

Connecting the Bits

A reference for using technology in teaching and learning in K-12 schools

Professional Development and Information Technologies

Introduction

Information technologies must play an important part in the education of America's children. Parents, students, and educators are united in the belief that a technologically rich curriculum is an essential component in preparing today's students for adulthood in the new millennium.

Schools are being wired. Many schools already have Internet connectivity; many also have their own local area networks. Further, local, state, and federal agencies are rapidly committing to connect every school classroom to the Internet.

There is wide public support for application of information technologies in education. Everyone wants students to use computers in schools. Yet, beyond computer literacy and willingness to learn new technologies, society has only the vaguest notion of what students should accomplish. The public understands little about how information technologies can most effectively enhance student learning and relies on educators to make prudent use of the considerable public investment in wiring the nation's schools.

Early efforts to integrate information technologies into the curriculum were pioneered by technologically literate teachers and educational researchers. Demonstrating both the practice and its effectiveness, their results helped galvanize the resolve of state and local districts to integrate technology and education. The goal was to enable large numbers of students to benefit from the technological revolution and its limitless contributions.

This paper discusses

- the need for technology-related professional development and the difficulty of integrating technology into teaching and learning;
- the key characteristics of high-quality professional development and their implications for technology;
- strategies for professional development that have promise for improving teacher knowledge and skills in technology;
- support, access, and structures that must be in place to help teachers make the most of technology-related professional development;
- assessment of the effectiveness of technology-based professional development;
- the promise of technology for improving professional development;
- an annotated bibliography.

As classrooms are wired, it is teachers who face the main challenge of figuring out how best to incorporate technology into their practice. They look to professional development to help them fulfill that mission. In a 1996 national poll conducted by the National Foundation for the Improvement of Education (NFIE), 93 percent of teachers placed “how to use information technologies for instructional purposes” as a top priority in striving for their overarching goal: helping students achieve. In survey after survey, these findings are consistent. Teachers recognize the importance of tapping into technology’s vast promise for enhancing teaching and learning, and they want to do it right.

One-shot workshops
are not the answer

Knowing how to integrate technology into the curriculum is a complex challenge. It will not be met by one-shot workshops. Instead, truly effective professional development in technology applications for educators is marked by several key components. Technologically proficient teaching and learning requires that teachers participate in ongoing individual and collegial study, reflective thinking, analysis of practice, and evaluation of student achievement. Such deep learning is job-embedded, rigorous, and systemically sustained—three hallmarks that differentiate solid, results-oriented professional development from the limited training reflected in much current practice.

Teacher learning is the key

NFIE focused on professional development as its primary strategy for exploring the best practice in the groundbreaking collaborations of its *Road Ahead* program. In this focus, NFIE drew upon decades of research and evaluation of what constitutes high-quality professional development. Consistently, the findings indicate that it is what teachers know and can do that makes the difference in improved student performance and that teacher learning is the key to helping students achieve. NFIE, the National Staff Development Council, and other groups have written extensively on this topic.

Two additional components augmented the strategy focusing on professional development in these school/community partnerships. The first was assigning experienced teacher mentors to each project site. Drawn from the ranks of successful NFIE grantees, these mentors had expertise relevant to the site's program but did not live in the same region. The second was developing online networks to facilitate communication among mentors, site teams, NFIE staff, and others who played a part in providing resources and support.

Mentors and online networks

The Road Ahead sites devoted an average of 36 percent of their grant budgets to professional development—a figure consistent with recommendations from research that schools spend about a dollar on technology-related professional development for every two dollars spent on technology acquisition and implementation (ISTE 1998). The total funding for professional development in *The Road Ahead* program was actually greater, because NFIE also conducted three national conferences for all the project teams as a main component of its professional development strategy.

36 percent of budgets
for professional development

This paper discusses recommendations for effective professional development resulting in technologically proficient teaching and learning. It is based on extensive research, collaboration among accomplished experts in technology education and practitioners in the field, and the results of the real-life application of these innovative programs. The discussion is centered upon field-tested programs and reflects the input of all that were involved in the programs' execution.

The Need for Technology-Based Professional Development

Technology can be a catalyst for changing how teachers teach, what they teach, and how they interact with students. It can also simplify routine responsibilities, thus freeing time for teachers by helping them and their students to work more efficiently.

Technology can facilitate teaching methods that build students' inquiry and problem-solving skills and their content knowledge in every subject. For example, students can gain access to a wealth of research sources and experts via the Internet, manipulate complex dynamic models and simulations, work cooperatively in small groups with portable technology, use multimedia tools to present what they have learned, and collaborate on projects with students around the world. Technology can accelerate changes in teacher roles, such as moving away from a lecture mode of instruction to one in which teachers coach students in solving complex, real-world problems.

When a teacher finds herself in a classroom with six computers, Internet connectivity, a wide array of software, and a mandate to integrate them into her teaching, the reaction may well be confusion, discomfort, or even fear. It is this very variety, flexibility, and complexity of technology that make it more difficult for teachers than other topics of professional development.

There are special challenges associated with learning how to use information technologies that are not present with other educational tools. When educational television programming was introduced a few decades ago, teachers could learn within minutes how to operate the hardware—turn on the set, change the channel, adjust the picture, etc.—and view the programming. They could begin right away to focus on the content. They had no control over software, and it was not interactive. Familiar and comfortable instructional techniques could be used to prepare students for viewing and debriefing them about the content of the program afterwards.

Special challenges for teacher professional development in technology

With computer-based technology, however, operational aspects take time to learn and still more time to practice and explore before the technology becomes familiar enough that teachers can truly attend to the content of learning. Teachers must learn how to use the technology itself at the same time they learn how to integrate it into their teaching. Also, because hardware, software, and applications change so rapidly, even teachers who are adept users of technology must pay constant attention to the basic operational procedures of new applications.

