TEACHER PROFESSIONAL DEVELOPMENT IN THE USE OF TECHNOLOGY

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INTRODUCTION

Teacher professional development is absolutely essential if technology provided to schools is to be used effectively. Simply put, spending scarce resources on informational technology hardware and software without financing teacher professional development as well is wasteful.

Experience around the world in developing, industrialized, and information-based countries has shown that teacher training in the use and application of technology is the key determining factor for improved student performance (in terms of both knowledge acquisition and skills development enabled by technology). Educational technology is not, and never will be, transformative on its own—it requires teachers who can integrate technology into the curriculum and use it to improve student learning.[1] In other words, computers cannot replace teachers—teachers are the key to whether technology is used appropriately and effectively.

That said, designing and implementing successful teacher professional development programs in the application of technology is neither easy nor inexpensive. There are more cases of inadequate and ineffective training programs than there are success stories. Moreover, success stories are not automatically transferable to other situations, and the total body of experience and knowledge in this field is in its infancy. While some people may know more than others in this area, there are few if any true "experts." This calls for humility, innovation, a willingness to fail, ongoing evaluation, sharing of both positive and negative experiences, and constant revision of teacher professional development programs related to technology.

Even if students could learn independently how to use technology to enhance their learning and skills development, with little or no involvement from their teachers, they are highly unlikely to have those opportunities if teachers do not let them have access to technology. Teachers remain the gatekeepers for students' access to educational opportunities afforded by technology: they cannot and should not be ignored. Moreover, providing technical skills training to teachers in the use of technology is not enough. Teachers also need professional development in the pedagogical application of those skills to improve teaching and learning.

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Traditional one-time teacher training workshops have not been effective in helping teachers to feel comfortable using technology or to integrate it successfully into their teaching. Instead, a new paradigm is emerging that replaces training with lifelong professional preparedness and development of teachers.[2] This approach includes at least three dimensions:

- Initial preparation/training (preservice) that provides teachers with a solid foundation of knowledge; competency in teaching, classroom management, and organization skills; mastery of the subject matter they will teach; and proficiency in using a variety of educational resources, including technology.
- Workshops, seminars, and short courses (inservice) that offer structured opportunities for acquisition of new teaching skills and subject matter knowledge, as well as skills development in the use of technology in the classroom, that are government-certified and linked to teachers' professional career development.
- Ongoing pedagogical and technical support for teachers as they address their daily challenges and responsibilities.

While technology increases teachers' training and professional development needs, it also offers part of the solution. Information and communication technologies (ICTs) can improve preservice teacher training by providing access to more and better educational resources, offering multimedia simulations of good teaching practice, catalyzing teacher-to-trainee collaboration, and increasing productivity of noninstructional tasks. ICTs also can enable inservice teacher professional development at a distance, asynchronous learning, and individualized training opportunities. Finally, ICTs can overcome teachers' isolation, breaking down their classroom walls and connecting them to colleagues, mentors, curriculum experts, and the global teacher community.

As has been pointed out elsewhere in this book, technology and teacher professional development in its use is best introduced in the context of broader educational reform, which embraces a shift away from teacher-centered, lecture-based instruction toward student-centered, interactive, constructivist learning. This has consequences for reform of curricula, examinations, provision of educational resources, and teachers' professional development. Indeed, one of the most exciting aspects of information and communication technology is its role as a catalyst for such educational reform.

This chapter begins with an examination of the theoretical principles and methodologies underlying such programs. The specific content of such programs is then discussed, after which the issue of teachers' motivation and incentives to participate in professional development programs related

to technology is addressed. The importance of training additional school community members is stressed, and recommendations are offered for overcoming the persistent problem of insufficient funding for teacher professional development. Next, the potential of technology as a medium for delivering teacher professional development programs is examined, followed by a discussion of future trends in teacher professional development. Finally, because most of this chapter is directed at educational policy makers designing teacher professional development programs, a series of recommendations is provided specifically for teachers considering professional development programs in the use of technology.

THEORETICAL PRINCIPLES AND METHODOLOGY

Most teachers want to learn to use educational technology effectively, but they lack the conceptual framework, time, computer access, and support necessary to do so.[3] A well-planned, ongoing professional development program, grounded in a theoretical model, linked to curricular objectives, incorporating formative evaluation activities, and sustained by sufficient financial and staff support is essential if teachers are to use technology effectively to improve student learning.[4]

When designing or implementing any teacher professional development program for technology, it is important to situate that program within the context of a theoretical framework for adult learning. For purposes of this chapter, a theoretical framework, developed by Reeves and Reeves[5] is used, based on 10 dimensions of interactive learning. Each of these dimensions is presented as a continuum, with contrasting values at either end. Teacher professional development in the use of technology should be designed and implemented to move teachers (and, eventually, students) toward the right-hand end of this continuum (see Table 8.1).

This framework emphasizes the potential of Web-based instruction to contribute to pedagogical reform, rather than technology's rich multimedia features or its ability to access information resources around the world. Stated more simply, technology can promote effective instruction that is more student-centered, interdisciplinary, more closely related to real-life events and processes, and adaptive to individual learning styles. Such instruction encourages development of higher-order thinking and information-reasoning skills (rather than memorization of facts) among students, and socially constructed (collaborative) learning, all of which are increasingly required in today's knowledge-based global economy. This

TABLE 8.1 • THEORETICAL FRAMEWORK FOR ADULT LEARNING

INTERACTIVE LEARNING DIMENSIONS	END OF CONTINUUM	1	2	3	4	5	6	7	8	9	10 (OBJECTIVE)	END OF CONTINUUM
Pedagogical Philosophy	Instructivist											Constructivist
Learning Theory	Behavioral											Cognitive
Goal Orientation	Sharply Focused											General
Task Orientation	Academic											Authentic
Source of Motivation	Extrinsic											Intrinsic
Teacher Role	Didactic											Facilitative
Meta-Cognitive Support	Unsupported											Integrated
Collaborative Learning Strategies	Unsupported											Integral
Cultural Sensitivity	Insensitive											Respectful
Structural Flexibility	Fixed											Open

potential of technology to improve instruction needs to be integrated (modeled) into the design and delivery of teacher professional development programs in the use of technology. Perhaps most important for the purpose of teachers' professional development, technology implies a shift in the teacher's role from being the sole source of knowledge and instruction to being a facilitator of students' learning, which is acquired from many sources. This is often referred to as a shift from being "the sage on the stage to the guide on the side." Again, teacher professional development for ICTs needs to incorporate and model this shift.

