and involving teachers in the planning process—is an important step in ensuring that the technology will be used by those it is intended to support. Many districts have found that it works best to start with small focused efforts, which can engender lessons, success, and experience before committing to more large-scale programs.
- Although sites have made significant progress in helping teachers learn to use generic technology tools such as word processing, databases, and desktop publishing, many still struggle with how to integrate technology into the curriculum. Curriculum integration is central if technology is to become a truly effective educational resource, yet true integration is a difficult, time-consuming, and resource-intensive endeavor. Research funding is needed to help explore and develop technology tools best suited for specific curriculum areas, especially disciplines other than science and math.

INTRODUCTION

As discussed in chapter 3, most schools and teachers today have at least some access to multiple kinds of video and computer-based technologies.[1] Yet much of this technology is not being used to its potential and most classroom environments are still not significantly influenced by technologies.

In contrast to chapter 2, which provided examples of promising uses to which teachers are putting new technologies, the first part of this chapter examines why teachers do not use technologies more and factors that affect how technology comes to be used in schools. This section draws on published surveys of technology use among teachers, the research literature on technology use, site visits made by Office of Technology Assessment staff to schools and districts throughout the country, a contracted series of interviews with and observations of teachers,[2] and conversations with hundreds of teachers and administrators at conferences and meetings and over electronic mail.

The chapter then describes some approaches schools have used to overcome barriers and implement educational technology more widely. Finally, drawing on places where technology has been a priority, the chapter suggests lessons learned about fostering technology implementation. In addition to the sources listed above, these sections draw on the research literature on educational and technological innovation, studies and evaluation reports from technology implementation projects, and a series of case studies contracted by OTA.[3]

FACTORS THAT INFLUENCE TECHNOLOGY USE BY TEACHERS

Why don't teachers make wider use of instructional technologies? What is the experience of teachers as they encounter new technologies in their schools? This section first provides a general

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[1] Most teachers do not yet have access to or experience with telecommunications networks and related technologies. See ch. 3.

[2] Melinda A. Griffith, "Technology in Schools: Hearing from the Teachers," Office of Technology Assessment contractor report, October 1993.

[3] John R. Mergendoller et al., "Case Studies of Exemplary Approaches to Training Teachers To Use Technology," Office of Technology Assessment contractor report, September 1994.

overview of some factors that influence the extent to which teachers use technology. These include availability, time, and differences among teachers in their attitudes toward change and technology. This section then focuses on three specific areas: 1) training and understanding, 2) onsite support, and 3) systemic factors such as planning and the assessment system.

Clearly, before teachers can use the technologies they must first have access to them. As chapter 3 has suggested, the amount of computer and video technologies used for instruction in schools has grown considerably in recent years. Most teachers now have some access to these technologies. Yet as chapter 3 has also illustrated, many of these technologies are not necessarily easy for teachers to access and use as part of their daily routines. In addition, a substantial portion of the school computer inventory is made up of older, less-powerful machines. Access to telecommunications technologies is especially limited. Beyond these problems of access to machines, however, lie a number of other important barriers to more widespread use of educational technologies by teachers.

First, it is important to recognize that technology tools require time to master. Hardware and software, no matter how "user-friendly," are complicated and constantly changing. In any profession, time must be invested in learning how to use a particular piece of software to accomplish work-related goals; furthermore, keeping up with upgrades or new software requires ongoing investments of time. But teachers, in particular, are "prisoners of time:" as a national study recently underscored.[4] American schools require teachers to spend the vast majority of the school day engaged in actual instruction, which leaves little official time for planning, preparation, or learning new things. **Even accomplished technology-using teachers, who are highly motivated, rated the lack of time as among the most problematic barriers to technology use in schools.**[5]

To learn to use new technologies, teachers need time for "hands-on" exploration and collaboration with colleagues.

Furthermore, teachers are an incredibly diverse group. Some teachers express eagerness to experiment with new ideas, even at the risk of failure, while others say they have little interest, energy, or time for experimentation.[6] The great majority of teachers probably lie somewhere in between these two poles. As one educator explained, "Most schools have a bell curve distribution of teachers ranging from the aggressive, active, enthusiastic innovators to those who are counting the hours until retirement."[7] Even the most energetic and inno-

4 National Commission on Time and Learning, *Prisoners of Time* (Washington, DC: U.S. Government Printing Office, April 1994).

5 Karen Sheingold and Martha Hadley, "Accomplished Teachers: Integrating Computers into Classroom Practice, "Center for Technology in Education, New York, NY, September 1990. See ch. 2 for further information on this study.

6 See, e.g., Michael Fullan, The New Meaning of Educational Change (New York: Teachers College press, 1991).

7 David Thornburg, quoted in Electronic Learning, vol. 13, No. 6, March 1994, p.16.

vative teachers experience many competing demands to learn new things—new curriculum standards, teaching methods, behavior management techniques, assessment methods, techniques for working with special needs children, and so on (see chapter 2).

This is also true when it comes to technology. Teachers, like others who use technology, fall along a bell curve in which there is a small percentage of innovators and visionaries eager to try new things, a larger number of those who follow the lead of others, and a small group who are skeptical of change[8] (see box 4-1). Teachers vary widely in their experience with and knowledge of technology. Some teachers already have computers at home, for example, while others have never been shown how to "boot one up." Some teachers may be unclear about what technology can offer them because they have had very limited experience with technologies or little exposure to models that use technology to enrich the curriculum, deliver instruction in different ways, or improve personal productivity. Furthermore, there probably are some teachers who will actively resist or avoid learning about technology for reasons that may not be well articulated.[9] The words of one high school geometry teacher illustrate that some teachers don't want to change:

> I'm the old-fashioned type—after so many years, you build up a file on your subjects. . .For me to go into teaching computers. . .I would have to start all over. I would have to actually sit down and work everything out, and it would require a lot more work on my part to run a class the way I want it run. . . I just don't want to do it. . .Don't want to change.[10]

The kinds of pedagogical beliefs and practices a teacher holds may also influence whether he or she uses technology.[11] For example, one interview study found that "high-tech" teachers tended to hold a student-centered approach to learning (e.g., inquiry methods, collaborative learning, hands-on practices) and had used the technologies to implement this philosophy.[12] The "low-tech" teachers (those who, despite being given opportunities to use technologies, were not doing so) were more diverse in their teaching approaches. Some held student-centered educational beliefs but were reluctant to use technologies because of personal fears or inhibitions or because of problems with accessibility and scheduling of equipment. Others were described as taking more traditional approaches to teaching (e.g., following the routines of the textbook, using a lecture format); these teachers reported not using technology because they feared it would undermine their authority with students or because they felt pressed by the number of district-mandated curriculum requirements and therefore did not feel they had instructional time to give to additional activities.

No systematic data exist to tell us what constitutes the normative "technology experience" of teachers in schools today, nor whether technology is more readily used by certain kinds of teachers. However, talking to teachers—hearing their concerns and stories—can help in finding what is required to encourage more widespread use of

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[8] See, e.g., Geoffrey A. Moore, *Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers* (New York, NY: Harper Business, 1991).

[9] See, e.g., Ronald G. Ragsdale, *Permissible Computing in Education* (New York: Praeger, 1988).

[10] Janet Ward Schofield, *Computers and Classroom Culture* (New York: Cambridge University Press, in press), ch. 4.

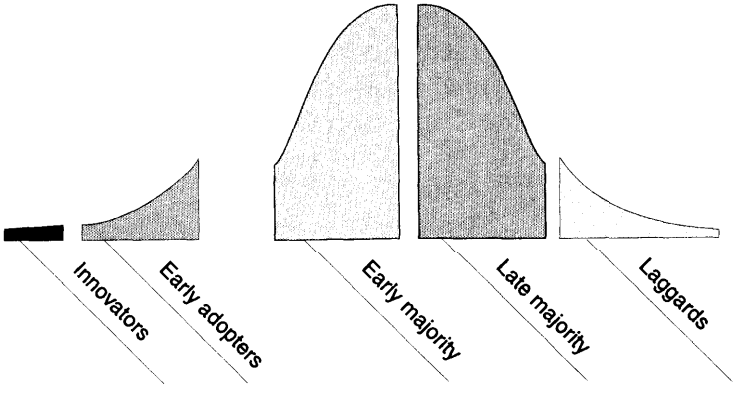
[11] See, e.g., Larry Cuban, *Teachers and Machines: The Classroom Use of Technology Since 1920* (New York: Teachers College Press, 1986); Larry Cuban, "Public School Teachers Using Machines in the Next Decade," Office of Technology Assessment contractor report, Oct. 8, 1994.

[12] "High-tech" and "low-tech" teachers were identified in each district by the district computer coordinators. Margaret Honey and Babette Moeller, *Teachers' Beliefs and Technology Integration: Different Values, Different Understandings*, Center for Technology in Education, Technical Report No. 6 (New York, NY: Bank Street College of Education, August 1990).

BOX 4-1: Acceptance of New Technologies: A Marketing Theory

This figure illustrates one market-based model of how any new technology product attracts new customers throughout its life cycle. The very small group of *innovators* pursue new technology products aggressively; they are "technologists" and make technology purchases simply for the pleasure of exploring the new technology product. *Ear/y adopters* are not technologists, but find it easy to imagine and understand the benefits of a new technology. According to this theory, there is a large "chasm" or gap between the early adopters and the next and much larger group-the *ear/y majority*. Winning the interest of the early majority is key to market success since they represent about one-third of the consumers; this groups shares some of the early adopter's ability to relate to technology, but they are also driven by a strong sense of practicality. These individuals want to see "well-established references" before investing substantially. This chasm exists, in part, because these individuals do not want to have to "debug" someone else's product—they want their technology to work properly and to be easily integrated.

The Technology Adoption Life Cycle



The *late majority* differs from the early majority mostly in that they feel less comfortable about their own ability to handle a technology product. As a result, this large group (again about one-third of the total) wants to wait until something has become an established standard. Finally, there are the *laggards* who don't want anything to do with the new technology. Generally, in marketing plans, laggards are viewed as not worth pursuing.

This model suggests that within any group of individuals, such as teachers, there will be tremendous variability in their willingness to explore and accept new technologies. Clearly there is a small group of teachers who have been active innovators and have eagerly embraced new technologies in schools. Similarly many schools have teachers who could be called "early adopters. " But today, the challenge may still lie in "crossing the chasm" and getting the next, and much larger, group of teachers sold on the usefulness and practicality of technology use for them.

SOURCE: Geoffrey A. Moore, *Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers* (New York, NY: Harper Business, 1991).

technology. In the section that follows, a number of common barriers that have been identified in the technology implementation literature will be discussed and highlighted from the teacher's perspective. In a real school setting, some, all, or none of these barriers--or other barriers-maybe present. The discussion that follows is not meant to reify these barriers or make teachers or policymakers feel that the situation is hopeless. Rather, it is intended to help alert policymakers and other readers to factors they should consider if they desire to integrate technology into teaching and learning.