Familiarity and facility of use

It is little wonder that many teachers are apprehensive. For all but a few new teachers, technology was not a routine part of their own preparation, and many have had limited formal training in or experience with using it. It is not unusual for students to be more comfortable and competent users of technology than their teachers are, which itself can be a cause for teacher discomfort. Conversely, it is also possible for teachers to tap into students' technology skills, creating an atmosphere that concentrates on multiple ways of sharing knowledge.

In a 1998 survey by the U.S. Department of Education, 78 percent of teachers reported that they had participated in professional development about integrating technology into the grade or subject they taught during the last twelve months. Yet despite this level of participation, only 20 percent said they felt very well prepared to integrate technology into classroom instruction, and another 37 percent said they were moderately well prepared. The figures were only slightly higher for teachers with three years or fewer experience; 24 percent of this group said they felt very well prepared.

In 1998, 20–24 percent of teachers felt “well prepared” to integrate technology into the classroom

Although need for professional development in technology is great, investments in high-quality professional development for technology can begin paying off relatively quickly. Several *Road Ahead* projects reported that teachers started integrating technology skills into their teaching almost immediately after professional development experiences.

Characteristics of High-Quality Professional Development

Whether technology will produce the deep, long-term, and systemic changes hoped for will depend greatly on the quality of the professional growth experiences in which teachers engage. Many people still think of professional development as one time “events,” like workshops, that take place on designated days. But as research over the past decade has shown, short-term activities that focus on building discrete skills do little to promote lasting improvement if they are not linked to more sustained and collegial opportunities for professional learning. This is especially true where technology is concerned.

Effective professional development is linked to sustained collegial teacher learning

Professional development has been a primary focus of NFIE throughout its thirty-year existence, and the foundation has learned a great deal from developing and analyzing its various programs of grants to educators. Based on this experience, NFIE has identified ten characteristics associated with high-quality professional development that apply to technology as well as any skill or content area.

These characteristics, which are explained fully in the report *Teachers Take Charge of Their Learning* (NFIE 1996), are similar to those identified by other groups with a longstanding interest in teacher professional development, including the U.S. Department of Education.

Below is an abridged list of key characteristics that mark high-quality professional development, adapted from the NFIE list and other sources. They are discussed in relation to their particular implications for technology, with concrete examples of their successful application from specific *Road Ahead* sites.

Key characteristics of high-quality professional development

Effective professional development efforts are

- **focused on student learning;**
- **designed and directed by teachers themselves, incorporating teacher needs.**

In addition, they

- **are rigorous and sustained over time;**
- **are realistic and visionary;**
- **build collegial professional culture.**

A Focus on Student Learning

High-quality professional development has at its heart the goal of improving student learning. Certainly, helping students become proficient users of technology can be one goal of technology-related teaching and learning, but as the primary goal, it falls far short of its ultimate best applications.

Educators must be able to use technology to further student learning in subject matter, such as science, mathematics, language arts, and other areas addressed in state and local content standards. In addition, educators must help students to extend their information technology strengths to nurture the habits of mind that support critical thinking.

Technology to further student learning in specific subject matter addressed in state and local content standards

The challenge, then, is to design professional development experiences that encourage teachers to incorporate technology into rigorous curricula and instruction.

Teachers are more likely to care about hardware and software when they can connect it with what goes on in their classrooms. Rather than centering professional development on hardware and software, educators should begin by looking at what students should learn. Then they can better determine the ways in which technology can support that learning and make it more effective (SEIR-TEC 1999).

Another approach is for teachers to look at how students can learn. Such an approach begins with a particular instructional strategy that will improve student performance. For example, in the Franklin, Tennessee, *Road Ahead* site, the goal was to use a project-based approach to teach science. After the strategy was defined, the teachers explored ways that technology could serve the educational objectives.

Professional development that is truly focused on student learning and employs technology as an educational tool must be attentive to the needs of students with diverse learning styles. Moreover, it considers effective methods of teaching students from a variety of cultural, linguistic, and socioeconomic backgrounds.

When technology is viewed as a servant to increasing knowledge, the integration of technology into the curriculum can open new opportunities for effectively teaching diverse learners. For example, the ability to manipulate visual representations of scientific or mathematical data on a computer can help visual learners to grasp concepts they find difficult to understand when those concepts are explained on the written page.

Increase of student motivation

In addition, when students must present a report that will be posted on the Internet, they are often more motivated to organize their work, attend to its accuracy, and provide a clear description. They can also be more creative when using presentation software to produce results that can be viewed by a worldwide audience.

A specific example of technology tailored to adapt to various learning styles may be seen in the *Road Ahead* project at Rice Creek Elementary School in Columbia, South Carolina. As a part of its professional development, the staff examined the learning styles of students in its school and wrote goals for a new curriculum. The results helped to create a three-year plan to revise and integrate technology into a curriculum based on multiple learning styles. The process of working together in groups to conduct research was rich professional development that led to actual changes in classroom instruction.

Expanding learning for diverse student populations

Technology can also expand learning opportunities for students from many ethnic and socioeconomic backgrounds. Many *Road Ahead* sites had ethnically and racially diverse school populations, and their projects were focused on improving the achievement of particular groups that were not performing up to expectations. At Alvarado Elementary School in Union City, California, the ultimate goal of professional development was to improve students' science learning, especially among girls and African-American and Latino students. The project in South Mountain High School in Phoenix, Arizona, sought to boost the achievement of Latino and African-American students, many of whom came from low-income families. Professional development in this school focused on helping teachers to incorporate technology into its Academic Decathlon competition and to use the Internet to expand the horizons of students who had seldom traveled outside their community.

Designed and Directed by Teachers, Incorporating Teacher Needs

One of the major findings from research and practice over the past decade is that professional development is more effective when it is designed and directed by teachers, rather than developed and delivered by central administration. Teachers know what they need in order to do their jobs better, and they are more likely to make a personal commitment to their own professional growth when they are involved in conceiving professional development and carrying it out.

The process of taking charge of one's own learning can be very empowering. It begins when teachers realize that they have knowledge worth sharing. It continues as they develop their knowledge and intellectual skills. It is augmented when they share their knowledge and skills with colleagues. It is amplified when they help one another professionally. It is sustained by the climate of collegial professional support that is the result.