Failure to incorporate these 10 dimensions of interactive learning into teacher professional development programs in the use and integration of technology will cripple the potential of technology to improve teaching and learning. This implies that teacher professional development in the use of technology should embody and model the forms of pedagogy that teachers can use in their classrooms. For example, these training programs should accomplish the following:

- Empower teachers to develop their knowledge and skills actively and experientially, in a variety of learning environments, both individual and collaborative.
- Include a variety of learning strategies, encompassing direct instruction, deduction, discussion, drill and practice, deduction, induction, and sharing.
- Aim at higher-order thinking skills.
- Provide an authentic learning environment so that teachers engage in concrete tasks within realistic scenarios.
- Emphasize ways that technology can facilitate and enhance teachers' professional lives.
- Encourage teachers to be mentors, tutors, and guides of the students' learning process (rather than simple presenters of knowledge and information).
- Develop teachers' skills in learning how to learn (define learning objectives, plan and evaluate learning strategies, monitor progress, and adjust as needed).
- Promote cooperative and collaborative learning.
- Be sensitive to the culture and diversity of teachers as learners, using a multifaceted approach to respond to different learning styles, opportunities, environments, and starting points.
- Enable learning independent of time and place (anytime, anywhere learning).

More concretely, this means that teacher professional development in the use of technology needs to combine lecture/presentation modalities with small-group and plenary discussion, individual and collaborative activities, and opportunities for teachers to reflect on their actual teaching practices and how they might do things differently with technology.

Such an approach also means that learning materials need to be in several formats: print, CD-ROM, e-mail attachments, online (HTML and Java), and even DVD. It also implies a need to develop both synchronous and asynchronous modalities, so that teachers can take advantage of training opportunities when they have the time, which is not necessarily when the trainer is available.

Key to successful teacher professional development programs is a modular structure, corresponding to different levels of teacher experience and expertise using technology. Adapting materials to teachers' comfort level and starting points is essential. In this way, teachers new to technology can be exposed to the full series of professional development modules, while those further along on the learning curve can enter where their knowledge and skills stop, and help their less technology-savvy colleagues along.

The basic principles of adult learning also should be incorporated into the training program. This implies that the program should be highly social and cooperative, with opportunities to share experiences and combine instruction with discussion, reflection, application, and evaluation. In addition to these principles, technology enables an even more collaborative approach and maximizes peer-to-peer sharing of the challenges, frustrations, advantages, and successes of using technology to teach and learn. Such an approach encourages use of illuminating failures in the use of technology in the classroom as well as examples of best practice.

Finally, these principles imply the need to build ongoing community and systems of support from peers, mentors, and experts. Single, "one-shot" training events that leave teachers alone afterward should be avoided.

CONTENT OF PROFESSIONAL DEVELOPMENT PROGRAMS

What should be learned? What skills and attitudes do teachers need to develop? What knowledge do they need to construct to use technology effectively to improve teaching and learning? This topic has been discussed at length over the last 10 years as information technology, and particularly the Internet, has been introduced into schools around the world.

To begin with, designers of a teacher professional development program for use of technology need to determine current teacher competency levels in this area. The International Society for Technology in Education (ISTE) has produced a set of standards for teacher skills and knowledge in the use

of technology ("Recommended Foundations in Technology for All Teachers"), a useful guide for determining the content of teacher professional development programs.[6] These standards were developed through a multiyear consultative process with thousands of teachers who were using (or trying to use) technology in their practice, principally in the United States and Canada. Another tool, the "Professional Competency Continuum," can be used to determine the skill levels of individual teachers and their professional development needs.[7] European, Asian, and Latin American educational associations have developed similar sets of standards adapted to their educational contexts.

No attempt is made here to resolve these ongoing discussions and divergent views regarding the content required for teacher professional development in the use of technology. Indeed, differing economic, social, cultural, educational, and technological realities require different approaches. That said, some minimum guidelines and suggestions for the content of teacher professional development in the use of technology are warranted.

Policy makers should assume as a bare minimum requirement at least 24 hours (three full days) of teacher training in the use of technology. This includes basic operating systems (turning computers on and off, opening and closing files, etc.), word processing, and spreadsheets (particularly useful for such noninstructional tasks as grading). Obviously, the more time allocated for this training, particularly hands-on time, the greater the mastery of these basic skills will be. Teachers should finish this basic course with at least the fundamentals necessary for them to practice and develop their skills further back in their schools. Adding another 16 hours of training and Internet access would enable teachers to access information on the Internet, do some basic lesson planning integrating technology, and exchange e-mail messages and files with colleagues and experts. With this base of 40 hours of professional development, provided the methodology of the course incorporates some of the key interactive learning principles described above, teachers should be able to begin using technology in their classrooms.