Training in Technology Use and Understanding Potential Applications

Teachers' Perceptions

When asked what would help them use technology better, many teachers mention the need for more knowledge about how to use various technologies. **For some, this means operational skills, i.e., how to make the technology *work*.** In one survey, a majority of teachers said that they felt they needed training in order to adequately use a personal computer (56 percent), standard computer software (61 percent), multimedia software (62 percent), instructional videodiscs (67 percent), and online databases (72 percent). Far fewer felt the need for training in using video resources; only 7 percent of teachers said they needed training to adequately use a videocassette recorder (VCR), 9 percent for a television monitor, and 14 percent for instructional videotapes.[13]

Some teachers worry that their lack of knowledge might result in embarrassment or "feeling like a fool" in front of their students. For some teachers, this situation may be intolerable. As one teacher said:

> You can't have trouble or be messing with the machine in front of a class. It may be due to my lack of confidence, but I have to be comfortable with it if I'm going to use. . . My computer phobia, I'm actually over that. I'm not afraid of using the machine anymore, like I was, but I am afraid of how they [the students] might react.[14]

For other teachers, the greater need is understanding what the technologies can *do*. Many teachers have not had the opportunity to observe and learn about the wide range of educational uses to which technology can be put—particularly various ways it can be incorporated into different curricular areas. For example, evidence collected by OTA suggests that some non-technology-using teachers, while they endorse the importance of student access to computers and other technologies, don't see why technology should be used in **their** classrooms or what resources technology can offer **them** as they try to meet their instructional goals. One high school teacher, who did not use the computer he had been given for his class of gifted and talented students, explained, "It didn't do anything I couldn't do easier and cheaper on the blackboard."[15] In that same high school, a home economics teacher stated, "If I could see a really good use for a computer I would use one. . .but I have yet to think of anything I could do on a computer that I can't do by myself just as well."[16]

Teachers who want to use technology also may find that educating themselves enough to be able to use a particular piece of hardware or software can require considerable amounts of extra time and effort.[17] One teacher, who described himself as a technology "want-to-be," said, "It is just prohibitive time-wise to go through and read through everything, to figure out how to do everything, every time I want to do something new."[18] Furthermore, finding and integrating software into the existing curriculum can be difficult without a fairly comprehensive knowledge of available software.

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[13] National Education Association, *Status of the American Public School Teacher,* 1990-91 (Washington, DC: 1992).

[14] Keith F. Allum, "Technological Innovation in a High School Mathematics Department: A Structural and Cultural Analysis," unpublished Ph.D. dissertation, Princeton University, June 1991, p. 185.

[15] Schofield, op. cit., footnote 10, ch. 4.

[16] Ibid.

[17] Susan A. Zammit, "Factors Facilitating or Hindering the Use of Computers in Schools," *Educational Research,* vol. 34, No. 1, spring 1992, pp. 57-66; Barbara Means et al., *Using Technology To Support Education Reform (*Washington, DC: U.S. Department of Education, September 1993).

[18] Griffith, op. cit., footnote 2, p. 57.

Teachers may also need more knowledge about how to organize and effectively manage their students in technology-based environments. Some teachers have just one or two computers in a classroom, and are not sure how to use them well when only few students at a time can work on the computer. One teacher described the problem of managing a classroom of students with limited technology this way:

> It is hard enough to figure out how you are going to allow 25 students access to the computer and equal time.. .That's a huge task, and if you don't really know the benefits and the advantages and the disadvantages and all the things that whatever system you have and whatever software you have can offer, the management is just such a nightmare that you turnoff the whole thing.[19]

Even when teachers have more equipment orchestrating its use often requires knowledge about how to really teach with it or how to organize learning activities to make optimal use of the technology. For example, one French teacher had to learn how to structure her classes differently once she got technology; eventually she learned how to rotate her students through workstations that included a station with computers for drill and practice and a station with tape recorders for oral language practice:

> It was a 9th-grade class, and most of the kids. . have already worked in a class where a number of things are going on at a time, so it didn't bother them at all. It drove me crazy, but I could see it was benefiting them. I felt tom. I wanted to be with this [student]. I wanted to be with that group. It was just a question of convincing my soul that when there is noise and everybody is doing something different, learning is taking place. It's difficult for me.[20]

Teachers who want to integrate technology into their classrooms need to bear in mind the time and effort required to preview and select appropriate software materials.

Availability of Training

How much actual training or coursework about technology and its educational uses have teachers had? Available data suggest that most teachers have had very little. In one survey, less than half of the American schools reported that an introductory computer course is available (either in the district or at a local college) for their teachers.[21] This pattern was particularly pronounced among teachers in middle schools, where only 27 percent of schools reported the availability of such a course compared with 51 percent of high schools and 43 percent of elementary schools.[22]

As regards video, a different set of data found that fewer than one-fourth of teachers reported having had training in the instructional uses of video or television. Fewer than one teacher in 20 reported having received formal training over the past three years in such topics as evaluating video

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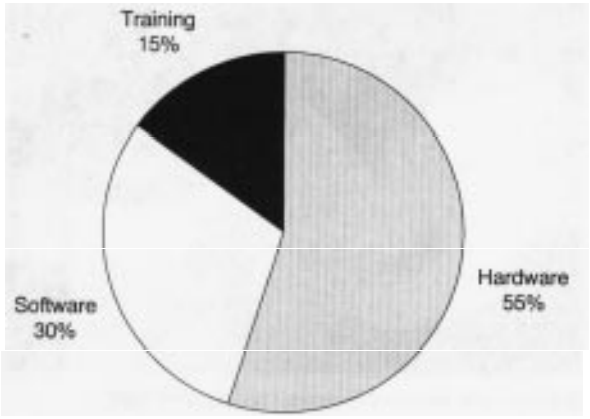
[19] Ibid., p. 54.

[20] Schofield, op. cit., footnote 10, ch. 4.

[21] Ronald E. Anderson (ed.), *Computers in American Schools 1992: An Overview,* IEA Computers in Education Study, (Minneapolis: MN, 1993), pp. 52-53.

[22] Ibid.

FIGURE 4-1: District Computer Budgets: Estimated Allocations, 1992-93



NOTE: District Computer technology coordinators were asked to estimate the amount of their total computer budgets spent in the above three categories, N = 3,927.

SOURCE: Market Data Retrieval, *Education and Technology,* 1993: A *Survey of the K-72 Mar/ret* **(Shelton, CT: 1993), p. 11.**

programming or curriculum coordination using instructional television (ITV) materials.[23] As noted above, however, this is an area where teachers feel more comfortable, and less in need of training.

Data on expenditures for educational technology indicate that far more resources have been allocated to hardware and software than to training or technical support. For example, in 1992-93, a national survey asked district technology coordinators to estimate how much of their total district computer budgets fell into each of these three categories. This survey found that approximately 55 percent of all technology spending goes to hardware, while software spending accounts for another 30 percent (see figure 4-l). Training accounted for only 15 percent. Noting that a higher portion of technology budgets is now devoted to software, the authors suggest:

> At one point in time, districts expected that teachers would create software and budgeted no dollars toward software purchasing. That has changed dramatically over the past 10 years. If any problem remains, it is found in the percentage of overall budgets devoted to computer training.[24]

These national patterns are reflected in an evaluation study of a major Educational Technology Initiative in Utah that provided schools across the state with money for technology. In the third year of the initiative (1992-93), the average Utah elementary school received $15,365 and spent 68 percent on hardware, 20 percent on software, 6 percent on repairs, and 6 percent on training. With its budget of $31,369, the average Utah secondary school allocated 75 percent to hardware, 15 percent to software, 6 percent to repairs, and 4 percent to training.[25] Data from the evaluation indicated that inservice training, though limited, had an important effect-teachers who received inservice training were more likely to use computer technology than teachers who did not receive training. Furthermore, teachers receiving training were more likely to use computers to stimulate higher-order thinking and creativity. Overall, however, the evaluators of the Utah project concluded that the current allocation of funding to inservice training was not sufficient to realize the potential of the state's considerable investment in hardware.[26]

As states such as Utah gain more experience with technology implementation, more are be-

[23] Andrew L. Russell and Thomas R. Curtin, *Study of School Uses of Television and Video: 1990-91 School Year* (Arlington, VA: Corporation for Public Broadcasting, February 1993).

[24] Market Data Retrieval, *Education and Technology, 1993: A Survey of the K-12 Market* (Shelton, CT: MDR, 1993), p. 11.

[25] John R. Mergendoller et al., *The Utah Educational Technology Initiative: Evaluation Update* (Novato, CA: Beryl Buck Institute for Education, January 1994), p. 11.

26 John R. Mergendoller et al., *Instructional Utilization, Teacher Training and Implementation of Utah's Educational Technology Initiative in School Districts and Colleges* (Novato, CA: Beryl Buck Institute for Education, June 1992).

coming convinced of the importance of investing substantially in technology training, especially in the early years of the technology adoption process. For example, Florida has revised its policy toward technology training. For the 1993-94 school year, the Florida legislature allocated $55 million for educational technology and $8.65 million for educational software. The appropriation required that schools applying for these technology funds set aside at least 30 percent of the money for training.[27] The Texas Education Agency recently recommended that districts allocate a substantial portion of their technology funds for staff development, suggesting that districts just getting started allocate 30 percent of their technology funds to hardware, 30 percent to software, 30 percent to staff development, and 10 percent to maintenance.[28] While Washington State does not require inservice training in technology, the state spends about 40 percent of its $4.5 million technology budget on teacher training activities (see box 4-2).[29]

One of the barriers to increasing technology training for teachers is the many competing priorities for limited staff development time.[30] This makes scheduling technology training difficult. Districts have multiple instructional goals, approaches, and philosophies they want teachers to learn about and use. In one district, for example, where the integration of "whole language"[31] teaching into the curriculum is the current educational priority, training not directly related to this goal is discouraged because it takes time that the central administration wants teachers to use for implementation of the whole language techniques.[32]

Nature of Training

The *kind* of technology training provided is as important to teachers as the availability of training. Some teachers observe that the content of training they receive is inadequate; there seems to be a focus on basic training in the mechanics of operating the machines, with little training about integrating technology into various subjects or learning to use it as a pedagogical tool. One observational study of computer use in a high school found that:

> One of the characteristics of the training teachers were most likely to complain about was its restricted technical focus. Specifically, teachers tended to be critical of the fact that the training often focused primarily on issues such as how to operate the computer without giving them much advice or assistance with two fundamental issues. . .what software was available to assist in accomplishing their educational objectives and how to organize the class to make efficient and effective use of students' time when there were a small number of computers in the classroom.[33]

Poorly timed or piecemeal training can also be a problem. Sometimes training is provided before the hardware or software arrives or before teachers know what equipment they will be using. One teacher described her school's policy in this way:

> Technology acquisition seems to have been done very piecemeal. We acquired certain pieces of equipment. We acquired certain kinds of software, whether someone donated it or we purchased it or the librarian wanted it or the computer specialist wanted it. . .It's difficult enough to sort of initiate getting training on a certain kind of equipment and then. . .the next

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[27] "A Technology-Ready State," *Electronic Learning*, vol. 13, No. 2, October 1993, p. 58.

[28] Mergendoller et al., op. cit., footnote 3, p. 6.

[29] R. Anderson, "State Technology Activities Related to Teachers," Office of Technology Assessment contractor report, Nov. 14, 1994.

[30] See, e.g., Jonathan W. Gallishaw, "The Integration of Technology into Education: A Study of Schools in Southeastern Massachusetts," thesis submitted to the graduate school of Bridgewater State College, May 1994.

[31] *Whole language* is an approach to teaching reading in which students learn words in context rather than by phonetics.

[32] Griffith, op. cit., footnote 2, pp. 25-26.

[33] Schofield, op. cit., footnote 10, ch. 4.

BOX 4-2: Teacher Inservice Technology Training: State Requirements and Resources

A recent OTA-sponsored telephone survey and review of state literature found that states rarely mandate inservice training in technology for teachers. Only Alabama and the District of Columbia require any inservice training in computers or technology for all teachers, In Alabama, five days of general teacher training are required per year; some of these inservice days must include some training about technology, but local districts can decide how much. Alabama also requires additional training for personnel who will serve as computer assistants and computer education teachers. Alabama has several state Department of Education staff assigned to assist schools with their technology training and followup, including technical assistance at school sites. The District of Columbia's recertification process requires that each teacher complete five credit hours of technology instruction (60 hours) every five years. The District's central training center has a small staff of persons who not only assist in the technology training but work with the schools on technology problems throughout the year.