Teacher-directed
professional development

Through such participation, teachers build their own leadership skills and empower themselves to take charge of their learning. In doing so, teachers also model the principles, the practice, and the effectiveness of self-directed learning, which is the behavior that they ultimately hope to nurture in their own students—to become self-directed, life-long learners.

Teacher-directed professional development was a fundamental principle of *The Road Ahead* program. In this type of professional development, teachers have a strong say in the issues to be addressed, the target group, the format, and the intensity. At Phoenix's South Mountain High School, for example, topics for professional development were derived from a school-wide survey of what teachers wanted to learn. The technology coaches of South Mountain were familiar with learning needs of the district's students. They understood the idiosyncrasies of the district's network and were aware of other specifics of the work environment. Thus, they were able to bring practical examples and contextual richness to the school's professional development and through that contribution, to establish credibility that no outside trainer could ever approach.

Teacher-determined issues, target groups, formats, and intensity

Teachers teaching teachers is a common model for teacher-directed professional development and was the dominant strategy used in *The Road Ahead* program. This model of developing cadres of skilled teachers is sometimes misunderstood. Schools may send a few teachers to a conference or workshop, then expect them to come back and immediately train a sizable group of colleagues in whatever new skills and knowledge they acquired. This approach seldom works, especially for technology, for many reasons: the content is too complex to master in a short time, no follow-up is provided, and the would-be trainers may not be experienced in organizing professional development for their colleagues (SEIR-TEC 1999).

Teachers teaching teachers: successful models

High-quality professional development programs build in time and incentives for teachers to reach a level of mastery and develop leadership competencies. The initial professional development made available to *The Road Ahead* team at Alvarado Elementary in Union City, California, had a ripple effect, thanks to an extended block of time once a week for technology-related professional development (Moursund et al. 1997-98). By the end of the third project year, more than twenty teachers had become coaches in technology for other teachers.

Rice Creek Elementary in Columbia, South Carolina, took a different route with its project by arranging for a University of South Carolina professor to teach a semester-long, three-hour graduate course in the school's computer lab. Because so many teachers participated in this class, they began working together to solve problems right away. The team soon realized there was no reason to designate a special cadre of teacher trainers.

Rigorous and Sustained over Time

High-quality professional development is rigorous. It aims to sharpen teachers' intellectual skills, deepen their subject-matter knowledge, and improve their understanding of learning. To accomplish this, participants must be able to concentrate, reflect, and study—behaviors that are difficult to apply in the middle of a busy classroom.

It takes time for teachers to master new technologies and still more time to consider, try out, and integrate new approaches into their practice. In the past, much of the technology training teachers received was informal, such as advice from technologically adept teachers who found themselves filling the role of technology guru. Formal activities usually consisted of a workshop on a self-contained skill, such as using a certain software package. Increasingly, however, educators and researchers have come to see the need for professional development that is structured, sustained, and meaningfully intense.

Professional development:
sustained and meaningfully intense

According to a U.S. Department of Education survey, 38 percent of teachers who participated in more than eight hours of professional development in technology during the last twelve months said it improved their teaching “a lot.” In contrast, only 12 percent of teachers reported similar improvement with eight or fewer hours.

Both the school reform literature and the practical experience of *Road Ahead* grantees strongly indicate that it takes three to five years to implement changes in practice built around new technologies. Often with technology, one of the principal goals is to change teachers’ fundamental beliefs and attitudes. To attain that goal, teachers need adequate time to discuss the implications of new beliefs, reflect on their practice, formulate new visions for where they are heading, find new methods of assessing progress, and develop new working relationships with peers, mentors, and others (Parsons 1998b).

Three to five years for
implementing changes in practice

It follows logically, then, that professional development for technology integration may need to be sustained for a period of years. Such professional development will require continuing support as teachers implement new ideas in their classrooms. In addition, it will require repeated cycles of shared professional development to help teachers keep pace with advances in technology and new research. As challenging as this path may seem, it is attainable, and by the best information available, it is also the most efficient and effective means to achieve technologically proficient teaching and learning.

Continuing support required for
teacher-led professional development

In the *Learning Tomorrow* program, an NFIE technology grant program targeted to students at risk of school failure, the more successful projects followed up professional development activities with continuing consultation with teachers in their classrooms (Hawkins, Baker, and Justin 1998).

Several *Road Ahead* sites set aside significant blocks of time over a period of months or even the entire school year for regular, sustained professional development. (How they managed to find the time is discussed later in this report.)

At Bijou Community School in South Lake Tahoe, California, for example, teachers participated in two hours of professional development one day a week.

Positive results

In the Phoenix *Road Ahead* project, the team devoted the entire first year to intensive professional development on technology integration. In the second year, two teachers were given release time for the whole school year to lead eight-week, one-hour classes for their colleagues on a variety of technology-related issues. The sessions were often well attended, and after a year of professional development, 60 percent of participants rated themselves as competent or proficient users of computers. The school also reserved one of its computer labs for teacher development for one whole day each week so those teachers could visit it during planning periods. Teachers also had remote access from home (Moursund et al. 1997-98). The school now has a grant to expand its professional development model to other schools in the district.

It also takes a critical mass of teachers to bring about fundamental change. Many *Road Ahead* sites made professional development available to the entire teaching staff and sometimes to support staff, student teachers, and community members as well. The project at Lakeside Elementary in Manistique, Minnesota, for example, provided technology-related professional development to all the teachers in the school. This created a sizable group of teachers proficient with technology and helped to diminish resentments that can arise when special programs are available only to a select group of teachers.

Realistic and Visionary

Rather than presenting abstract concepts, high-quality professional development addresses the real issues that teachers face in using technology in their classrooms. Many effective programs set teachers to work on solving authentic problems that are relevant to their subject matter or grade level. Relevant professional development also means that teachers use the same tools their students will use. Teachers utilize technology applications in much the same ways as they expect their students to do.