Experience of the World Links program suggests that at least 80 hours of professional development are required before teachers can really begin to integrate technology into their teaching. Additional content would include linking curricular objectives to technology-based activities, development of lesson plans and evaluation strategies that incorporate technology, construction of educational Websites, and discussion of ethical issues related to technology and education. Ideally, this is provided in various stages, allowing time for teachers to experiment with and apply their new technological skills and knowledge in the classroom before moving on to move advanced applications. This approach also allows teachers to reflect on and share their learning experience (both positive and negative) with their peers, thereby promoting the social construction of knowledge.

World Links has been a pioneer in developing and delivering teacher professional development programs in the use of technology to improve teaching and learning in developing countries. It is by no means the "definitive" program, nor is it the most easily replicated and scaled. However, for purposes of illustration, the complete World Links Teacher Professional Development program includes 200 hours of training, equivalent to five 40-hour weeks. This takes teachers with no prior contact with computers to full competency over a two- to three-year period. As an example, the descriptions of these five training modules are provided in the Annex to this chapter.

In addition to content, professional development for technology should incorporate the fundamental components that research has found to be essential, including:

- Direct connection to student learning. The goal of teacher professional development is improved student achievement.
- Hands-on technology use. This requires development of core technology competencies and skills (referred to above) and actual application of skills in the classroom.
- Curriculum-specific applications. To the fullest extent possible, teachers need to see a direct link between technology and the curriculum for which they are responsible.
- New roles for teachers, as facilitators and guides, not simply as lecturers or instructors.
- Active participation of teachers and collegial learning.
- Professional development as an ongoing process.

MOTIVATION AND INCENTIVES

A key issue that must be addressed is teacher motivation to participate in professional development workshops in the use of technology. While so-called "champion teachers" ask for and seek out professional development opportunities in the use of technology, the vast majority of teachers do not. Teachers generally are reluctant to change their teaching styles and habits; are cautious of time-consuming activities that may take away from other high-priority obligations (economic, familial, or educational); have difficulty seeing the potential payoff beforehand of this kind of training; and may feel so threatened by technology that they want to distance themselves from it rather than embrace it. Put simply, many teachers require additional motivation and incentives to participate actively in professional development activities.

A brief description of some incentives (extrinsic and intrinsic) that have been used successfully in the past follows.

Certification by Ministry of Education (Extrinsic)

Ministries of education should be more active in designing criteria for certifying technology-focused teacher professional development programs. They can begin by seeking examples of best practices/examples of professional development programs (domestic or international), relating training programs to existing teacher knowledge and skill standards, and comparing programs to curricula. Then, departments of inservice training should certify the best teacher training programs and link teachers' progress in salary and grade scales to successful certification. This would send a clear message to teachers and school directors that such training is valued at the highest levels of the ministry, and that it increases teachers' incentive to actively participate.

Recognition and Time Allocation by Supervisors (Extrinsic)

Teachers need to be encouraged by administrators, particularly their school directors, to participate in training activities. Administrators need to ensure that teachers have adequate time to participate, and do not have to sacrifice too much personal time to do so. From an administrative perspective, this should be viewed as an investment and a contribution to the capacity building of the country's teaching force. But, in addition to time allocation, supervisors should recognize publicly teachers who successfully complete professional development courses. This provides immediate personal reward to teachers, raises their status in the eyes of their peers, and encourages others to participate.

Reduced Isolation and Increased Professional Satisfaction (Intrinsic)

Many teachers lead an isolated professional existence, with little input from or collaboration with their peers or supervisors. Alone in front of a class of 25-75 students, they teach according to what they learned (both content and pedagogy) several or more years ago in a preservice teacher training institute. Learning new technological skills, especially if they include Internet and e-mail, allows teachers to break down the walls of their classroom and share lesson plans, evaluation strategies, student assessments, and even just the joys and frustrations of teaching.

For example, more than 80% of teachers in both Africa and Latin America who responded to the survey included in the 1999 evaluation of the World Links professional development program, conducted by SRI International, gave the highest possible ranking to the program's impact on their motivation and satisfaction as teachers. In other words, technology reduced their isolation and made them more excited about teaching. Sharing that experience should serve to motivate other teachers to participate in similar professional development programs.

Enhanced Productivity (Intrinsic)

Technology can speed up and increase the efficiency of a range of noninstructional teacher activities such as student attendance, grading, textbook distribution, and preparation of administrative reports. It also can enhance the productivity of basic instructional tasks, such as preparing lesson plans and class outlines, developing quizzes and examinations, and writing up comments on student papers and reports. More advanced applications include fast identification of educational resources (online), use of CD-ROM materials, and curriculum-linked telecollaborative projects.

In fact, there is a nearly limitless range of opportunities for teachers who develop the necessary skills and knowledge in the effective use of technology in the classroom, and who have access to technology and Internet. They can:

- plan, conduct, and evaluate learning projects with colleagues and students;
- receive and provide support following courses;
- participate in (or lead) topical discussions;
- conduct and attend course activities;
- find resources, experts, and new colleagues; and
- serve as resources for other educators.[8]

Becoming a Trainer (Extrinsic and Intrinsic)

Teachers may be motivated to participate in professional development workshops in the use of technology because they see them as an opportunity to become a trainer/mentor for other teachers. In many cases, becoming a trainer brings additional financial and professional opportunities (travel, participation conferences, publications, etc.). If the training workshops come with some form of official certification for successful completion, motivation is enhanced further.

TRAINING OF OTHER SCHOOL COMMUNITY MEMBERS

Administrators

School directors, finance officers, and other administrative personnel also need professional development in the use of technology for noninstructional purposes. Technology can improve significantly the productivity of activities related to financial management, class scheduling, personnel management, student tracking, administrative reporting, communicating with parents, etc.