Until this year, Texas required a minimum of 20 hours of inservice training per year for all teachers, in a range of areas. A recent change in legislation now allows local districts to set their own standards, Texas funds the majority of the teacher technology training in the state through 20 regional service centers. Mississippi is developing a new state educational technology plan that is projected to include a specific requirement for inservice technology training.

While most states do not mandate technology training for teachers, some support training in other ways by "strongly" recommending training, providing offsite resources, or encouraging local districts to provide funding for training. For example, Vermont strongly recommends that districts provide training for teachers in "all forms of educational technology. " Florida established technology centers at universities and other sites to provide resources, training, and curriculum development services.

Montana has established 15 regional training centers, interconnected by a state telecommunications network, the Montana Educational Technology Network (METNET). METNET facilitates the sharing of teaching resources among the centers through bulletin board systems that feature curriculum guides, lesson plans, and cooperative learning projects.

SOURCE: Ronald E. Anderson, "State Technology Activities Related to Teachers, " Off Ice of Technology Assessment contractor report, Nov. 14, 1994.

> year might come and you are faced with new equipment, something you are not really familiar with. [34]

It is also a challenge to structure training for teachers with widely varying experience with and knowledge about technology. Finding oneself in a training session that is too complicated or advanced can be especially frustrating and discouraging for the novice technology user, as a school librarian described:

> I went to an all-day training session. ..1 didn't even know the basics of computers. . .At one point they were talking about a menu. I started wiping my glasses. ..1 kept cleaning my glasses looking for the word menu. Then I got upset, started running to the bathroom like a child because I don't know what is going on here. Finally I raised my hand timidly. [I said] "I don't see anything that looks like food. . ." It was overwhelming for me. ..1 was not computer literate. [35]

[34] Griffith, op. cit., footnote 2, pp. 52-53.

[35] Schofield, op. cit., footnote 10, ch. 4.

■ Onsite Support and Assistance

Teachers' Perceptions

Typically, formal training sessions in the uses and mechanics of educational technologies provide only the basic knowledge that gives teachers an impetus to further experiment. Beyond this, teachers consistently report that having a person at the school site who can help them makes all the difference in the likelihood of their going further with technology-someone who is knowledgeable about technology and can help them with questions or problems. For example, when asked what one factor would help her decide whether and how to use a computer, one teacher replied:

> If I could have a few hours one-to-one with a really competent teacher that has used it—just let me ask questions [about] what I'm afraid of about a computer, what I don't understand.[36]

The inevitable technical and logistical problems that arise with technology are one reason many teachers feel the need for onsite assistance. These include such problems as machines that won't work as promised, restricted access to locked closets filled with equipment, media carts that must be scheduled and shared among many classrooms, equipment that remains broken for weeks or even months because no one knows how to fix it and repair requests take weeks or months to process. For example, one teacher who had to coordinate computer use with others in her grade, said that she would rather not have the computer than to "scuffle around the school" looking for it. It had become a "pain," rather than an asset to the classroom.[37]

Problems with scheduling shared resources such as computers in a lab can also create frustration.[38] For example, one elementary school teacher reported that all teachers at her school are scheduled to use the computer lab twice a week for half an hour at a time. Some teachers purposefully miss the time slots: "You're not supposed to, but people do, because it is a pain." According to this teacher, the scheduled time slots are too short to accomplish anything, the lab itself is poorly organized, and "some of that stuff up there is so old. . . and there are always a couple of computers broken."[39]

Technical support is important in schools, but teachers also need informal, onsite assistance with tasks such as setting up equipment in class or trouble-shooting problems with hardware or software.

Even experienced technology-using teachers can find themselves preoccupied with trouble-shooting hardware and software problems, rather than assisting students in their learning activities. The following notes made by a researcher observing a high school lab illustrate the trials that can arise; in this case, three teachers, all fairly knowledgeable, were trying to help a half-dozen or so students who liked to use the computer lab during their lunch time:

> The students. . continue to have a lot of very nitty-gritty problems. Kathy can't get the printer going. . .She's scowling and says in an annoyed tone of voice, "Please help me." Mr. East sug-

36 Ibid., p. 28.

37 Griffith, op. cit., footnote 2.

38 Zammit, op. cit., footnote 17.

39 Griffith, op. cit., footnote 2, p. 42

> gests several things, and after they try out four or five different approaches they finally get the paper to print out. Ms. Prentiss has been working with Sharon on word processing. . .For the last 10 minutes cries like, "I don't believe it" and "Oh, no. Not again!" have been emanating from both of them. . .She can't get [a second] printer to work. . .At this point Mark calls to Ms. Prentiss, "I need help. . ." Ms. Prentiss puts her head down on the desk briefly. She looks at me with what appears to be a mixture of mock and real despair and trudges over to Mark. [Later in the same period] Dan is trying to use a printer which Mr. East thought he had fixed. Dan's essay comes out quadruple spaced. In addition, every single word is underlined. Ms. Prentiss looks at it and breaks into almost hysterical laughter. Dan looks annoyed. Ms. Prentiss says, "I'm sorry, this is just too much—too, too much!. . ." Mr. Adams and Mr. East are still working on the second malfunctioning printer. Mr. Adams says, "You know I have a trick. What I do with my [home] computer is just turn it on its side and hit it. Maybe that will work here. . ." They turn it on its side and give it a whack as one of them holds the tension on the paper feed. The machine begins to work.[40]

As the above examples suggest, a great deal of what teachers need to know about technology cannot wait for a scheduled training session. As do most individuals dealing with new technologies, teachers also need informal assistance—often with a kind of immediacy that does not lend itself to afterschool telephone calls. This kind of assistance might include help setting up equipment or trouble-shooting hardware and software problems in the classroom—the more "nuts and bolts" kind of technical support.

However, as discussed in the next section, teachers also need pedagogical support such as advice on choosing relevant software and integrating it into a specific lesson, suggestions for ways the technology can be used to meet particular curricular goals, or ideas about how to organize the whole class to use four computer workstations or a single computer with a modem. Some schools attempt to overcome these barriers by having a person onsite who has responsibility for technology coordination within the building.

Availability of Onsite Computer Support[41]

OTA finds that onsite technology support personnel for assisting teachers are limited in most schools. The percentage of schools that assign a full-time nonteaching position to coordinate teachers' and students' computer use did not change at all between 1989 and 1992 and remains very small. In 1992, as in 1989, only 6 percent of elementary schools and 3 percent of secondary schools employed a full-time school-level computer coordinator who did not also have teaching responsibilities. In nearly three-fifths of all schools, there was no one in the school who had any portion of their workweek officially allocated to coordinating or supervising the computer program. In about one-fifth of these schools, one person, usually a regular teacher or the school media specialist, has at least half of the job officially defined in terms of computer coordination responsibilities.

In those schools where there is a "major" computer coordinator, how do they report spending their time?[42] As a group, the "major" computer coordinators report spending an average of 38 hours per week on tasks associated with computer coordination. But working with teachers to use

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[40] Schofield, op. cit., footnote 10, ch. 4.

[41] Data in this section are from the 1992 International Association for the Evaluation of Educational Achievements (IEA) Computers in Education Study as described in Henry J. Becker, "Analysis and Trends of School Use of New Information Technologies," Office of Technology Assessment contractor report, March 1994. For further description of the IEA study and its findings, see ch. 3 and app. B.

[42] For this analysis, "major computer coordinators" includes two groups—"official computer coordinators," those whose official job descriptions included at least half-time computer coordination duties, and those who reported spending at least 20 hours per week on the tasks of a coordinator, even though their "official" job description required less.

computers is a very small part of their job, taking up an average of only 3.6 hours per week, or less than 10 percent of their total computer coordination time.[43] Most of their coordination time is spent teaching or supervising students who are using computers in computer education classes or in other subjects. Hardware and software maintenance occupies a larger percentage of time for this group, on average, than working with teachers. **Thus, OTA finds that even schools with an onsite coordinator do not provide teachers with very much school-based assistance with computers.**

Onsite Support for Instructional Television and Video[44]

Although two-thirds of schools have a person designated as a coordinator of instructional television or video, it is very rare for this to be a full-time position. In all but 3 percent of schools surveyed in 1990-91, that person had other duties; most often he or she was the school librarian, or else was a teacher, computer coordinator, or administrator.

Whatever their other responsibilities, ITV coordinators performed a variety of support functions. As reported by the school principals, these included recording programs for teachers' later use (in 81 percent of all schools), distributing teacher guides to programs (82 percent), assisting with equipment (90 percent), training teachers to use video in their teaching (56 percent), coordinating previews and screenings (53 percent), and helping to produce instructional TV and video materials (35 percent). Mirroring the fact that video is used more in secondary schools than elementary schools, ITV coordinators at the secondary level seemed to have more varied responsibilities than those in elementary schools.

Systemic Factors Influencing Technology Use

In the last several decades, researchers have begun to understand some of the processes involved in bringing about change in schools. Effective implementation of new practices or innovations in schools is influenced by many factors; these determine the extent to which new educational practices are adopted and maintained over time. Schools are organizations with many different players and constituencies. Some school cultures promote and encourage innovation, others do not. Teachers are only one part of this complex system that includes district administrators, principals, parents, students, local communities, and governmental agencies.[45]

Some educators think that training and onsite assistance are the primary ingredients necessary to facilitate widespread technology use among teachers. **While these ingredients are important, OTA finds they are not sufficient to assure that technology will be explored and used by the majority of teachers in a school or district.** Other factors that affect whether teachers use technology resources include policies that encourage teacher experimentation and collaboration, the presence of incentives for teacher use of technology, administrative leadership about technology, and public understanding and endorsement of the importance of technology as a learning and teaching tool. Two of the most critical among these are:

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[43] The "official" computer coordinators (that is, those with job definitions where computer coordination responsibilities constitute at least one-half of their job) spend somewhat more time in teacher training, but even they average only five hours per week in that activity.

[44] Data in this section are drawn from Andrew L. Russell and Thomas R. Curtin, "Study of School Uses of Television and Video: 1990-91 School Year," Corporation for Public Broadcasting, February 1993, as described in Henry J. Becker, Office of Technology Assessment contractor report, March 1994. For further description of the CPB survey and its findings, see ch. 3 and app. B.

[45] See, e.g., Michael G. Fullan, op. cit., footnote 6; William A. Firestone and H. Dickson Corbett, "Planned Organizational Change," in Norman J. Boyan (ed.), *Handbook of Research on Educational Administration* (New York: Longman, 1988); David K. Cohen, "Educational Technology and School Organization," in Raymond S. Nickerson and Philip P. Zodhiates, *Technology in Education: Look Toward 2020* (Hillsdale, NJ: Lawrence Erlbaum, 1988).

- having a vision and plan for using technology to meet instructional and professional goals, and
- evaluation and assessment policies that encourage technology use.

Clarity of Goals: Articulating an Educational Rationale for Technology Use

As explained in chapter 2, teachers who are experienced technology users can cite many reasons for using technology in their classrooms. Less experienced users, however, sometimes give rather vague rationales for adopting technology—for example, "because students need to be exposed to technology; it's the future"—reasons that do not offer a vision of how technology might be used or a clear directive as to what a teacher might need to do differently.