Being based in reality need not mean a loss of vision. Technology-related professional development is most effective when it is not singled out as an end in itself. The best results are achieved when it is an aspect of a clearly articulated vision for school reform, and also when it is closely tied to district or school improvement goals. In both the *Learning Tomorrow* and *The Road Ahead* programs, the most successful projects prepared teachers to use technology in ways that were practical and immediate but were also linked to broader reforms.

Linking technology to practical and immediate goals and to broader reforms

In the *Learning Tomorrow* program, the most extensive changes occurred in sites that helped teachers adapt technology to local reforms, rather than just teaching them the raw applications of various software (Hawkins, Baker, and Justin 1998). All of *The Road Ahead* projects had specific improvement goals for their schools—from improving reading comprehension to finding better ways to teach science. Some, however, were more closely linked than others to the district’s vision for comprehensive school reform.

Building a Collegial Professional Culture

Many effective strategies for professional development have a common goal of building a collegial and collaborative culture of teaching professionals. Collegial communities share certain characteristics: all the professional staff work toward common goals; they participate together in high-quality professional development; they share ideas and knowledge; they publicly recognize good ideas and accomplishments; and they provide constructive criticism and encouragement to their peers.

Working together to learn technology and to teach other colleagues

The members of such learning communities share values and facilitate continuous learning. The goal is to create a climate where systemic improvement can take hold, even as individuals are improving their own skills and knowledge. Becker and Riel (1999) found that the more teachers were engaged in collaborative work within and beyond their schools, the more likely they were to report using instructional practices that emphasized deep thinking and project-based learning.

This type of culture takes time to build. People need to reach a point where they trust each other, recognize the specific strengths that each team member can contribute, and become accustomed to peer assistance and constructive criticism. Just as in other workplaces, teachers have different levels of comfort with and expertise in technology. They must learn to work with colleagues of different skill levels.

Many effective professional development efforts extend their models of collaborative communities to include people other than teachers, such as school administrators, support staff, representatives of after-school programs, and representatives of community-based organizations. They also bring outside expertise from universities, museums, and other cultural resource institutions into the mix as appropriate. Effective collegial teams are composed of people who share mutual benefit from the collaboration.

Students and teachers
learning together

Some projects also experimented successfully with the idea of having students learn alongside teachers. In *The Road Ahead* project in Renton, Washington, for example, teachers were asked to bring along a student to their learning sessions. Often students were more technologically adept than teachers and could give teachers valuable input about using new software. This helped teachers get used to the idea that it was all right to learn from their students. The students, for their part, received positive reinforcement of their knowledge and were exposed to a model of lifelong learning. After the learning sessions, students served as classroom assistants for information technologies.

Everyone may have brought different strengths and knowledge, but everyone gained valuable knowledge from this mutually beneficial model of professional development. Renton's approach to professional development had the additional benefit of preparing students for the modern workplace, where people of diverse ages, skills, and backgrounds must work together in collaborative teams.

Professional Development Strategies for Improving Technology Skills and Knowledge

Professional development can take many different forms and use a variety of strategies. The short-term and long-term goals of the teachers and the school determine the specific professional development strategy.

For example, if the short-term goal is to acquaint teachers with the Internet—what it is and how to access it—then a workshop may be an appropriate starting point. If the long-term goal is to help them use the Internet to change their teaching practices, then a combination of more intensive strategies will be required.

Described below are some of the most common forms of professional development that have been effective in developing knowledge and skills related to technology.

Conferences, Institutes, Workshops

Although the field is moving far beyond the idea of one-shot workshops, shorter-term conferences or workshops can still have a place in professional development. They are often useful to introduce a topic or provide information on specific skills that can be linked to more sustained forms of professional development at the school site.

Effective use of traditional models

The annual summer conferences of the *Road Ahead* program provided an opportunity for project teams to learn in a structured way from others with expertise. It also provided a venue for them to meet with their electronic mentors face-to-face, to interact with people from other sites, and to meet with project evaluators. The conferences were designed to expose the teams to ideas that could inform more sustained professional development efforts back in their districts.

Courses and Classes

Formal courses and classes are another traditional approach that continues to have a place in technology-related professional development. In the Columbia, South Carolina, *Road Ahead* project, a graduate class at the school site had a major impact. Teachers began implementing what they were learning while the class was still underway, and they continued their collaboration and professional development after it was over. As an extension of the initiative, the university chose the school to become a professional development school for its teacher preparation program.

Action Research and Study Groups

Action research is a process that encourages teachers to systematically study what they do as a way of improving their practice. As described by Susan Loucks-Horsley and her colleagues (1998), teachers examine their own teaching and their students' learning by writing descriptive reports about classroom processes, by engaging in meaningful conversations, by reflecting critically about their own practice, and by sharing their findings with their colleagues.

Additional effective approaches

The underlying message communicated through these reports is that teachers are intelligent, inquiring professionals with valuable practical experiences and problem-solving skills. They can advance professional knowledge just as much as scholars do through empirical studies.

Action research: teachers may develop their own research designs

In action research, groups of teachers define—or play a meaningful role in defining—a key research question that would help them improve practice, such as whether they treat boys differently than girls in access to classroom computers. After reading up on the research on this issue, teachers might develop their own research design. The design may include such data-gathering elements as keeping logs of which students used the computers and for which tasks, audio taping their classes to see how they respond to students' requests for computer time, and observing each others' teaching. Together, these teachers might then review the data, analyze their findings, come up with a strategy to address any problems, and share their recommendations with other faculty.

Study groups: together, teachers examine a substantive issue

Study groups bring together teachers to study a substantive issue they care about—for example, how to assess students' understanding of key concepts in a project-based science curriculum. Groups meet regularly to discuss, share, analyze, reflect on, and ask questions about various approaches they are using or would like to use (Loucks-Horsley et al. 1998). Individual group members may assume responsibility for collecting information and keeping abreast of research on one or two aspects of the issue chosen, so that each person develops a particular expertise that can be shared. Teachers who become well versed in those particular aspects then have a responsibility to help colleagues improve their capabilities.