However, training of school directors should not be limited to noninstructional uses of technology. It is vital that school directors understand and support teachers' efforts to integrate technology into the classroom. Far too often, school directors minimize the time and effort required for teachers to develop the skills and knowledge required to use technology effectively, and, in many cases, directors actively oppose teachers' efforts to use technology in innovative ways. For this reason, it is strongly recommended that all school directors participate in introductory professional development workshops in the pedagogical application of technology. If at all possible, this should be done in collaboration with teachers (even students!), so school directors understand that technology requires us to be both learners and facilitators of the learning of others.

School directors need to see the potential of technology to be a catalyst for more effective learning. They also need to understand (and empathize with) the process and the time required to tap this potential. If this happens, they will be far more likely to encourage their teachers to participate in training workshops, allow them needed release time, and encourage them to experiment with innovative teaching practices using technology.

Students

Parallel to, and in conjunction with, teacher professional development is the need to provide training for students in the use of technology. It is shared wisdom now that youth acquire technological skills far more quickly than adults, and they are far more likely to share their skills with their peers (either deliberately or simply through interaction). Rather than seeing this as a threat to their authority, teachers should embrace this reality and use it to their advantage.

Technology training for students has a "viral" character to it in that it tends to replicate itself spontaneously and spread among other students, many of whom have extremely strong intrinsic motivation to learn new skills. This motivation is related to youth's natural affinity for new technologies, their desire to improve their academic performance for downstream educational and economic opportunities, and their understanding that these skills are increasingly demanded in their countries' labor markets. Such motivation is not often present among teachers.

Technologically savvy students can help teachers use technology in the classroom in many ways, especially when collaborative, constructivist, and authentic learning strategies are used. At a basic level, students can provide technical support in the classroom to their peers and even to the teacher in the use of software, Internet research, leadership of small groups, and even simple computer maintenance and troubleshooting of common glitches.

At a more advanced level, students often have more time and desire than teachers to develop their technological skills further. Thus, they can "instruct" the teachers themselves, by demonstrating new software applications, building educational Websites, and handling administration of networks/servers/IP (Internet Protocol) addresses, etc. Having students take on these responsibilities can free up time for teachers to focus on pedagogical issues, and empower them to promote a more interactive learning environment.

Parents

Generating parent support for technology in schools is important if technology investments are to be sustained and/or expanded. World Links' experience in more than 20 developing countries suggests that parents are often the primary source of recurrent financing for technology in schools and, actually, the most logical source from an economic perspective. This is because universal access to technology simply is not possible now (even if the hardware and software were free, a huge proportion of schools in developing countries lack the electricity and phone lines needed to use them), and those schools that meet basic technical criteria usually are located in more urban and/or middle-class socioeconomic areas. In other words, technology can exacerbate inequity of educational and economic opportunities within a country. With their children as the direct beneficiaries of technology-enhanced learning, parents are the natural source of financial support to sustain technology at the school level.

Offering training for parents in the use of technology helps them to understand its potential for their children. Consequently, such training makes them more likely to bear a portion of the financial burden and encourage their children to take advantage of these new opportunities. In addition, trained parents can become invaluable "monitors" or aides in school computer labs, either paid or volunteer. This eliminates the need to assign teachers to the computer lab during nonteaching hours, encourages greater school-community integration, and provides opportunities for students and adults to share their skills and knowledge with one another. In many cases, "champion students" (such as those described earlier) can offer training to parents and other community members.

COSTS AND FUNDING

Traditionally, teacher professional development is woefully underfunded, at the preservice and inservice levels. This is *doubly true* with training in the use of technology because education policy makers typically work within fixed

technology budgets and are inclined to give priority to hardware and software acquisition over teacher professional development (to spread technology access as broadly as possible, often for political and institutional reasons). In the political economy of education financing, teacher professional development is a low priority. It doesn't excite parents, equipment vendors, or politicians who like ribbon-cutting ceremonies. Indeed, it often is viewed negatively because it is costly, time-consuming, pedagogically and logistically challenging, and often results in difficult-to-measure outcomes.

However, without training, teachers will not use technology; it is that simple. The result of underfunding teacher professional development is that a lot of technology provided to schools is never used—it sits in boxes or closets, gathering dust and becoming obsolete. This is more than a loss of potential learning and skills acquisition; it is also a waste of the resources used to procure technology in the first place.

Actual funding requirements for teacher professional development in the use of technology obviously will depend on the scope (content, duration) and methodology of the program itself, and on the number of teachers who are targeted. Whether teachers have full access to computer training facilities (at least one networked computer for every two teachers) as part of their training also influences costs. To illustrate, the World Links program was operational in approximately 20 developing countries during the 2000-01 school year. More than 16,000 teacher-training-days were provided, through 400 local and international workshops, in five languages. Training costs varied from US$25 to US$400 per teacher per day. Taking into consideration the minimum training content guidelines discussed earlier in this chapter, which would translate into a minimum cost of US$75 per teacher, if the training goals of a ministry of education extend to integrating technology (not just use) into the curriculum, this minimum cost (for 80 hours) would be US$250 per teacher. If the full 200-hour World Links professional development program were implemented according to actual year 2000 cost parameters, US$625 per teacher would be required.

Generally, but not always, the unit cost per teacher declines as the number of teachers trained increases, which suggests that there are important economies of scale to be maximized. This is because the costs of developing the program itself are spread over a wider number of participants, and because, as more teachers are trained, less expensive ways of training new teachers can be used (use of local trainers; mentor programs; school-based activities that do not require travel, accommodation, and per diem expenses; etc.).