It is not only teachers that may lack a clear understanding of what technology can offer them, however. Responding to external pressures to "modernize," some schools and districts have acquired technology without a clear goal or educational rationale for its use.[46] For example, a computer lab might symbolize to parents and the public that a school is well-equipped to prepare children for the world of the future, even if the computers are never turned on. As one teacher said:

> [Having a computer lab is] something you can brag about to parents. . .We're in direct competition with private schools and Mr. Miller, the vice-principals, and the counselors romance the parents at the beginning of 9th grade. "You sure want to send your students here. . .Let me show you what's going on. . ." They [visit] the room downstairs showing them the marvelous new machines. . .which many private schools simply cannot afford.[47]

Furthermore, many school systems have not begun to explore the ways that technology can help them function better or differently as institutions and workplaces. **Few teachers have been encouraged to view new technologies as professional tools that can help them do their jobs better, more efficiently, or in new ways.** For many teachers, the technology that has most revolutionized their working life has been the copying machine; not only has the drudgery of the ditto machine and preparing masters been eliminated, but copying substantially broadens the range of materials a teacher can easily make available to students. Yet, some teachers report that access to and use of copying machines is restricted or cumbersome in their school buildings—for example, there may be long lines at machines during precious times when teachers are not in charge of their students or budgetary restrictions on the amount of paper teachers are allowed to use. When so many schools do not encourage teachers to use even the most basic labor-saving tools, it is not surprising to find that teachers are not supported in using more advanced technologies.

Compatible Assessment and Evaluation Systems

Ultimately, teachers will evaluate themselves and be evaluated by others based on the performance of their students. Teachers may be reluctant to experiment with new ways of teaching or new technological tools unless they are reasonably sure results will be reflected in improved student test scores.[48] Seldom can such an assurance be made, because **traditional standardized tests may not**

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[46] Means et al., op. cit., footnote 17.

[47] Janet W. Schofield and David Verban, "Barriers and Incentives to Computer Usage in Teaching," Technical Report No. 1, Learning Research and Development Center, September 1988, pp. 30-31.

[48] U.S. Congress, Office of Technology Assessment, *Testing in American Schools: Asking the Right Questions*, OTA-SET-519 (Washington, DC: U.S. Government Printing Office, February 1992).

be particularly good measures of the kinds of learning fostered by innovative uses of some technologies.[49] This problem was illustrated by the experience of a California school that purchased computers for all its students and teachers, as well as videodisc players and television production equipment. These technologies were used for challenging projects, such as producing a television news show, that required students to work together and engage in planning and solving problems.

When test scores on the Iowa Test of Basic Skills for the first year of this project failed to show any increases, disillusionment set in. The computers were removed from students' desks or even sold and a new school board, stressing a "back-to-basics" approach, was selected. All this happened in spite of the fact that the new approach had hardly been in place long enough to reasonably be expected to show a strong impact and that the Iowa tests are not an appropriate measure of the ability to work cooperatively or to plan complex projects.[50]

The evaluation and assessment system by which teachers are judged can be either an incentive or disincentive for technology use by teachers. When decisions regarding promotions or tenure take technology use and expertise into account, teachers are encouraged to experiment and work in this area. Furthermore, if teachers are expected to use technology as a tool in their own development, this sends strong signals to the profession. For example, teachers seeking national "Master Teacher" certification from the National Board of Professional Teaching Standards must fulfill a number of requirements to apply for the certification, including using technology to videotape their own classroom instruction and going to an assessment center to evaluate other teachers' videotapes of instructional practices.[51]

High school teachers develop their own projects as part of a TERC LabNet workshop, where they learn how to implement project-based investigations in their classrooms.

However, evaluating teachers on how often or how well they use technology in their teaching can have drawbacks, especially if, for example, the principal is not well versed in the various ways teachers can use technology effectively. Moreover, teachers may feel it is unfair to evaluate them if they have not received training and support in technology use. For example, one teacher who shared a computer among three classrooms admitted to her principal during her end-of-the-year evaluation that she did not use the computer much. She cited the logistical struggles associated

49 Means, op. cit., footnote 17; Joan L. Herman "Evaluating the Effects of Technology in School Reform" in B. Means (ed.), *Technology and Education Reform: The Reality Behind The Promise (San* Francisco: Jossey-Bass, 1994).

50 Means, op. cit., footnmote 17, p. 88.

51 Lynda Richardson, "First 81 Teachers Qualify for National Certification," The New York Times, Jan. 6, 1995, pp. **A-1, 16.**

with sharing the computer and the problems stemming from a lack of any computer experience or training. This teacher was marked down on her evaluation form for not using the computer, and her overall rating was lowered from "outstanding" to "good." The teacher felt quite angry about this, stating, "If she wants me to use it, then she needs to train me and she needs to have a computer available in my room."[52]

APPROACHES TO ENHANCE TECHNOLOGY IMPLEMENTATION

Overview

There are many schools that have thriving technology efforts, and many teachers who are using technology adeptly. The experiences of these places and people offer examples of strategies, pitfalls, and lessons for others that are beginning the process of integrating technology into teaching and learning.

Through case studies, a workshop, site visits, and literature reviews, OTA has examined the experience of schools, districts, and states where the adoption of technology has been made a priority.[53] Many of these places were "early adopters" and have several years of experience with the process of technology diffusion. How have they gone about infusing technology into classrooms? What resources, such as training, onsite support, planning, and more, have these places provided teachers to help them learn about technology and understand how it might help them meet their educational goals? What incentives have these sites offered teachers to enlist their interest, enthusiasm, and commitment? What other conditions are necessary to assure that technology is used effectively?

Schools and districts have undertaken different strategies to get technologies used more widely in their educational programs. These approaches share certain characteristics and they are not mutually exclusive; most schools combine more than one approach. The choice of approach will vary depending on the educational goals a site hopes to achieve with its technology and existing technological and human resources at the site. There are not a great deal of independent data on the effectiveness of these different strategies or which ones work best for different goals or in various kinds of schools. In describing these strategies, OTA offers examples of approaches that districts and schools say have worked for them.

Behind each technology implementation strategy lies a set of decisions about how best to allocate scarce technology resources. Each place has made decisions about how to invest in and distribute hardware and software—not only which technology to buy, but whether to concentrate re-

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[52] Griffith, op. cit., footnote 2, p. 60.

[53] In addition to the works directly cited, the next two sections also draw on the following: Arkansas Department of Education, *IMPAC Phase I Research and Phase II Programs: Instructional Microcomputer Project for Arkansas Classrooms* (Little Rock, AK: 1992); California Department of Education, *Building the Future: K-12 Network Technology Planning Guide* (Sacramento, CA: 1994); Central Kitsap School District, *Strategy 2020: Creating a Culture for Change* (Silverdale, WA: 1991); Chapel Hill-Carrboro City Schools, *Moving Ahead with a Vision of Instructional Technology Use* (Chapel Hill, NC: spring 1991); J.D. Ellis, "Teacher Development in Advanced Educational Technology," *Journal of Science Education and Technology*, vol. 1, No. 1, 1992, pp. 49-65; M. Fullan, M.B. Miles, and S.E. Anderson, *Strategies for Implementing Microcomputers in Schools: The Ontario Case* (Toronto: Ministry of Education of Ontario, 1988); D.S. Hurst, "Teaching Technology to Teachers," *Educational Leadership*, vol. 51, No. 7, April 1994; S. Milton et al., *Microcomputers and Other Educational Technology in the Florida Public Schools: Impact, Access, Implementation and Policy Issues* (Tallahassee, FL: Center for Policy Studies in Education, June 1989); S.E. Persky, "What Contributes to Teacher Development in Technology?" *Educational Technology*, vol. 30, No. 4, 1990, pp. 34-38; D. Paul, "An Integration/Inservice Model That Works," *T.H.E. Journal*, vol. 21, No. 9, April 1994, pp. 60-62; J.D. Russell, D. Sorge, and D. Brickner, "Improving Technology Implementation in Grades 5-12 with the ASSURE Model," *T.H.E. Journal*, vol. 21, No. 9, April 1994, pp. 66-70; J.H. Sandholtz, C. Ringstaff, and D.C. Dwyer, *Teaching in High-Tech Environments: Classroom Management Revisited, First-Fourth Year Findings*, Apple Classrooms of Tomorrow Report #10 (Cupertino, CA: Apple Computer, Inc., 1990); L. Schrum, "Tales from the Trenches: Educators' Perspective on Technology Implementation," *Journal of Technology and Teacher Education*, vol. 1, No. 4, 1993, pp. 409-421; P.A. Sturdivant, "Technology Training. . . Some Lessons Can Be Learned," *Educational Technology*, vol. 29, No. 3, 1989, pp. 31-35.

sources to make some sites "technology rich" or spread the technology more thinly across many more sites. For example, some states and districts have created ***model technology schools,*** described more fully below, choosing to invest heavily in a limited number of "technology-rich" sites. Even within a building, there can be different models of implementation: distributing technology resources evenly among classes, as opposed to placing all the technology in a lab or other central location or targeting placement in certain classrooms, grades, or curricular departments.

Schools and districts must also determine how to allocate human resource investments to assure that the technology will be used effectively in school buildings. Most of the strategies described below make significant investments in three elements of teacher support: appropriate and timely training; expertise to support and help teachers; and time for teachers to learn, "mess around" with technology, and work with colleagues. Some sites have chosen to develop a few "master teachers" at a site who are then responsible for teaching and training their colleagues, referred to as the ***"train-the-trainers"*** strategy. Other sites choose to invest more in providing an ***onsite expert,*** such as technology coordinator, who can support teachers and keep the school moving forward on incorporating new technologies. Still others choose to distribute the expertise by providing a critical mass of teachers at one site with technology tools and opportunities to learn, experiment, and adapt the technology to their own instructional needs. Additionally, ***giving every teacher a computer,*** training ***school and district administrators*** and establishing ***technology resource centers are*** implementation strategies, often used in combination with these other approaches. Each of these strategies is described in the section below.

■ Training the Trainers

A common strategy used to train teachers in many different topic areas is the "train-the-trainers" approach. In this model, selected teachers—those who are most enthusiastic and motivated to learn about a particular topic—are given intensive training. These teachers return to their buildings where they demonstrate and provide onsite training in the new techniques to other teachers. Teacher-trainers can share new knowledge with other teachers in any number of ways, including one-on-one peer tutoring or school-sponsored workshops on release days or in the summer. An advantage of this model is that teacher-trainers can continue to be available to other staff after the formal training has ended.

In the "train-the-trainers" model, teachers are selected for extensive technology training in specific applications so they can then return to their schools and train other teachers to implement those technologies.

This train-the-trainers model has been used to support school improvement and change for a variety of curricular and pedagogical goals in the past, and has also been adopted in some places to facilitate the integration of technology into classrooms. For example, in 1984-85 the Jefferson County (Kentucky) School District launched a major four-year plan, called the New Kid in School Project.[54] A 32-unit networked computer lab was installed in each of the district's 87 elementary schools and five teachers from each school were chosen to participate in a 60-hour training program at a central district site. These

[54] Mergendoller et al., op. cit., footnote 3.

teachers were then expected to train other teachers in their schools. The district offered participating teachers release time, stipends, and inservice credit for their training activities. Jefferson County used the same training approach when it implemented major technology initiatives in its middle and high schools. An independent evaluation of the New Kid in School Project, six years after its inception, concluded that the trained teachers had emerged as instructional leaders in their schools and took key roles in managing and guiding technology use.

The idea of training more than one person from a site seemed to be a key ingredient for the project's success. As one superintendent said, "The change process follows an old notion, that two people in a building can support each other and encourage the change to take hold."[55] However, training teachers in groups is not the only factor required for success.