Both action research and study groups motivate teachers to examine their basic beliefs, often motivating them to modify or replace those beliefs with others that are grounded in research and good practice. These forms of professional development can enhance a teacher's sense of professionalism and can also create a climate where people are comfortable with openly discussing their practices.

Mentoring

Mentoring pairs teachers who have experience in a particular skill or area with one or more teachers who can benefit from their expertise. It was a key professional development strategy in *The Road Ahead* program. For mentoring to be effective, the creation of mentoring teams requires careful matching; the teams should be designated rather than created by informal pairing.

Mentors can provide advice, reassurance, encouragement, and technical assistance. They can serve as a sounding board for new ideas and give objective critiques of plans or ideas. Some of *The Road Ahead* mentors also gave workshops at project sites or arranged for other kinds of professional development, and a few even intervened on behalf of their site team to solve problems within the district (Moursund et al. 1997).

Characteristics of effective mentoring

It is important to choose mentors who will be a good fit for the individual or group of protégés in terms of interests, goals, and skills and who have knowledge and time they can and will devote to the relationship. For the relationship to work, the people being mentored must be willing to accept outside help. Furthermore, mentors cannot be expected to take on these responsibilities without incentives—recognition, some type of compensation, professional development for the mentoring role, and (a critically important component) time.

The mentoring relationship brings benefits both to those being mentored and to the mentors themselves. According to a 1998 U.S. Department of Education survey, 70 percent of teachers who were mentored at least once a week said it improved their teaching “a lot” (U.S. Department of Education 1999). Mentors grow professionally, too, by reflecting on what they know, distilling it into an accessible form, and carrying out new leadership roles.

Benefits of mentoring

Mentors can be located at the site or connected by technology. The *Road Ahead* project used long-distance mentors who communicated with their teams by email and telephone (which is preferable for sensitive discussions). The mentors also met face-to-face with their teams at the summer conferences, and several made site visits to schools. When mentoring relationships depend upon long-distance communications such as email and written correspondence, occasional high-quality, face-to-face meetings are vital to the success of the mentoring experience. These meetings create a feeling of trust and facilitate the critiquing of project plans. Such activities are better accomplished around a table and give validation to both the mentor and the project (Moursund et al. 1997).

Models of mentoring

Although the mentors in *The Road Ahead* kept in fairly frequent contact with their sites, especially during the first year, the quality of contact appeared to be more important than the frequency. Some mentors felt underused and wanted clarification of their purpose. In response NFIE asked project mentors to play a greater role in planning the 1997 summer conference, which turned out to be the most highly rated of all the conferences. The mentors did much of the planning online with selected team members. They also facilitated most sessions and handled many of the logistics.

This model, which entrusted mentors with elements of program leadership and engaged them as teachers as well as advisers, had much to recommend it. It took better advantage of highly skilled people and allowed more people to benefit from the collective skills of all the mentors, rather than just from a single mentor assigned to a specific team (Moursund et al. 1997).

Teacher Networks and Online Communities

Networks of teachers who come together for learning, sharing, and support can be either local or electronic. Each has its advantages. Electronic networks can break down barriers of position and status that might inhibit face-to-face interactions. They also give teachers an opportunity to model the kinds of online networking they expect their students to do.

Characteristics of successful online mentoring

Successful online communities for professional development are ones that communicate regularly, use the medium to solve problems and advance their work, and persist after the initial reason for coming together is over. A review of electronic networking among *Road Ahead* project teams found that some of the sites were very active users, and others were very infrequent users. The most active individuals were the team leaders and mentors. Often the communications were about the projects or the mentoring process, but just as often they were informal and not related to the projects. *The Road Ahead* experience suggests organizing electronic forums topically rather than by site, creating temporary strands around topics of interest, and appointing a moderator or facilitator for online projects (Underwood and Bielefeldt 1996).

The development of online communities will continue to benefit from increases in bandwidth and improvements in networking software. Technical difficulties, concerns about privacy, and a confusing or overwhelming interface can discourage participation by all but the most intrepid.

Participation in online networks must come to be seen as a valuable collegial work activity, not an extra or add-on. To achieve this status the networks must be able to show links between their activity and tangible learning results for participants and their students. Researchers can help by conducting more studies of electronic communities to determine the most effective structure, support, and content. Administrators can demonstrably support the value of online learning environments by making time for teachers to participate in them.

Professional Development Embedded in Other Responsibilities

Teachers are learning and expanding their skills as educators even as they go about parts of their job not overtly labeled as professional development. Assessing students is one example. When assessment results show that students need to improve in a particular area, it causes teachers to examine their practice and consider ways to make it more effective. In *The Road Ahead*, the national evaluation of the program (ISTE 1998) became a form of professional development for teachers by providing formative information that helped the sites improve their programs.

Professional development occurring through other activities

Strategic planning is another example. When teachers are involved in developing a technology plan, they must learn more about various options for hardware and software and think about how they would use them. They must also weigh their own needs against those of a broader set of schools and place their priorities for technology integration within the wider context of school improvement planning.

Support, Access, and Structures for Technology-Related Professional Development

The effectiveness of professional development is shaped by many factors in the larger context. Having in place certain kinds of structures and services can make it easier to expand successful professional development efforts to a larger scale and can help to sustain them over time. Research from NFIE and others (NFIE 1996; Parsons 1998a; Parsons 1998b; Loucks-Horsley et al. 1998) has identified some of the most important supports, which are described below.

Time

As noted already, it takes time for teachers to learn how to integrate technology. Lack of time and scheduling problems were frequently mentioned as impediments by *The Road Ahead* sites (ISTE 1998). Nevertheless, some teachers and administrators figured out innovative ways to create more time for professional development.