Experience in both industrialized and developed countries suggests a guideline of professional development financing equivalent to 40% of hardware/software expenditures. For example, if a school (or a ministry of education) spends $15,000 to establish a computer lab (computers, server, printers, network architecture, software, furniture, etc.), an additional $6,000 (at least) should be budgeted for professional development of teachers, administrators, and students in that school over a two- to three-year period. Assuming a training cost of $25 per day per participant, and an average of 80 hours (or 10 days) of training per participant, that translates into $250 per trainee. A budget of $6,000 would enable 24 teachers, administrators, and students at that school to be trained over several years. This should be enough to promote not only the introduction of technology into the school, but also its integration into the curriculum for improved teaching and learning.

The Costa Rican experience in introducing technology in primary and secondary schools is instructive here. Budget outlays for training and pedagogical support were almost equal to those for computer hardware. Teachers working as computer lab coordinators participated in 120 hours of initial training, with additional hours provided during the school year. Both face-to-face and virtual delivery modes co-exist.[9] The successful use and integration of technology in Costa Rican schools, seen in many evaluation studies, attests to the value of this well-funded approach.

TECHNOLOGY AS A MEANS FOR OFFERING PROFESSIONAL DEVELOPMENT

Once teachers have mastered the basics of ICTs—operating systems, word processing, and e-mail and Internet navigation—they can use the technology to access professional development opportunities. This enables anytime, anywhere learning and overcomes the conventional limitations of face-to-face training workshops (cost, travel, accommodations, and low numbers of participants).

Models for Online Professional Development

Many different technologies have been used to support or provide teacher professional development. Often grouped under the vague heading, "distance learning," they include basic correspondence courses, broadcast television, interactive radio, and video. This section focuses on the potential of new digital technologies (the Internet, digital radio, CD-ROMs, DVDs) for teacher professional development.

To begin, it is important to distinguish among different approaches or models for online professional development. As Bob Tinker of the Concord Consortium states, "Broad claims about the value of online learning need to be qualified by the kind of model being discussed."[10]

Four models are discussed here, based on Tinker's taxonomy:

- the course supplement model,
- the online lecture model,
- the online correspondence model, and
- the online collaborative model.

The *course supplement model* complements a traditional face-to-face teacher training course with online resources that often include readings, suggested activities, chat rooms and discussion forums, and answers to problems and tests. Many developing countries looking to improve the quality of their preservice and/or inservice teacher professional development programs can begin here. However, this approach does not reduce costs (it increases them), nor does it replace face-to-face instructional time (the primary cost) or improve scalability of training.

The *online lecture model* offers opportunities to reduce instructional costs and reach large numbers of teachers. It emphasizes primarily one-way delivery of high-quality content. Considerable resources often are invested in developing online instructional resources, with personal contact provided over the Internet through instructor responses to assignments and exams, moderated discussion groups, online "office hours" for questions and answers, and collaborative project work.

For motivated and disciplined teachers, this model can be an effective way to provide professional development at a reasonable cost, particularly in countries where qualified teachers are in short supply. However, the loss of personal contact implied by this model typically results in extremely high dropout rates (around 50%).

The *online correspondence model* is similar to the online lecture model, but it usually invests fewer resources in content delivery in exchange for increased personal contact with the teacher through graded assignments and examinations. Indeed, quite a few traditional correspondence training programs that used postal systems to exchange the work of participants and instructors have transferred their courses to the Internet. The cost is relatively low, but the lower quality/quantity of instruction (much of the training is actually self-paced reading) limits this model to highly motivated teachers and specialized content.

The *online collaborative model* emphasizes the full potential of technology to enable teacher-teacher collaboration during their training course. Typically, it emphasizes asynchronous collaboration (essential for learning across time zones, less costly, and easy to implement); limited enrollment (no groups larger than 20 teachers, although these may be part of courses with much larger enrollments); and expert facilitation, trust-building activities among participants, explicit schedules, high-quality learning materials of many kinds, continuous assessment, and quality assurance with respect to instructional design, subject matter content, delivery, and impact. This model often requires more time (i.e., more money) to design and deliver than traditional face-to-face courses, but it does offer many advantages (higher impact, anytime/anywhere learning, modeling of what teachers may do in their classrooms with their students, etc.).[11]

For developing countries, the ideal online teacher professional development program may be a hybrid of these models, combining the high-quality content delivery (lecture model) with a system of mentors/facilitators for personal feedback (correspondence model) and frequent participant collaboration on assignments/learning activities (collaborative model).

Advantages of Technology Use

The Costa Rican experience in training teachers to use technology, and using technology to train teachers, is instructive. Over the course of 12 years, more than 15,000 teachers and administrators have been trained, using both face-to-face and distance methodologies. Teachers engage in training online on their own, at their convenience, and they can do so as often and for as long as they want. Ongoing pedagogical support and teacher networking, key ingredients of effective inservice training, are facilitated by the technology. By infusing technology into the teaching and learning process, teachers' career-long professional development has become a continuous and planned process. Technology extends training into and beyond the classroom, no longer bound by fixed schedules or physical spaces for instruction (anytime, anywhere learning).[12] This dramatically increased Costa Rican teachers' motivation for, and participation in, professional development in the use of technology to improve teaching and learning.

This potential can been seen in the evaluation of the World Links Program by SRI International, in which more than 80% of teachers surveyed reported that their attitudes about teaching improved "a lot" or "a great deal" as a result of their involvement in the program. The program offers access to technology and the Internet, teacher professional development, involvement in international telecollaborative projects, and development of online educational content by the teachers themselves.

But perhaps more important than providing additional training opportunities, the use of the Web as the training medium exposes teachers to pedagogical practices analogous to what

they may do with their own students using technology. Teachers begin to learn skills and develop new knowledge online, through interaction with instructors, mentors, peers, and subject matter experts, modeling the potential learning experience of their students after the training. More specifically, from a pedagogical perspective, teachers working together online with their instructors, peers, and experts share and collectively construct their skills and knowledge. This replaces the traditional vertical training model of trainer imparting information "down" to a teacher.