Another factor critical to the success of many train-the-trainers projects is the availability of support and resources for the teacher-trainers once they return to their buildings. If these trained teachers are expected to share their knowledge with colleagues, they must be given time and administrative support. Furthermore, research suggests that there are personal characteristics that affect success; effective onsite technology leaders need interpersonal and organizational skills, as well as technical knowledge, in order to interest and motivate colleagues less inclined toward using new technology.[56]

An extension of the basic train-the-trainers model is being used at Webster Elementary School, a model technology school in St. Augustine, Florida. When their technology program began in 1989, the school held training sessions for all staff two afternoons a week, from 2:45 p.m. to 3:30 p.m., as part of the normal workday. As teachers began to feel comfortable with the technology and show enthusiasm, planners offered them the opportunity to become an expert in a particular piece of hardware or software. Those who were interested were given extra time to learn about the technology, more one-on-one training, and opportunities to attend technology conferences. A central list identifying these "experts" was posted in the building, and when other teachers had problems with a particular piece of hardware or software, they could consult the resident expert. According to the principal, teachers have developed pride in their new skills and have become quite self-sufficient. Technology use within the building no longer depends on outside facilitators or a single onsite expert. The principal notes with pride, "Our teacher experts do the training."[57]

Providing Appropriate Technology Resource Personnel

Several models have been used to supply the continuing specialized technology support that teachers find so valuable. These include providing temporary onsite support from commercial vendors or the school or district, or continuing support provided onsite by the school or the district.

At the beginning of a technology initiative, when a school is implementing a new technology plan or making a significant investment in hardware, bringing in a facilitator or resource person from outside of the school may be an important component of that plan. Research on implementa-

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[55] Ibid., pp. 7.4.

[56] For example, see Neal B. Strudler, "The Role of School-Based Technology Coordinators as Change Agents in Elementary School Programs: A Follow-Up Study," paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA, Apr. 5, 1994; Matthew B. Miles, E.R. Saxl, and A. Lieberman, "What Skills Do Educational 'Change Agents' Need? An Empirical View," *Curriculum Inquiry,* vo1. 8, No. 2, 1988, pp. 157-193.

[57] Cathy Hutchins and Roger Coffee, "Teacher Experts: Empowering Staff Through Technology," paper presented at the meeting of the National Association of Elementary Principals, Orlando, FL, Mar. 8, 1994, p. 2.

tion of innovations in schools has consistently shown that onsite assistance contributes to effective implementation of new ideas.[58] For example, if a commercial vendor is supplying a large amount of software and hardware to a site, its package will often include a resource person, employed by the vendor, who spends a designated amount of time at the site training teachers and helping to "work out the glitches" with the technology. Alternatively the district or school may commit funds for a district employee or teacher at the school to facilitate the technology implementation for an initial year or two. Often this strategy assumes that the facilitators will "work themselves out of a job" after the initial implementation phase.

Some evidence suggests, however, that it may be difficult for onsite technology facilitators to phase themselves out completely. A researcher who visited three Oregon schools to observe the computer programs at two different points in time, seven years apart reported:

> During the initial study, all of the [computer] coordinators projected that they would work themselves out of their jobs in anywhere from two to five years. Implicit in this goal was the idea that as teachers became comfortable with computers and various software programs, they would eventually use them in their teaching and no longer rely upon the help of a coordinator. While this is a laudable goal to work toward, in retrospect, it underestimated complexity of educational change with technology and the amount of sustained effort that it would require of teachers. . .
>
> Three factors. . .contributed to the difficulty that coordinators found as they attempted to "work themselves out of their jobs": the rapid pace of technological change as it pertains to schools, the concerns of teachers that appear to affect their adoption of technology-based innovations, and the need for coordinating the "nuts and bolts" of educational computing.[59]

Regarding the ongoing concerns of teachers, the researcher wrote:

> When will technology become a high enough priority for a majority of teachers so that they pursue it as a regular part of their professional responsibilities? Data gathered indicate that we are still in an awkward transition period in which the benefits of teaching and learning with technology do not necessarily outweigh the costs. While teachers are increasingly citing the benefits that students derive from computer use, they must weigh the costs in terms of their time and the difficulties of managing to find appropriate software and then get adequate computer access for their students. It follows that as the quantity and quality of technology-based applications increase in the schools, more teachers will make technology a high priority. Meanwhile, the support provided by an effective coordinator serves to "tip the scales" for teachers weighing the costs and benefits of technology use.[60]

Jefferson County (Kentucky) provides an example of a districtwide attempt to provide a centralized resource pool of experts who advise and train teachers.[61] This very large urban district (96,000 students, 5,000 teachers, 153 schools) has been expanding and refining a major technology initiative begun in 1984. The District's Computer Education Support Unit, now staffed by 22 people, has primary responsibility for countywide technology training and support. In addition, the support unit has many other responsibilities, including helping schools determine their technology needs, integrating technology into the cur-

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[58] Firestone and Corbett, op. cit., footnote 45.

[59] Strudler, op. cit., footnote 56, p. 18.

[60] Ibid., p. 19.

[61] Mergendoller et al., op. cit., footnote 3.

riculum, and overseeing implementation of the state technology guidelines. To provide technical support, the support unit maintains a "help desk" that any county public school employee can call with a question; the help desk receives 20 to 30 questions a day. Support unit staff have prepared 50 independent inservice units on topics that range from basic computer operation, to software selection and use, to integrating video into instruction. The unit has several training rooms set up with appropriate equipment, where inservice workshops for teachers are held. Twelve Computer Inservice Teachers are employed by the support unit to provide direct support to teachers and schools (see box 4-3). This is a coveted position; last year the unit received 60 applications for two positions. In 1993, the support unit cost approximately $916,000 for staff operation—a tiny fraction (0.2 percent) of the district's $500 million budget.[62]

Model Technology Schools and Classrooms

A number of states and districts have set up model technology schools, that is, regular schools in which a special emphasis is placed on developing student skills with and through the use of technology. By creating technology-rich environments and enlisting the involvement of those teachers and administrators who are most enthusiastic, model technology sites can "pave the way" for other schools to follow and can yield lessons to guide later technology investments. These sites can also serve as living laboratories that others can visit and learn from.

Monterey Model Technology Schools (MMTS) Project is one such example—a partnership between the Monterey Peninsula Unified School District and the California Department of Education.[63] The MMTS project represents one of six projects funded by the California Department of Education "to develop and validate a wide range of technology-based instructional and administrative programs, practices and planning procedures to be disseminated to other schools throughout California."[64] Although there are 24 schools in the Monterey Peninsula Unified School District, only four (two elementary, one middle, and one high school) are Model Technology Schools. The four schools were selected not on the basis of their readiness to adopt technology, but on two other criteria—schools had to be located in a community where the demographics of the student body mirrored the state as a whole, and the schools participating had to provide a continuum (i.e., the elementary schools fed into a participating middle school and then the participating high school).

The project was funded by the state, and all teachers in the participating schools—whose interest in and familiarity with technology varied greatly—were asked to commit themselves to the project.[65] It was recognized that teachers embrace instructional technology use at different rates. By bringing together the technologically naive and fearful with the proficient and adventurous, it is possible to build a climate of mutual support and a culture of school technology use. It was anticipated that this process was more likely to be ex-

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[62] Overall, Jefferson County Schools spent about 1 percent of the yearly budget on technology purchases, installation, upkeep, and support. Ibid.

[63] Ibid.

[64] J.D. Cradler et al., *Monterey Model Technology Schools: Cumulative Research and Evaluation Report,* 1987-1992 (as cited in Mergendoller et al., op. cit., footnote 3, p. 6.4).

[65] Those who did not want to work in a school endorsing substantial technology use were given the opportunity to transfer to other schools in the district, but none did. Some teachers chose not to participate during the first year of the project; some of these teachers and some others later transferred to other schools or retired.

BOX 4-3: Computer Inservice Teachers in Jefferson County

In Jefferson County, Kentucky, 12 computer inservice teachers (CITs) work directly with the teachers in the districts' 153 schools. Each CIT is currently assigned to 16 schools, a challenging load in the opinion of many. Typical duties include:

- talking on the phone or in person with school technology coordinators to schedule teacher training workshops or ensure that the pace of the school's technology spending is on track;
- trouble-shooting software and hardware problems;
- ordering equipment for schools through the district's procurement service;
- working with individual teachers to integrate technology into their instruction;
- working with the school technology committee and the technology coordinator to review school technology needs and prepare a technology plan;
- presenting three-hour afterschool workshops for the teachers in their assigned schools; and
- presenting all-day workshops on a particular computer topic such as Hypercard or using spreadsheets in history classes.

With so many different demands, CITs have found that they must rely on each other for expertise and support. CITs carry a Powerbook with an internal modem. This allows them to access the Computer Support Unit e-mail system, and leave and receive messages for each other or their supervisors at any time. Although the expertise of each CIT is somewhat different, they share a core knowledge about feasible ways to integrate technology into instruction. As one CIT put it:

> We start with curriculum first, We ask teachers, "What do you want to do?" Then we look to see how technology can accomplish it. But it always comes back to the *curriculum first.* Do you really need the technology, or have you just been sold a line?

The CITs respect the teachers they work with and appreciate the human dimension to technology infusion. As one teacher told us:

> Computer Resource people are not insulting when they talk with you. And the attention and support they give you is just incredible. They don't tell you what to do, they invite you to do it. They just put this little bug in your ear and walk away. "You know, " they say, "You really should try telecommunications. Take a look at this World Classroom program...." and then you think, "Hmmm. This does look interesting. ." The Computer Inservice Teachers set the stage and the environment, and then I drive myself to learn it.

Another teacher talked about the informal process of technology infusion that occurs within a school:

> First the Computer Inservice Teachers help you. And then you finally get it down and it spreads. It's exciting Other teachers see you using technology. All you got to do is show what your kids are doing to another teacher. They see that the kids are so excited and learning things and they want to do it in their class. So they learn it, and the teacher next door comes down and says, "Now Cindy's kids are using computers; I want mine to use them too. When are you going to show me how to do it?"

SOURCE: John R. Mergendoller et al , "Case Studies of Exemplary Approaches to Training Teachers to Use Technology, " Off Ice of Technology Assessment contractor report, September 1994, pp. 18-19.

portable to other schools than selecting a school where all teachers are "ready" to use technology.

Originally funded in 1987, the first five years were focused on developing technology implementation projects and training, with dissemination activities targeted for year six onward. First-year training centered on "Technology Awareness Days" focused around the subject areas of language arts, mathematics, and science, to provide a general overview of what could be accomplished with educational technology. Gradually, what began as a technology training program

At Monterey Model Technology Schools, teachers produce a video for dissemination to other schools as part of the district's teacher training.

evolved into instructional mentoring, changing the focus from broad curriculum areas and operating skills to an emphasis on targeted student outcomes and behaviors. At this point, MMTS developed the Classroom Intervention Plan (CIP), which became the centerpiece of the MMTS technology infusion model. Each teacher or teacher team develops a CIP outlining the curriculum emphasis (and its relationship to their school's planning goals and those of the California curriculum framework), the desired and measurable end results; the necessary hardware, materials, and staff development; the evaluation plan; products and procedures for dissemination; and a budget (including substitute time). In addition to hosting scheduled visits by interested teachers and administrators, the Model Technology Schools provide three types of training and dissemination activities to teachers from Monterey and other districts in California:

1. **Technology Demonstration Centers.** Teachers who are well-trained veterans of the MMTS program hold a day-long session in which they demonstrate their knowledge for a group of 2 to 12 teachers. Topics include such things as InfoTrek and Telecommunications, Logo in Mathematics Courses, Using Laptops for Process Writing, and Using Video and Camcorders across the Curriculum.
2. **Technology Training Seminars.** More extensive two-day hands-on training workshops are offered to teachers on six different technology configurations: Telecommunications, One-Computer Classroom, Laptops and Process Writing, Multimedia, Video, Instructional Television. Teams of at least two teachers from the same school must attend together to facilitate support when they return. In addition to spending considerable time on hands-on exploration of hardware and courseware, participating teachers develop an individual project to use in their own classrooms.
3. **Teacher Productions. The** MMTS teachers have produced several documents, discs, and videos showcasing the projects they have implemented in their classrooms. These are based on the CIPS described above. Selected project descriptions and productions in the MMTS products catalog are shown in box 4-4.