Adequate time and flexible scheduling enhance professional development

In Union City, California, the district obtained a waiver from the state that allowed it to delay the students' starting time every Wednesday to give teachers an extended block of time for professional development. Many teachers felt that what the students gained from being taught by better prepared teachers more than offset the loss of instructional time. Bijou Community School in South Lake Tahoe also delayed its starting time one day a week, but this school did so by extending the school day by 15 minutes for the four other days and by pooling contractual preparation time. Lakeside Elementary, in Manistique, Minnesota, reserved a half-day for technology-related professional development every three weeks; this school used substitutes to cover for teachers.

These are just some of the options available for creating more blocks of time for teacher growth. Among the others are pooling of early release time, team teaching, eliminating unnecessary meetings and administrative tasks, reorganizing teachers' individual preparation time to allow more common time together, and extending the school day (Loucks-Horsley et al. 1998).

Access to Equipment and Technical Support

Ready access to technology equipment by well-trained teachers is necessary

Although access to sufficient hardware and software seems like an obvious prerequisite for technology-related professional development, access remains a problem in many schools and districts. In some cases, there is not enough equipment. A teacher with one computer in the classroom and no Internet access or projection equipment cannot implement some of the more exciting possibilities for technology-based instruction. Almost half of *The Road Ahead* sites were hindered by problems relating to access to technology, such as insufficient computers, computers tied up for administrative tasks, problems with donated equipment, lack of connectivity, and unreliable network access.

In some instances, the technology is there, but may be distributed in an inefficient and inconvenient way. For example, all technology may be concentrated in a technology lab and not in the classrooms. Such restricted access limits serendipitous learning, where teachers and students can capitalize on loosely structured opportunities that arise and could be enhanced by the use of the Internet.

A related issue is the degree of synchronicity between technology acquisition and professional development. A general rule of thumb is that teachers should do their professional development on the hardware and software that is actually installed in the school as soon as it is installed, with repeated sessions for new staff or as new hardware and software are added.

Access to on-demand, onsite technical assistance is another necessary support. Some schools rely on the district to provide this support, while others provide their own. *The Road Ahead* project in Union City, California, gave release time to a media specialist to help teachers with technology integration—a level of coordination that was made easier because the district had in a place a technology plan.

Strategic Planning

Professional development tends to be more effective, substantive, and long-lived when it is aligned with or built into a school's or district's strategic plan. This plan should be created with meaningful involvement of teachers. It should also give teachers a continued role in decision-making. Some of the most effective *Road Ahead* projects had in place district-wide technology plans that included professional development as a critical element.

Working on a strategic plan can itself be a valuable form of professional learning for teachers. Strategic planning can help participants to remain focused on the school's or district's broad goals for educational reform. Technology can sometimes command undue attention, causing teachers to lose sight of their role in facilitating subject matter learning and student learning goals. Participating in strategic planning can help teachers put learning, not technology, first.

Professional development best
when built into strategic planning

An Openness to New Teacher Roles

High-quality professional development often encourages teachers to assume new roles—as mentors or coaches, as teacher leaders or teacher trainers, as technology coordinators—but teachers will be less effective in these roles without certain kinds of support from the school or district.

An openness to new forms of teacher leadership is one such support. In districts with an authoritative or centralized approach to leadership, some of the types of collaborative or decentralized leadership encouraged by professional development could be viewed as a threat and could fail to thrive unless care is taken (Parsons 1998a).

Incentives for teachers to learn and teach new skills and assume new roles are another form of support. Teachers cannot indefinitely keep up the levels of energy that several put forth to make a special program like *The Road Ahead* work. Examples of effective rewards include not only cash stipends but also release time and formal recognition of achievement.

Leadership

Supportive leadership from the district level is another critical factor for technology-related professional development. A district's formal commitment to technology can create a climate where professional development will flourish. A superintendent or other influential leader with a vision for technology-based systemic change can take such vital steps as reallocating staff time, improving access to technology, revamping schedules, or encouraging coordination. *The Road Ahead* projects tried to instill support among school leaders by including administrators on local project teams.

Superintendents and principals are not the only ones who can exercise leadership for professional development. Professional teacher associations can provide leadership and encouragement and can put in place conditions that will help to ensure that supportive structures live on when district leadership changes. Teacher associations can help establish these conditions and structures by negotiating with local districts, influencing state policy, engaging the community, and establishing teacher centers (Parsons 1998a). External groups like NFIE can help sites enhance the quality of their professional development and can make suggestions for designing programs and influencing policies.

Organizational and administrative support

State and Local Policies

State and local policies are a powerful force that can support or impede professional development. Particularly salient are state policies regarding curriculum and content standards, assessment, school finance, professional development, strategic planning, teacher preparation, licensure, certification, and evaluation (Parsons 1998a). Also relevant are such local policies as professional development priorities, teacher time and roles, and site-based decision-making. Supportive policies can initiate a philosophical shift that results in change.

Supportive policies can result in high-quality professional development

Even if these policies are not in place, the situation is not hopeless. Sometimes the policies follow after local actions prove to be successful.

Teachers are feeling a major impact from the state policies to adopt content and performance standards for student learning, along with high-stakes accountability measures based on those standards. Standards can affect the priorities for professional development by delineating what students need to learn and teachers need to teach.

Pressure to improve student achievement rapidly on standards-based assessments can drive the curriculum in ways that may or may not appear to be consistent with the goals of technology-based teaching and learning. Integration of technology that puts content learning objectives first and lets curriculum drive the use of hardware and software is most likely to be compatible with standards-based learning.

Emphasizing content learning objectives is compatible with standards-based learning

Community and Parent Support

Support for professional development can come from community agencies and organizations, museums, libraries, businesses, higher education institutions, and other local partners. It helps to have formal policies to lay the foundation for collaboration.

Parents and public informed about value of professional development

The Road Ahead projects required community representation on project teams. Among the partners selected were museums, community agencies, laboratories, and universities. These partners provided sites and resources for professional development and also participated in it. Several community members greatly appreciated these professional development opportunities, which are far more rare in the community-based sector than in schools. These forms of collaboration also helped to generate a community buy-in for the changes occurring. At Page Middle School in Franklin, Tennessee, teachers and other team members said that the collaborative strategy had created “circles of support” for technology comprised of teachers, parents, and community members (Moursund et al. 1997-98).