Not a Panacea

Using technology to train teachers should not be considered a panacea, however. It is very hard to implement, and the number of successful cases in developing countries is very small. Even in the United States, online teacher professional development programs experience an average dropout rate of more than 30%, in most cases because of a decline in participants' motivation or availability of time.[13]

There are a number of strategies and approaches to maintain participant motivation:

- Don't overload the course. Comprehensive coverage of every topic may not be possible or desirable. Focus on quality not quantity.
- Whenever possible, include materials and assignments that can be used in the classroom.
- Look for ways to involve trainees in course assignments.
- Encourage group work and discussion among teachers.
- Take advantage of the fact that your audience is composed of fellow educators.
- Endeavor to involve teachers in the latest research.
- Expose teachers to new educational products and teaching methods.
- Always keep teachers informed about grades, assignments, etc.
- Use teaching assistants extensively to increase personal contact.
- Clarify course requirements and grading policies.
- Expect diversity among participants in terms of both mastery of subject matter and familiarity with technology.
- Keep online conversations active and lively.
- Grade and return assignments promptly.
- Help teachers to set and adhere to a study schedule.
- Use short, open-ended responses to promote online discussion.
- Force teachers to stay together and keep up with all readings and assignments.[14]

For some middle-income developing countries (e.g., Chile, Malaysia, parts of Brazil, Turkey, etc.) online learning is already in reach because of the spread of technology in the schools and sufficient communication infrastructure. For most developing countries, however, problems of low bandwidth, telecommunications costs, limited computer access, etc., require maximum use of offline training modalities, such as CD-ROMs; use of store-and-forward e-mail for sharing documents and mentor support, video, diskettes; and even printed materials to support other technologies.

This presents a paradox: Before technology can be used for teachers' professional development, teachers need face-to-face professional development in the use of technology. But experience in countries such as Chile has shown that with as little as a half-day of face-to-face training, teachers can develop enough knowledge and skills to participate successfully in technology-based distance learning activities.

In the state of Rio Grande do Sul in Brazil, the state federal university, in partnership with the state department of education, developed a training model that incorporates face-to-face training of teachers in the use of technology with Web-based instruction. In Armenia, the *Three Pomegranates Network* provided almost its entire teacher professional development through the project's Website. Even though none of the teachers had used computers or the Internet with their students previously, they were able to use Web-based tutorials and online training to implement online, collaborative project-based activities with their students.[15]

Economies of Scale

In the corporate world, e-learning has demonstrated over the past five years that it can cut training time by one-third, increase training effectiveness by one-third, and reduce training costs by one-third. The same efficiencies need to be explored in the public sector, even if some of the costs and technology investments are different. (For example, in the private sector, a major cost of face-to-face training is simply the opportunity cost of participants' time, which translates into lost sales and revenue. Shifting to an anytime/anywhere e-learning approach allows private-sector employees to get training during nonworking hours or anytime they can squeeze it in, thereby minimizing these opportunity costs. Public-sector teachers typically have far lower salaries, and their participation in training does not result in revenue loss.)

While experience in this area varies greatly, most observers agree that the key to successful e-learning programs (from both cost and effectiveness perspectives) is attaining sufficient economies of scale. For example, compare the $8,000 cost of a 40-hour face-to-face World Links training

workshop for 40 participants with Fundacion Chile's $400,000 cost of providing a 60-hour online training workshop for 15,000 participants. The face-to-face workshop had a 100% completion rate, while only 50% of teachers completed the online workshop. This translates into a unit cost of $200 per teacher for the World Links program, compared with approximately $50 per teacher completing the course for the Fundacion Chile program. Even with a very large dropout rate, the e-learning approach appears to have reached greater numbers of teachers at lower unit costs.

That said, one must take into consideration all of the costs associated with the e-learning approach. In addition to the costs of computers and Internet access, there are considerable costs in designing the online course itself and providing course coordination, participant registration, technical support, and assessment/certification. Over time, these costs can be reduced through standardized templates and greater skill in using the technology and software among all participants, but initial investment costs are likely to be substantial.

FUTURE TRENDS

Future trends in teacher professional development in the use of technology will be shaped by two main factors: increasing demand for teacher training and new technologies/methodologies to enable that training.

Increasing Demand for Teacher Professional Development in the Use of Technology

The demand from ministries of education and teachers themselves for professional development in the use of technology is outpacing the capacity of conventional approaches, such as face-to-face training, to respond. There is a simple issue of scale as ministries of education implement nationwide educational technology programs (in countries as diverse as Chile, Senegal, Turkey, and Sri Lanka), and the sheer numbers of teachers who need to be trained exceeds financial, human, and technical capacity to handle teacher training requirements. In addition, greater complexity and content of the training are required as the Internet and other new technologies are introduced.

At the societal level, what teachers are expected to know and do is increasing every year. Teachers not only have to know their subject matter and basic pedagogy, they also are expected to model higher-order thinking processes, work in interdisciplinary teams, and demonstrate leadership and communication skills. At the same time, they are supposed to deliver better student results on standardized tests, while addressing larger societal problems (HIV/AIDS, conflict resolution, disintegration of families, etc.).[16] Traditional teacher training approaches simply are not equipped to deal with all of these new expectations. By contrast, ICTs can help teachers to meet these expectations, by providing productivity tools, access to information and colleagues, and collaboration opportunities. As teachers experience these external pressures, and realize the potential of technology to help them respond, their demand for training in the use of technology will grow.

Scale and complexity exacerbate the issue of teacher motivation. Ministries of education around the world are struggling for techniques and incentives to get beyond the "champion teachers" and so-called early adopters to reach the average teacher. Paradoxically, there is both excess teacher demand for training (relative to capacity to provide it) and insufficient teacher demand for training (relative to the physical distribution of computer hardware in the schools). New teacher professional development methodologies are required to address this issue of motivation.