On a smaller scale, some schools or districts have chosen to start with model technology classrooms instead of schools. The Integrated Technology Classrooms (ITC), begun in 1987 in Bellevue, Washington, are one such example.[66] Under a pilot program in two elementary classrooms, teachers who had demonstrated enthusiasm for using computers were given a range of instructional technologies. The theory was that concentrating technology expenditures in a single classroom would demonstrate the value of technologies.

The program has been very popular and successful in drawing in other teachers. The number of ITC classrooms has grown from two in 1988 to more than 60 today. The ITC teachers, each in a different school, have worked with colleagues in their buildings to model technology use and help teach others about it.

[66] Mersendoller et al., op. cit., footnote 3.

BOX 4-4: Teacher Productions Showcasing Promising Practices

The following are examples of handbooks, software, and videos produced by Monterey Model Technology School teachers to illustrate technology activities they have used in their classrooms.

Minds in Motion

A series of learning activities for the elementary classroom using LogoWriter™ and Lego® logo kits in cooperative learning groups.

Integrating Technology into the California Writing Project

This guide stands as a roadmap for teachers who wish to enhance the writing process through the use of instructional television, video, and computer technology.

Into the Eye of the Atom

This physical science unit has been developed to assist students in visualizing and conceptualizing the structure of atoms and molecules using laser, video, and computer technology.

Database of Dietary Choice

A guide to creative uses of databases and spreadsheets in the home economics curriculum.

The Whole CAKE: Computers Assisting Kids in Education

A team of elementary teachers developed this integrated, technology-based instructional model to help students improve their oral and written expression, increase exposure to quality literature, develop good handwriting skills, and improve the quality of television viewing.

Lit Vid Kits

This model was developed as a means of creating motivating language arts experiences in a school-to-home format for elementary students. Its focus is on English language acquisition and non-English-speaking parent education. It includes reading, listening, viewing, speaking, and writing activities related to thematic units in literature and science (available in English or Spanish).

An Integrated Approach to Geometry Using Manipulative, Robotics, and Computers

This collection of classroom learning activities was developed to meet the needs of middle school students facing difficulties in mastering geometric concepts.

Echoes

This kit provides teachers with a model for developing units that intensify student interest in civics and economics and enhance cooperation in teamwork settings.

ARTT

This resource outlines planning, building and management of video libraries to enhance the instructional process in a secondary arts program.

SOURCE. California Model Technology Schools Project-Monterey, 1995.

Giving Every Teacher a Computer

Although this strategy is still quite rare and experimental, some schools and districts are giving each teacher a computer to use as a personal and professional productivity tool. As discussed in chapter 2, computers can help teachers carry out many aspects of their job, such as keeping records, updating lesson plans, and constructing tests. The rationale is that as teachers begin to see direct benefits from technology, in terms of saving time or expediting routine tasks, they will become more motivated to learn about computers. And as teachers gain confidence with and understanding of computers and related technologies in their own work, they may begin to experiment with using technologies with their students. While some training is still important in this strategy, the real learning is believed to come from giving teachers unlimited access to the technology (and potentially more time on the equipment), new motivation for learning to use it, and a community of peers who are trying to master the same tools. Because teachers do much of their planning and paper work at home, some sites allow teachers to take their computers home routinely or keep them there; others provide laptop computers they can carry back and forth.

One innovative program that uses this strategy, and is sponsored by the Indiana Department of Education, is called A Computer for Every Teacher (CET). Begun in 1990, CET made competitive grants to four small schools on the basis of proposals. Participating schools had to assure that all teachers and other professional staff in the school would participate. Every teacher in the funded schools received a computer and printer for use at home or in school, as they saw fit. The program aimed:

> . . .to improve teacher productivity and enhance teacher professionalism with the long-range goal of improving student performance. It is based on the belief that teachers are information-age professionals who should be using contemporary technology to accomplish their work. By using such technology, their personal productivity will improve and, consequently, so will their instructional efforts and impacts in the classroom.[67]

CET program grants covered training that focused on basic computer functions and software selected by each school. Training at all sites included basic elements of wordprocessing, graphics, spreadsheets, and databases; most teachers were also taught how to use a gradebook program. Participants viewed the requirement to involve all professional staff as an important component of the program; "everyone means teachers, administrators, and support staff, all working together on the same tasks of mastering computers and software."[68]

This formal, public commitment also gave leverage to the coordinators when it was time to train the school staff. While there was some reluctance—and training did not turn around every teacher—almost all teachers and administrators learned how to accomplish some basic functions on the computer. An outside evaluation of the project two years after it had been implemented in the four sites concluded that the program was highly successful in meeting its goals and helped teachers improve their productivity, enhance their sense of professionalism, and increase individual and institutional esteem.[69] (See box 2-6 in chapter 2.)

Results of another experiment in Utah, the "Lifestyle Change" Project, indicated that teachers are highly motivated by the opportunity to have a computer of their own. Recognizing the drawbacks of training teachers to use technology that is only sporadically available to them, this

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[67] Saul Rockman, James Pershing, and William Ware, "Productivity, Professionalism, and Empowerment: Given a Computer for Every Teacher," report prepared for the Indiana State Department of Education, October 1992, p. 3.

[68] Ibid., p. iv.

[69] Ibid.

project put a computer in the hands of all teachers and administrators in Utah's Morgan School District. To qualify for a computer, which could be used at school or at home, teachers had to complete a comprehensive program of training, including a course introducing Macintosh hardware, a gradebook package, word processing, graphics manipulation, a program for developing classroom tests, Hypercard for software authoring, and a course on videodisc/CD-ROM. Teachers were also required to complete a portfolio of computer-generated materials such as gradesheets, worksheets, Hypercard stacks, videodisc lessons, and word-processed documents.

An outside evaluation of the Lifestyle Change Project concluded:

> The "Lifestyles" Project of the Morgan School District has succeeded in enlisting the active involvement of 84 out of 86 potential participants. From the results of a written questionnaire, a series of interviews, onsite observations, and an examination of individual assignments completed, the Project receives high marks for both involvement and attitude change. Along a number of dimensions. . . this has the earmarks of being a superior project.[70]

Training Administrators

Research on the adoption of innovations in schools consistently points to the key role of administrative leaders in successful implementation. Involved and supportive superintendents are central to districtwide reform efforts, and principals are key to implementation within the school building?[71] **OTA has consistently found that when administrators are informed about and comfortable with technology, they become key players in leading and supporting technology integration activities in their schools.**[72] Some technology implementation efforts are building on these lessons by including principals or other key administrative staff in training opportunities offered to teachers.

Including principals in school-based technology training means they will be informed and comfortable with the technology, and more likely to provide leadership and support for school wide technology use.

One approaches to include principals in school-based teams chosen to receive intensive training in technology use. For example, the Apple Classroom of Tomorrow Teacher Development Center Project looks at the commitment of the principal when selecting teacher teams for training. Not only are principals encouraged to attend portions of the training program with the teacher team, but they also must commit to the following conditions: release time for teachers to attend project training sessions, time for teachers to meet and

70 Nick Eastmond and Inhae Kim, "An Evaluation of the Project 'A Lifestyle Change' Final Report," unpublished manuscript, Apr. 9, 1992, pp. 22-23.

71 Fullan, op. cit., footnote 6; Firestone and Corbett, op. cit., footnote 45.

72 See, U.S.Congress, Office of Technology Assessment, *Power On!: New Tools for Teaching and Learning,* OTA SET-379 (Washington DC: U.S. Government Printing Office, September *1988); Linking for Learning: A New Course for Education,* OTA-SET-430 (Washington, DC: U.S. Government Printing Office, November 1989); Mergendoller et al., op. cit., footnote 3; Griffith, op. cit., footnote **2.**

plan each day, time for teachers to reflect on practice, and acknowledgment of the importance of their teachers' efforts to the rest of the staff.[73]

Since 1990, Indiana has sponsored a statewide training program specifically for principals. In its first two years, the Principals' Technology Leadership Training Program served almost 400 Indiana principals.[74] Over the course of a year, each principal takes four days of professional training with other principals at a central site. By scheduling sessions at different points in the year, the program built in time for principals to go back to their schools, practice what they learned, and talk to staff and better define what they needed and wanted. In the workshops, principals learned about a broad range of technology and software available for classroom and office use and had a chance for hands-on exploration of a large collection of equipment.

Participating principals have been very enthusiastic about the Technology Leadership Program. In addition to reporting that they felt more confident and credible in dealing with technology, and better able to use technology for administrative tasks, participating principals said they were more capable of creatively using capital project funds, writing grants, or justifying expenditures to school boards. After the training, many principals conducted training for their teachers; others reported that they were better equipped to think comprehensively about the technology in their schools and how best to use it. Principals rated an update session, held the following year, as very valuable, and most principals endorsed the need for some kind of ongoing "refresher programs."

Although there are no systematic data on the effects of training principals, the Apple Classroom of Tomorrow (ACOT) and Indiana examples demonstrate the feasibility and importance of enlisting principals in the diffusion of technology in schools.

Establishing Technology Resource Centers

Some states and districts have established technology resource centers where teachers can experiment with different hardware, try out software programs before buying, consult experts, and receive training. For example, Calcasieu Parish Schools in Lake Charles, Louisiana, established a district "Tech Center" that offers training on different technologies, a satellite dish to receive or record educational teleconferences, and online computer access to a library of over 100 current periodicals and other resources. The center remains open until 7 p.m., three nights a week, and is open on Saturday mornings.[75]

Texas supports 20 Regional Education Service Centers (RESC) that provide a wide range of services to school districts in their region on a variety of educational issues, including technology.[76] Although RESCs receive operating funds from many different budgets, the Texas Education Agency distributes $6 million a year to RESCs specifically to support technology initiatives. Each RESC has considerable flexibility in the way funds are used but is expected to carry out the following activities, at a minimum: 1) maintaining a Technology Preview Center where district personnel can "investigate and select technologies appropriate to meet local needs;" 2) helping districts train teachers, administrators and other staff in technology-related topics; 3) training first-year

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[73] Cathy Ringstaff, Keith Yocam, and David C. Dwyer, "ACOT Teacher Development Center Annual Progress Report: Year One," unpublished manuscript, n.d.

[74] S. Rockman and K.R. Sloan, "A Program That Works: Indiana's Principals' Technology Leadership Training Program," report prepared for the Indiana State Department of Education, San Francisco, CA, June 1993.

[75] As described in Metropolitan Education Research Consortium (MERC) Research Brief #8, "Developing Exemplary Technology-Using Teachers," May 1994, *MERC's Work*, vol. I, No. 2, 1994.

[76] Mergendoller et al., op. cit., footnote 3.

teachers in technology use; and 4) disseminating material from the Texas Center for Educational Technology. (See box 5-3 in chapter 5.)