It is critical that parents, as well as the larger public, understand the necessity of high-quality professional development. Parents and the public should be informed about issues such as why teachers need to spend time outside the classroom on professional development, why technology implementation requires an extensive level of professional development, and what high-quality professional development looks like (Parsons 1998a).

A lack of understanding about these issues can be a real impediment. Educators must take the time to explain the dimensions and benefits of professional development in terms that make sense to parents and other citizens. School-business partnerships can help the public to understand the changing nature of knowledge workers’ jobs. School-business partnerships can also educate parents and the public about how the job of today’s teacher has significantly changed over the past several decades, thus widening recognition of the need for continuous and well-supported teacher learning.

Adequate Funding

High-quality, sustained professional development costs money. Often schools or districts rely on special funding sources, such as state, federal, or foundation grant programs, rather than district sources; however, this strategy runs the risk of having the reforms disappear with the external funding. It is important to institutionalize professional development with local contributions, which may include in-kind support.

In general, it makes sense to reserve a significant portion of general technology acquisition funding for professional development. Existing professional development funds may need to be refocused on the most effective strategies.

Assessing the Effectiveness of Professional Development

How do teachers know whether professional development is working? Are they teaching in new ways that improve the learning experience for students? One way to evaluate the effectiveness of professional development is to measure changes in what teachers do in the classroom.

Gauging the effectiveness of professional development in technology applications

Many assessments rely on the teachers themselves to report the extent to which programs have changed their practice. This is one useful source of information, but it can be augmented by external assessments, such as classroom observations, interviews, analyses of lesson plans and other products, performance tasks, and focus groups. Projects do not necessarily have to create their own evaluation instruments from scratch, but can use or adapt those produced by groups experienced in evaluating professional development (Loucks-Horsley et al. 1998).

A second measure, and a more elusive one, is a change in student achievement. Because achievement is affected by many factors, it is more difficult to attribute improvements specifically to professional development. Nevertheless, there is some research indicating that high-quality professional development has a positive impact on student achievement.

Cohen and Hill (1998) found that certain kinds of teacher professional development affected teacher practice, which in turn made a positive difference in students' mathematics achievements. The critical elements were that the professional development was grounded in the specific curriculum the students were studying, that it was aligned with assessment and other elements of instruction, and that it was extended in time.

In fourth-grade classrooms where teachers reported classroom practices more oriented to the curricular framework, students had higher achievement scores. No such relationship was found in schools where teachers used conventional practices or where professional development focused on special topics. These findings emphasize the importance of aligning professional development with what students are expected to know.

A third type of measure relates to systemic changes in the school environment. Examples include changes in the amount and types of collaboration, in leadership and decision-making authority, in policy, and in planning (Parsons 1998b).

The Promise of Technology for Improving Professional Development

As the above discussion illustrates, technology can change the process of professional development as well as the content. Information technologies open up new ways of conducting and participating in professional development.

Technology uses in professional development

For example, teachers can learn new skills by video taping classrooms in action. They can acquire new information by connecting with online experts and databases. In addition, technology can link teachers with distant learning opportunities and create professional learning communities not bound by location. Technology also allows teachers to work either individually or collaboratively.

Technology can help to embed professional learning opportunities into teachers' everyday responsibilities. Many technology-supported learning resources are available at any time and can be called up when needed.

Finally, projects that start by focusing on technology can end up leveraging greater support for professional development in general (Parsons 1998b). Successful models of technology-based professional development can be applied to teaching and learning in other areas.

It is an exhilarating time for technology in schools, in large part because technology can stimulate opportunities for life-long, job-embedded professional development that significantly increases how well we prepare students to meet the world of the twenty-first century.

“Professional Development and Information Technologies” is one of several papers included in *Connecting the Bits, A reference for using technology in teaching and learning in K–12 schools*, issued by the National Foundation for the Improvement of Education in 2000, and available at www.nfie.org.

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This paper examines the relationships among teachers' role orientation, the school culture they experience, and their personal teaching practices using information from a national sample of 4,000 teachers across 1,100 schools, including schools involved in major reform programs. The findings suggest that teachers who are engaged in collaborative professional activities extending beyond their classrooms are more likely to have their students work in collaborative ways as well.

Cohen, D. K. and H. C. Hill. Jan. 1998. State policy and classroom performance: Mathematics reform in California. *CPRE Policy Briefs*.

This report presents findings from a survey of California elementary school teachers on the classroom effects of state efforts to reform mathematics teaching and learning. The report focuses on findings related to three main questions: What learning opportunities were available to teachers and others responsible for implementing the new Mathematics Framework? What mathematics content and pedagogies were teachers taught? Was there any connection between teachers' learning opportunities and practices?

Hawkins, J., T. Baker, and G. Justin. 1998. The Learning Tomorrow Project: Final assessment report. Paper prepared for the National Foundation for the Improvement of Education. New York: EDC Center for Children and Technology.

This final assessment of the *Learning Tomorrow* program reviews the technology integration activities of ten sites; the logistical, professional development, and planning support infrastructure provided to the sites; and the assessment activities of the sites. The analysis focuses on issues of leadership, infrastructure building and operation, curriculum and pedagogic goal development, community building and interaction, strategies for school change related to technologies, and school policy changes required for technology integration.

International Society for Technology in Education. 1998. The Road Ahead evaluation. Report submitted to the National Foundation for the Improvement of Education. Eugene, Ore.: ISTE.

The document summarizes *The Road Ahead* program and describes methodology. The report examines student learning, professional development, technology use, systemic change, factors that helped and hindered programs, and program support. Recommendations, a bibliography, and an appendix are included. Available on NFIE's web site, www.nfie.org.