In the future, ministries of education will issue new standards for teacher competencies in the use of technology, which will affect both preservice and inservice teacher training levels. These standards are likely to be linked to official certification requirements and processes, so that education ministries can track the proportion of teachers who have the necessary skills and knowledge, and so that teachers have an incentive to participate (certification tied to salary and/or grade enhancement, for example).

As the need and demand for teacher professional development increases, the key challenges will be ensuring content quality, reliable and appropriate training delivery infrastructure, follow-up support, and measurable outcomes—and all at an acceptable cost.

New Technologies and E-Learning

As discussed earlier, e-learning is a way for teachers to learn new knowledge and skills using computer network technologies. The technologies provide not just text, but also sound, video, simulations, and collaboration with other learners who may be scattered around the country or the world. Currently, most e-learning is delivered using the World Wide Web; however, future e-learning could include delivery via mobile handheld devices, cell phones, and digital video devices.

The rapidly declining cost of digital video disc (DVD) production and replay offers exciting opportunities to capture the work of master teachers and trainers and share this with teachers wherever they are. Internet-enabled DVD will be available soon, so that teachers learning with a DVD will be

able to access materials and resources located on the DVD itself and on the World Wide Web. A $250 DVD player linked to a computer (and perhaps an Internet connection) would bring full video and audio capabilities to professional development, in combination with community-building tools and other resources. This will open up a whole new range of visual and audio possibilities in a distance training format, which is easily scaled.

As Internet access and bandwidth improve in developing countries, additional Web-based synchronous and asynchronous teacher professional development opportunities will arise. For instance, a reliable 56 Kbps Internet connection would enable online teacher professional development that includes live voice-over-IP, file sharing, control of all participants' computer screens by the instructor-facilitator from anywhere in the world, online assessment, and many other features. The instructor-facilitator would control the microphone, be able to "pass" it to participants when they want to ask a question or make a comment, provide individualized evaluation and support to participants, and do this with teachers located in 25 different countries simultaneously. Holding this up are basic telecommunications infrastructure, the telecommunications costs of extended online connections, and regulatory issues surrounding voice-over-IP.

E-learning is rapidly developing because of four main factors:

- gradually increasing availability of higher-speed computer networks to deliver information and services;
- recognition that teachers need to "work smarter" with constant updating of skills;
- convenient just-in-time education for teachers (often "anytime, anywhere"); and
- cost-effective alternative to traditional classroom-based education and training.

RECOMMENDATIONS TO TEACHERS

This chapter is intended to be as practical as possible. In this spirit a series of recommendations is included directed at teachers seeking to improve their skills and knowledge in the use of technology in their classrooms. Many of these recommendations have been taken from Burniske and Monke's excellent book, *Breaking Down the Digital Walls: Learning to Teach in a Post-Modem World.*[17]

- Be critical. Don't blindly embrace or adopt technology as a panacea. Seek the appropriate place and time for computing and the pedagogical rationale for using it.
- Reflect on your own teaching practices. If you are going down the wrong road, technology will get you there faster. Look for ways that technology can help to catalyze pedagogical reform toward more student-centered, interactive, constructivist learning as opposed to traditional methods of "chalk and talk," teacher-oriented, one-way instruction, which is defined in part by the limited resources at hand.
- Demand technical assistance. Not every teacher should have to become a technical expert at hooking up computers, configuring servers, and loading software.
- Seek training opportunities and demand time from administration to learn how to use technology, especially the Internet. Whether it is formal professional development workshops, self-paced training manuals, or simply hands-on experiential learning, teachers should not have to give up family or personal time outside of normal school hours to learn how to integrate technology effectively into their classrooms.
- Join a community of teachers. This may be one person in the same school, 25 teachers in surrounding schools, or a huge network of teachers online around the world sharing their experiences, frustrations, lesson plans, encouragement, problems, and solutions.
- Consider what existing teaching/curricular activities may need to be dropped to integrate technology (and perhaps telecollaborative projects) into the classroom. Technology should not be an automatic add-on to already full curriculum/teaching loads. For instance, when Singapore developed its Master Plan for Information Technology in Education, the Ministry of Education reduced the amount of curriculum content by up to 30% to allow time for achieving curricular goals using IT.[18]
- Be willing to be a student (or an apprentice) again. Teachers need to recognize that their desire/need to learn new skills and knowledge means learning from others, whether that comes from working with their own students, professional trainers, or other teachers. Patience is required to learn new techniques, to apply them in a limited fashion in the classroom, and to accept comments/suggestions from others.
- Be strong. Having students use computers and the Internet does not mean that the role of the teacher fades away. On the contrary, it requires the teacher to project more forcefully into the students' learning, insisting that students reflect on their learning, evaluate Internet information, develop information-reasoning skills (not just memorizing information), and acquire a deeper understanding of their subject matter.

CONCLUSION

Professional development of teachers in the use and application of educational technology should be designed and implemented as part of a broader educational reform

program that, at a minimum, combines technology access with teacher professional development and local content development. No strategy that ignores any of these three elements is likely to succeed beyond superficial applications.

Ideally, teachers' professional development should not be isolated from other elements of instructional and noninstructional educational environments, such as curriculum reform, physical/technological infrastructure, examinations, and research. Simply providing professional development for teachers in the use of computers and the Internet, in a situation with outdated curricula, traditional standardized test systems, and insufficient technology access, is unlikely to produce any systemic improvements in learning. In fact, the high-stakes traditional examinations system frequently operates against teachers trying to incorporate technology and encourage deeper forms of learning, which frequently are not measured by standardized tests.