A typical RESC has at least one training room equipped with computers, all with connections to TENET, the statewide computer network for teachers. Some of the computers also have network connections to the Internet. (See box 3-4 in chapter 3.) This room or an adjacent room generally serves as a Preview Center. RESCs purchase software and hardware for the center, and several software publishers provide copies of their products to each center at no charge. Most RESCs offer a continuous series of workshops, seminars, and training sessions on various topics related to technology use in schools; teachers are the primary users of these staff development activities. Larger RESCs have as many as five or six staff who work full time in the technology area.

LESSONS ABOUT TECHNOLOGY IMPLEMENTATION

Based on OTA-contracted case studies and site visits, and a number of other research and evaluation studies, OTA has drawn some lessons about how to foster effective use of technology by teachers in K-12 schools. Sites that have made technology a priority, such as those described above, provide lessons about how to implement new technologies, how to make decisions about acquisition and investment in technologies, and what kinds of support can help teachers use technology effectively. Leadership necessary to infuse technology comes from many sources: the state, the district, and the individual school (see box 4-5). Ideally, all these work together to support the teacher's efforts to learn about technology and use it to meet classroom goals.

Key Issues for Investing in Technology

Access

Several factors seem to be essential for making the best use of hardware and software in schools. The first condition is **ready access** to hardware and software. Access cannot be assessed simply by looking at the numbers—how much hardware and software a school owns tells you little about its accessibility. To be accessible, technology must be readily available for teachers to use when they need it:

> . . .not simply for uses that can be predicted in advance and squeezed into a fixed time slot. For example, teachers are far more likely to use video for instruction when the choice and timing are under their control. Similarly, teachers and administrators are less likely to use telecommunications networks when they must go to a remote location to do so. Nor can students exploit the full power of word processing if they must wait for their daily or weekly scheduled time in a lab.[77]

Ready access to equipment is also a precondition for teacher training. It is extremely frustrating for teachers to learn to use technology in a workshop, then return to a classroom that does not have it. Some have experimented with postworkshop "Try and Buy" programs that supply teachers with necessary equipment for four to six weeks or so, to enable them to become more familiar with a technology before the school decides whether it wants to buy it. Schools are trying to increase teacher access by letting them take equipment home.

Access also requires keeping hardware and software in up-to-date working order. For schools to incorporate technology into their program in a meaningful, long-term way, they must recognize

[77] Jane L. David, "Realizing the Promise of Technology: A Policy Perspective," in B. Means (ed.), op. cit., footnote 49, p. 178.

BOX 4-5: State Planning for Technology: The New Jersey Experience

The State of New Jersey provides an interesting example of the planning process involved in bringing technology into K-1 2 schools, and how that process has evolved over time.

In 1986, the New Jersey Department of Education developed *Education/ Technology in New Jersey: A Plan for Action,* which outlined the department's role in helping districts develop policies, practices, and programs to increase student learning through computers and other forms of educational technology. It was recognized that changes in technology would probably necessitate a new plan within a few years. In 1991 New Jersey Commissioner of Education John Ellis initiated a process for developing a statewide long-range plan for educational technology, an idea reinforced by the Quality Education Commission of New Jersey. In February 1992, the Department of Education formed a 60-member task force composed of individuals representing school districts, higher education, business and industry, research laboratories, museums, libraries, government and community agencies, and other major educational stakeholders. The task force produced the second version of *Education/ Technology in New Jersey: A P/an for Action,* completed in 1993.

The vision outlined in the 1993 plan is a bold one: "All New Jersey students will be able to use the tools of educational technology effectively, holding in their own hands the means to shape their own destinies.'" The outcomes envisioned in the plan include the following: student access to learning technologies, high-quality professional development and training for educators, multimedia workstations for all teachers, online access for administrators to gather and report data, school facility retrofitting to integrate technology throughout school operations, and equitable funding to each school district through a technology entitlement that provides funding on a per pupil basis each year to districts with an approved technology plan.

The overall plan has four broad "action plans" that were slated to be fully in place by 1997. These action plans are:

- ***Building Educational Leadership:*** "To establish coalitions of key stakeholders" that will build on the state's human, capital, and corporate resources and provide vision, leadership, and support to implement local technology plans.
- ***Preparing Educators for New Roles:*** "To provide educators with ongoing, accessible educational technology preservlce and inservice professional development opportunities that prepare them for new roles as facilitators of the learning process and improves instruction and learning. "
- ***Modernizing Learning Environments*** "To provide leadership with financial and legislative support to restructure the educational environment in school facilities" by constructing a voice, video, and data communication network in each school.
- ***Developing Networks and Technology Infrastructure*** "To provide vision, leadership, and support in the construction of statewide voice, video and data networks" to deliver timely resources and integrate data management among districts, other agencies, and the Department of Education. Networks will be governed by a coordinated organization with representation from public schools, libraries, vocational-technical centers, community colleges, four-year colleges or universities, government, and industry.

The second action plan, dealing with professional development, has five primary objectives:

- Establish a network for professional development with collaboration of K-12 education, higher education, and the private sector.
- Provide statewide support for ongoing, accessible staff development opportunities to integrate educational technology into Instruction.
- Provide resources to prepare educators for new roles, including the establishment of educational technology training and support centers.

[1] New Jersey Department of Education, *Educational Technology in New Jersey A Plan for Action* (Trenton, NJ April 1993), p I

BOX 4-5 (cont'd.): State Planning for Technology: The New Jersey Experience

- Collaborate with higher education institutions and classroom practitioners to develop and provide educational technology preservice opportunities.
- Prepare educators to use technology to acquire more detailed knowledge about student performance.

The implementation of the overall plan has been contingent on appropriations provided by the state legislature, Five funding recommendations were proposed for the state legislature:

- appropriate $50 per pupil for every full-time K-12 student in New Jersey public schools—roughly $60 million—and renew annually to keep the technology current;
- appropriate a one-time investment of approximately $8 million to fund development of a statewide fiber-optic telecommunications network capable of carrying voice, video, and data transmissions;
- provide an annual $1 billion appropriation to provide financial incentives, such as low-interest loans, to districts for construction and retrofitting projects to support technology infusion;
- create a "megasystem" for data management to streamline administrative tasks and increase communication between districts, agencies, and the state, at an estimated cost of $30 million over three years; and
- appropriate funds for technology modeling incentives to develop and demonstrate exemplary uses of educational technology, at a cost of $5 million the first year, $10 million the second, and $15 million the third.

The State Board of Education was encouraged to take a number of actions, including:

- requiring student performance proficiencies with the new and emerging technologies,
- requiring provisions for new and emerging technologies in new construction and retrofitting plans, and
- requiring staff training in technology be included with all technology purchases made by districts.

Recommendations were also made to the State Department of Education:

- create a clearinghouse of educational technology resources, accessible to the entire education community,
- provide technical assistance for the effective use of technology in the instructional process, and
- provide leadership in constructing and developing a statewide network and interagency data management system.

Local Education Agencies (districts) were encouraged to:

- develop and implement a multiyear technology plan;
- designate a technology coordinator for the district;
- designate funds for the purchase and maintenance of technology, and for professional development in technology use; and
- develop, approve, and implement a board policy on the infusion of technology into the curriculum and school operation.

Despite the extensive planning, assignment of responsibilities and attention to detail, political realities have made it difficult to carry out the plan as envisioned. The major barriers have been fiscal constraints and changing political administrations, which has meant re-submitting proposals many times over and subsequently losing valuable time. Two years ago, budget constraints led to a reduction in the staff of the state Educational Technologies Office from 11 to two. Governor Christine Todd Whitman's austerity program has also trimmed the budgets of most state agencies considerably. Nevertheless, the Educational Technologies Office has been able to maintain its efforts on a limited budget, and this year was granted a $500,000 appropriation with which to begin implementation of the technology plan.

SOURCE: Julia Stapleton, Education Technology Coordinator, New Jersey Department of Education, *Educational Technology in New Jersey:* A *Plan for Action* (Trenton, NJ: New Jersey Department of Education, April 1993).

that there will be considerable costs. Technology must be repaired, upgraded, and replaced. In addition, seemingly small but ongoing costs—paper, printer ribbons, discs—have been known to cripple some technology initiatives. **Schools must not view technology as a one-time investment but must budget for maintenance, upgrading, and replacement costs.**

Instructional Vision

A second factor related to equipment that schools should consider is the suitability of particular technologies. Available technology must be *suited to the educational goals* for which it is intended. Investments should not be made in technology for its own sake, but because it facilitates or extends instruction. **This requires that a well-defined instructional vision should precede the technological one; teacher involvement in defining this vision is essential.**

Most successful districts and schools have spent considerable time and effort planning for technology infusion before purchasing and distributing equipment. Often states or districts require individual schools or classrooms to develop a technology plan. The planning process requires people to think through the reasons for the technology before they buy it. It also helps to assure that sound educational reasons guide the technology decisions, instead of technology driving the educational process. Furthermore, the planning process brings people together and requires them to consider technological and instructional priorities. Although the resulting written plan affords a useful guide, it should be seen as a starting point, subject to revision over time. Nonetheless, it is the process itself that animates individuals, focuses their attention on instructional goals and technology's role in meeting them, and supports cultural changes in technology use.

Plans should not be ironclad; they should make it possible to revise or adapt as the implementation process proceeds. Lessons can be learned, and some parts of programs can be imported or changed. Sites have learned that they need to be flexible and encourage experimentation and sharing. **They have found that they have to expect to change and update their plans as the program evolves, as teachers gain expertise, and as technologies and applications advance.**

Sustainabilty

Programs have found that it is extremely important to think about continuation of the technology program from the beginning. Although seed money can get things started, a successful program will need to think about how technology use can be built into the continuing culture of the school. Research on organizational change has suggested that for innovations to be built into the organization on a regular and permanent basis, adjustments must be made in at least five ways:

- new practices must be codified as rules;
- curriculum must be revised to accommodate the innovation;
- training programs must be established for newcomers to the district;
- evaluation procedures have to reflect the new practice; and
- project-related activities must be supported as line items in the regular district budget.[78]

Key Issues for Investing in the Human Resources

Once a site has accessible technology suited to its particular purposes, what else is needed? Perhaps the most central lesson from successful implementation sites is that those who wish to invest in technology should also plan to invest substantially in human resources. For every investment in

[78] M. Huberman and M.B. Miles, *Innovation Up Close: How School Improvement Works* (New York: Plenum, 1984); Firestone and Corbett, op. cit., footnote 45, p. 331.

hardware or software made, there should be a substantial investment in human resources, through expenditures for training, technical support, maintenance, and time to learn to use the technology.

> Life cycle cost models from business and industry support the critical role of training and support. These models suggest that hardware and software reflect approximately 30 percent of the total system cost over the technology's life cycle. Too often funding initiatives ignore the entire set of funding components and focus on hardware and software. And yet, experience has shown that only by addressing the other components, as well as the hardware and software, will the technology expenditures be successful. This is most particularly true of the staff development cost component . . . Teachers need extensive and on-going training not only in how to use technology, but how to fully integrate it into their curriculum, instruction and assessment practices.[79]

Redefining Training

Some of what teachers can do with technology can be learned on their own through experimentation and self-instruction. But there are other things that teachers can learn best by attending a workshop or watching an experienced teacher. **A good staff development program will have opportunities for both types of learning.**

"Hands-on" training with technology is more than a gimmick or motivator; it is a necessity. Teachers must have the chance to make the computer (or camera or whatever) work and gain confidence in their own competence before trying the same thing with their class. Moreover, the different types and applications of technology will require different amounts and kinds of training, support, and mentoring. For example, learning to use a telephone voice-mail system for communicating with parents and teachers is likely to require less training than learning to create multimedia lessons using Hypercard and a videodisc player. There is no one generic course or workshop that can effectively teach teachers all that they need to know about technology.