Lewis, L., B. Parsad, N. Carey, N. Bartfai, E. Farris, and B. Smerdon. 1999a. Teacher quality: A report on the preparation and qualifications of public school teachers. *Education Statistics Quarterly* 1(1): 7-11.

This report focuses on teachers' preservice qualifications, continued learning, and workplace support. It examines and provides a context for teachers' feelings of preparedness to meet new challenges posed by education reforms, technological changes, and increased student diversity.

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This report is based on efforts by the National Center for Education Statistics to collect data on teacher preparation and qualifications using a nationally representative survey of full-time public school teachers. The report includes indicators of preservice and continued learning, and examines work environments in which educators teach. It discusses how teacher quality has been defined and studied, preservice learning and teaching assignment, continued learning, supportive work environments, and teachers' feelings of preparedness.

Loucks-Horsley, S., P. W. Hewson, N. Love, and K. E. Stiles. 1998. *Designing professional development for teachers of science and mathematics.* Thousand Oaks, Calif.: Corwin Press.

This comprehensive guide discusses how to design staff development in science and math. It is tailored specifically to the needs of individual schools or departments. The book provides fifteen strategies for professional development and describes each one with its underlying assumptions and implementation requirements. Vignettes from real schools illustrate concepts within the book.

Moursund, D. and T. Bielefeldt. 1998. Computer technology and professional development: Suggestions for schools. Paper prepared for *The Road Ahead* program. Eugene, Ore.: ISTE.

This report examines the professional development challenge in information technology. After listing a number of professional development challenges, it discusses three approaches of staff development that can help meet the challenges. The report provides an outline of an effective model for staff development for technology in education.

Moursund, D., T. Bielefeldt, S. Underwood, and D. Underwood. 1997-98. Site reports on individual projects funded through The Road Ahead. Prepared for the National Foundation for the Improvement of Education. Eugene, Ore.: ISTE.

These documents provide project summaries and evaluations for the twenty-two *Road Ahead* sites. Included in each site report are an overview, goals, outcomes, and the project's future plans. The site reports are available on NFIE's web site, www.nfie.org. Also located on the web site are links to each site's project and team, site evaluation, and web sites created by the students participating in the program.

———. 1997. *Mentoring on The Road Ahead*. Paper prepared for the National Foundation for the Improvement of Education. Eugene, Ore.: ISTE.

This report discusses the role of team mentors in *The Road Ahead* program. The mentors helped teams revise proposals and develop workable plans that met the requirements for the grant and provided ongoing technical assistance to the teams as needed. The report presents findings from surveys and interviews of mentors focusing on how the mentors assisted their teams, what the mentors got out of the experience, and the effectiveness of mentoring at a distance.

National Commission on Teaching and America's Future. 1996. *What matters most: Teaching and America's future*. New York: NCTAF.

The premises of this two-year study are: (1) what teachers know and can do is the most important influence on what students learn; (2) recruiting, preparing, and retaining good teachers is the central strategy for improving our schools; and (3) school reform cannot succeed unless it focuses on creating conditions in which teachers can teach and teach well. This report focuses on perceived barriers to achieving these goals and offers five major recommendations: get serious about standards for both students and teachers; reinvent teacher preparation and professional development; fix teacher recruitment and put qualified teachers in every classroom; encourage and reward teacher knowledge and skill; and create schools that are organized for student and teacher success.

National Foundation for the Improvement of Education. 1999. *Creating a teacher mentoring program*. Washington, D.C.: NFIE.

This issue brief provides guiding principles for structuring a mentoring program based on tested findings in schools and school districts throughout the country. Topics include ensuring time for mentoring, maintaining confidentiality, selecting and training mentors, measuring results, and establishing partnerships among educational organizations and associations. Available on NFIE's web site, www.nfie.org. A list of resources and key questions is included.

———. 1996. *Teachers take charge of their learning: Transforming professional development for student success*. Washington, D.C.: NFIE.

This report explores the conditions and policies needed to incorporate teachers' learning into their daily work in the schools. It identifies the incentives, processes, policies, and structures that support wise, shared decisions about teachers' own learning and that of their colleagues so that they will be better able to serve their students. Findings from this study indicate that providing for effective professional development requires: (1) flexible scheduling, (2) extended school year for teachers, (3) school-based professional development, (4) standards and accountability, (5) balancing individual teachers' and school needs for learning, (6) peer assistance and review, (7) expanded role for teachers, and (8) induction of teachers.

Parsons, B. A. et al. 1998a. Historical patterns and trends impacting professional development: Case studies of four districts in A Change of Course. Paper prepared for the National Foundation for the Improvement of Education. Ft. Collins, Colo.: InSites.

Through four in-depth case studies, this report looks at how historical trends and patterns impact the process of change as school systems seek to achieve sustained high-quality professional development for all teachers. Using a theory of change, the report analyzes the patterns of factors influencing professional development in each site. The report concludes by addressing consideration for the sites and how external organizations can support the education system at local, state, and national levels to achieve the goal of sustained, high-quality professional development for all teachers.

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This evaluation of the *A Change of Course* initiative focuses on whether grantees have put in place the long-term support structures that will lead to high-quality professional development. Specifically, there are descriptions of grantee strategies to support professional development, a discussion of crosscutting themes that impact professional development, a refinement of a theory of change, and a discussion on the roles that the National Foundation for the Improvement of Education plays to support the sites.

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Underwood, D., S. Underwood, and T. Bielefeldt. 1996. Online communities in The Road Ahead. A presentation at the Fifth International Conference on Telecommunications/Multimedia in Education, December 7, 1996.

U.S. Department of Education. 1999. *Teacher quality: A report on the preparation and qualifications of public school teachers*. Washington, D.C.: U.S. Dept. of Educ., <http://nces.ed.gov/spider/web spider/1999080.shtml>.

The results of this national profile of teacher quality, the first in a series of biennial reports, includes information on teachers' education, certification, teaching assignments, professional development, collaboration, and supportive work environment. The report provides a context for understanding teachers' reports of preparedness to meet the challenges they face in their classrooms.