Teacher professional development in the use of technology to improve teaching and learning needs to be:

- multifaceted,
- modular,
- authentic,
- collaborative,
- "incentivized,"
- iterative and ongoing,
- allocated sufficient time and financial resources,
- cost-effective, and
- evaluated and revised.

While it is neither easy nor inexpensive to design and implement teacher professional development programs in the use of new technologies, it is an absolutely critical element of any initiative to introduce technology into schools to improve teaching and learning. Failure to invest sufficient resources in teacher training will result in failure of school-based technology initiatives, which would result in substantial wasted investment that few, if any, developing countries can afford.

Success in ensuring that teachers acquire the skills and knowledge they need to use technology effectively opens the door to all kinds of new educational opportunities for both teachers and students, and downstream economic opportunities for graduating youth and their countries. It is the key to participation in the global knowledge-based economy. Accordingly, teacher professional development in the use and application of technology must be given the priority and resources it deserves, while maintaining a constructively critical eye on its costs, methodologies, and impact.

ENDNOTES

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PHASE I—INTRODUCTION TO THE INTERNET FOR TEACHING AND LEARNING
TABLE OF CONTENTS

Objectives: Introduce fundamental concepts, technologies, and skills necessary for integrating networked technology and the Internet into teaching and learning; initiate discussion of new possibilities; generate basic e-mail projects.

1. Introduction to the World Links Program
2. Expectations & Overview—Clarification of expectations and objectives for Phase I professional development
3. Conceptual Orientation—Definition of key terms: collaboration, community, cooperative learning, project-based learning
4. What Is the Internet?—Structure, e-mail, www, ftp, technical aspects, shareware, etc.
5. Introduction to E-mail—Emphasis on communication and collaboration; receiving, sending, group e-mail, public vs. private, organization, newsgroups, listservs
6. Introduction to the WWW—Navigating the WWW, skills, literacy, evaluation, search engines, html, Web page development, creating content
7. Information Literacy
8. Telecollaborative E-mail Projects
9. Action Plans—Follow-up professional development, professional development plan for schools, coordinators' role, action plans for projects
10. Closing Ceremonies

PHASE II—CURRICULUM & TECHNOLOGY INTEGRATION
TABLE OF CONTENTS

Objectives: Develop skills and understanding of how to create, incorporate, and facilitate innovative classroom practices that integrate networked technology and curricula. Create at least one collaborative publication that reflects the week's activities and encourages future work.

1. World Links Program Update—Progress report from World Links coordinators
2. World Links Schools Update—How are things going with the World Links program in your schools (progress reports written and submitted to coordinator before professional development)?
3. Expectations & Overview—Clarification of expectations and objectives for Phase II professional development
4. Instructional Technology—Examination of new and emerging tools that support integration of technology for instructional purposes, classroom management, and administrative duties
5. Best Practices of Technology Integration—What methodologies or instructional practices work best? Case study methodology and activities designed to address subject-specific concerns, telecollaborative projects, and interdisciplinary studies
6. Online Exchanges and Collaborations—Best practices and case studies to integrate Internet/technology into the curriculum (from participants and instructor): how to find, create, and link resources to the curriculum, including telecollaborative projects
7. Content Creation—Activities designed to help participants use software applications to create content for classroom purposes
8. Websites as Pedagogical and Curricular Tools—Activities designed to investigate the possibilities for educational Websites to serve a dual purpose
9. Closing Ceremonies

PHASE III—TELECOLLABORATIVE PROJECTS
TABLE OF CONTENTS

Objectives: Introduction to educational telecollaboration: from activity structures to creation, design, implementation, and dissemination of original projects.

1. World Links Program Update
2. World Links Schools Update—Review experience since Phase I and Phase II professional development: what have you done since your last professional development?
3. Expectations & Overview—Clarification of expectations and objectives for Phase III professional development
4. Key Concepts—Project-based learning, constructivism, collaboration, telecollaborative projects, activity structures, etc.
5. Telecollaborative Project Types—Activity structures and exemplary projects
6. Designing Telecollaborative Projects—Connections to curriculum, brainstorming ideas, steps toward a successful project
7. Project Facilitation & Collaboration—Time management, 'Netiquette, 'Net safety, classroom management
8. Websites & Telecollaborative Projects—Process approach, collaborative process, digital archives, communication tools
9. Publicizing Telecollaborative Projects—Venues for publicizing projects online; creating a successful call for collaboration
10. Action Plans—Next steps in the process to ensure implementation of pilot project
11. Closing Ceremonies

PHASE IV—INNOVATIONS: CONTENT CREATION, DIFFUSION, & EVALUATION
TABLE OF CONTENTS

Objectives: Develop skills and understanding of how to create, evaluate, and diffuse innovative classroom practices that integrate networked technology and curricula while addressing social and ethical concerns. Create at least one collaborative publication or activity to promote dissemination of instructional technology's "best practices."

1. World Links Program Update—Progress report from World Links coordinators
2. World Links Schools Update—Progress reports written and submitted to coordinator before Phase IV
3. Expectations & Overview—Clarification of expectations and objectives for Phase IV professional development
4. Diffusion of Innovations—Collaborative activities designed to brainstorm and implement ways of sharing innovative practices that integrate networked technology and curricula
5. Content Creation—Creation and development of learning units that integrate information and communication technology with existing curricula
6. Evaluation—Exploration of ways to evaluate student performance, Web documents, Websites, telecollaborative projects, etc.
7. Assessment—Exploration of alternative methods for assessment of student learning via ICT
8. Online Ethics and 'Netiquette—Case studies and online activities to discuss intellectual property, decorum, and acceptable use within the classroom and school community
9. Experimenting with Innovations—Activities to explore synchronous communication tools and their potential for teaching and learning
10. Closing Ceremonies