In workshops, teachers have opportunities to explore different technologies in ways that can be transferred to the classroom.

There is abundant evidence that "one-shot" or short duration training programs have little impact. Teachers need time to learn, plan, try things out, reflect on their successes and failures, revise, and try again. This takes time—months, if not years.

Incentives like providing release time for teachers or paying them for staff development can increase the participation of teachers in good staff development programs. But release time can be problematic. Many teachers want to minimize the amount of time they spend outside their classrooms (and find the job of preparing plans for substitutes a time-consuming task). Some sites have tried to find creative and low-cost approaches to release time, such as conducting inservice activities onsite and having a teacher from the building as instructor (see box 4-6).

Staff development is most effective when it is individualized. This means matching learning opportunities to the needs of specific teachers so they can choose what they need to know, how they

79 Michael Radlick, *A Cost Model: Implementing Technology in New York State Public Schools* (Albany, NY: New York State Education Department, November 1994), p. 11.

BOX 4-6: SuperSubs: Making It Easier To Learn About Technology

When teachers leave the classroom, they usually prepare lesson plans for the substitute teacher (sub) who will take their place. Because the regular teachers are trying to guide a stranger into the instructional routines that are second nature for them, the sub release lesson plans are often much more detailed and take more time to prepare than a regular lesson plan. In the Monterey Model Technology Schools (MMTS), this caused a problem: teachers didn't want to take the time to be trained in technology use because each time they left their class to visit other classes or attend training sessions, they had to labor over lesson plans for their substitutes, But without the training, they couldn't use the technology.

The MMTS staff sought a "turnkey" solution: a generic substitute teacher who could come into a class with a minimum of preparation required of the teacher who was to be released. Since the project was about technology, they thought it would be appropriate if the substitute provided technology-based learning experiences while their regular teacher was also becoming more proficient in technology use. Another concern was that of cost. If considerable substitute activity was to be central to the training model, the substitute service had to be cost-effective.

Thus was born the "SuperSub Service, " a strategy that enabled MMTS staff to continue to individualize the staff development assistance they provided while reducing the burden teachers experienced when preparing for a substitute. Briefly, this strategy:

- provides for weekly release time for teachers during the work day (ranging from 45 to 270 minutes);
- removes the necessity for teachers to prepare lesson plans for the substitute teacher;
- provides a technology-enhanced problem-solving, critical-thinking skill development lesson aligned with the district curriculum for each SuperSub to deliver; and
- provides the teacher with written feedback about the SuperSub's lesson as well as a followup activity.

To maintain continuity and lower the cost, the SuperSub Service is staffed by four Monterey district teachers and administrators who elected to take early retirement. All district teachers who elect to retire before the mandatory retirement age are required to contribute 30 days of work to the district each year for three years. By drawing on this network of early retirees, the MMTS Project did not exacerbate the existing difficulty district schools have in finding qualified substitute teachers, and released the funds that would have been spent on substitute teachers for other purposes.

SuperSubs are equipped with an Apple portable computer, a LCD projection device, a notebook of lesson plans and suggested followup activities, necessary supplies such as scissors and crayons, and a letter the SuperSub can use to describe what went on while the regular teacher was away. A schedule of SuperSub visit days is established at the beginning of the school year. The schedule lists both the days SuperSubs are available and the staff development activities teachers can participate in on those days.

If the demand for SuperSubs is evidence of the program's effectiveness, this approach to provide release time for teachers is an effective one. Between the second and third year of the program, use of SuperSubs doubled, while use of full-day regular substitutes and afterschool training sessions declined. Project funds originally allocated for full-day substitutes were reallocated to additional instructional materials or attendance at technology conferences. Increasingly, teachers are using the SuperSub service as an opportunity to share their skills with their school colleagues or observe how their colleagues teach their classes. Teachers appreciate that their own professional development activities can be scheduled within *the school day at a time they choose.* They also like the continuity the SuperSub service provides—the same SuperSub returns several times over the course of the year and gets to know the students and the teachers, making the substitute teacher experience a more positive one for everyone involved.

SOURCE John R Mergendoller et al , "Case Studies of Exemplary Approaches to Training Teachers to Use Technology, " Office of Technology Assessment contractor report, September 1994

wish to learn it, and the time frame in which they will learn it. This matches the "just-in-time" training models increasingly adopted by business and industry.

Followup support and coaching after the initial learning experience are essential to effective staff development. Teachers cannot "learn all" they tried at a training session, even if it extends over several weeks. When they return to the classroom, the unexpected inevitably happens. At this point, teachers need to be able to access technical assistance and support. Some sites structure courses so that they meet periodically through the year or for a month or two, rather than one or two long days. Participants can try out new skills, practice, then come back to class and discuss or refine their approaches. During teachers' initial efforts to integrate technology into the classroom, it helps a great deal to have support immediately and continuously available. Increasingly, schools are finding that electronic networks linking participants with instructors and each other provides a resource for continuing support.

Technical and Pedagogical Assistance

Because districts, schools, and teachers vary widely in their "technological readiness," most successful sites have found that they need to provide a variety of resources and supports such as those described in this chapter. Some kind of onsite technical support—someone to set up, trouble-shoot and fix the machines—is usually necessary.

However, sites are increasingly realizing that it's not just technical expertise that is required of good support resource personnel. Some technology-using educators are arguing that a new kind of professional is needed in schools—conversant in the technical issues but also experienced and knowledgeable about teaching methods, curriculum, students, and instructional design.

Although most sites have made significant progress in helping teachers learn to use generic tools such as word processing, graphics, and desktop publishing, many are struggling with how to integrate technology into the curriculum. **Supporting teachers in their efforts to integrate technology throughout their teaching is central if technology is to become a truly effective educational resource, yet true integration is a difficult, time-consuming, and resource-intensive endeavor.** In many places technology is treated as a content area separate from the basic curricular areas. Students and teachers are expected to become skilled in using technological tools. Yet few resources and expertise are available to help teachers put the technology to work in delivering curriculum in traditional content areas, such as English, math, or social studies. Learning to use the hardware and master the software tools is not enough; learning how to teach with technology—harnessing the tools for instructional ends—is a much more complex and lengthy process.

If the goal of using technology is to change how teachers teach and how children learn (for example, adopting more cooperative learning or more student projects), then teachers will need support and training to learn new pedagogical methods as well. **More technology or more use of technology will not be sufficient to assure other innovations or reforms.** As discussed above, teachers and administrators also should have a shared educational philosophy and a shared vision of how technology can facilitate that philosophy.

To get going, many technology programs have had to rely on a few particularly eager and dedicated teachers in a school. However, burnout can also be a real problem for these teacher-innovators, who are actively exploring technology resources, trying to keep up with new developments, and helping their colleagues. If a site truly wants to encourage its expert teachers to help their colleagues, these individuals could be compensated and recognized for their efforts.

Although enthusiastic individuals may help spark technology efforts, experience suggests that schools should not rely exclusively on a small cadre of "gurus." **As a long-term strategy for continued technology use, expertise should be shared among multiple individuals at a single site.** It is easy for a school to fall back on a technol-

ogy guru who knows how to fix computers when they don't run and can suggest new strategies for using technology. But technology gurus may move to a new school, leaving the original school without a resource. Training multiple individuals increases the chances that expertise will remain.

Furthermore, **students can be effectively tapped as resources to help teachers with technology.** At some sites, teachers bring a student or two along to workshops or other learning experiences. They are eager, available, and "free" (see chapter 2). Some knowledgeable students become great resources for the teacher. However, this requires a teacher comfortable with letting some of the expertise reside with the student.

Incentives

Programs that seek to involve a large number of teachers should identify incentives that encourage teachers to use technology. Many teachers will not be motivated by the mere presence of more technology in their classrooms, but they can be motivated by a concrete vision of how it can help them meet their instructional goals. For example, encouraging teachers to find their own favorite uses of technology or develop specific areas of expertise can be an effective long-term strategy. As noted above, putting technology in the hands of teachers can be a good motivator for teachers. Some districts have given teachers computers as a "reward" for undertaking training.

Sites also have found that they may have to accept that some teachers will never really become interested in using technology. An alternative approach is to focus on gaining the interest and acceptance of a critical mass of teachers. For example, the technology coordinator in Bellevue, Washington, described three types of teachers: about 10 percent are the self-taught enthusiasts, highly motivated, who will try anything; about 60 percent are those making "hesitant progress," who like to take the classes and want to participate in technology in classrooms; and about 30 percent are resistant, don't take the class, or come only to get specific help with a particular problem. To reach this last group, Bellevue has encouraged more onsite inservice activities, conducted by a teacher in the building.[80]

Administrative and Community Backing

The role of the principal is crucial in promoting school technology use. Similarly, for technology to become diffused across a district, leadership by the central administration, especially the superintendent, is critical. These findings are supported by the organizational change research, which has consistently found that **change efforts do not succeed without active administrative leadership, particularly by principals**. Research has shown that leaders perform four important tasks: "(a) obtaining resources, (b) buffering the project from outside interference, (c) encouraging staff, and (d) adapting standard operating procedures to the project."[81]

Community support and understanding of the goals of technology use are also critical. Lessons from experienced sites indicate that without community support and buy-in, many new ideas fail to take hold in schools. Teachers and school administrators can educate and convince the community of the necessity and importance of their particular educational vision. As one noted researcher writes:

> An essential partner in any kind of educational regimen is the community, represented by many individuals ranging from respected elders to powerful business people and officials elected at the local and the national levels. In the United States today, probably the most important agents of change in the community are the parents, in their dual roles as advocates for their children and citizens of the society. . .If the

[80] Mergendoller et al., op. cit., footnote 3.

[81] Firestone and Corbett, op. cit., footnote 45, p. 330.

community fails to support the desires and standards of school people, the educators are destined to fail.[82]

Conclusions About the Process of Implementation

If there is a single overarching lesson about the process involved in these efforts it is that **effective technology implementation takes more time and effort than many anticipate when first undertaking technology initiatives.** Based on the experience of sites visited for this report, and reports in the literature, it appears that five years may be an appropriate time frame for large-scale technology infusion. Change is not sudden and dramatic; it takes hard work on the part of many people over time to see the benefits of these endeavors.

None of the schools or districts portrayed here has experienced a smooth or uncomplicated process of technology training and implementation. Changes have been continually necessary to overcome unforeseen obstacles, such as staff reassignments, delays in equipment delivery, gaps between technology knowledge and utilization, or budget cuts, or to capitalize on unexpected success. State, district, and school-technology staff have continually revised their technology implementation plans based on evaluation results or unexpected events.

Some sites have found that small efforts that focus on one educational need or goal can be an effective way to get started using technology. For example, technology implementation in the Monterey Model Technology Schools was instituted one classroom at a time, based on the teacher's Classroom Intervention Plan. Similarly, at Webster Elementary School in St. Augustine, Florida, teachers with expertise in a particular application became the role models for their colleagues. By staying small and focused, specific goals can be addressed and successful outcomes are more likely. Initial success engenders enthusiasm, interest, and confidence, which then begets more success.

Evidence clearly indicates that when conditions are right—resources, time, and support are high—exciting things happen in technology-rich school environments. A key issue today is how to disseminate broadly the lessons of certain schools. How can the technology tools and knowledge be shared with schools whose resources are not as rich? Or when teachers are not as enthusiastic, energetic, or motivated? Who can help to support states and districts in promoting and disseminating successful strategies (see chapters 1 and 6)? Future efforts should focus on better and more comprehensive dissemination strategies and on ways to seed more projects in more challenging school environments.

[82] Howard Gardner, *The Unschooled Mind* (New York, NY: Basic Books, 1991), p. 255.