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AUTHOR   Gooler, Dennis; Kautzer, Katherine; Knuth, Randy
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ABSTRACT
        This policy brief focuses on teacher competence in using
technologies in the Pacific region, identifying key policy issues that must
be addressed if teachers are to be prepared to capitalize on the investments
being made in technology at the local and entity level. Section 1 focuses on
what teachers must know and do in order to effectively use technologies and
improve student learning (teacher knowledge, skills, and behaviors). Section
2 looks at formal and informal approaches to help teachers gain the knowledge
and skills they need to use technologies (e.g., conferences, workshops,
courses, action research, study groups, distance learning, professional
development embedded in practice, mentoring, and teacher networks). General
characteristics of effective professional development are noted (e.g., a
focus on enhancing student achievement, teacher participation in decision
making about professional development design and delivery, and evaluation
which ensures that each activity meets the learning needs of its
participants). Section 3 considers what policy issues must be addressed in
order for teachers to avail themselves of opportunities to gain knowledge and
skills to use technologies effectively (encouraging teachers to acquire
necessary skills, sustaining support for teachers to use technologies, and
evaluating teachers' use of technologies). (Contains 25 references.) (SM)

PREL BRIEFING PAPER

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Teacher Competence in Using Technologies: The Next Big Question

By
Dennis Gooler, Ph.D.*
Katherine Kautzer, Ed.D.
Randy Knuth, Ph.D.

Educators in the Pacific region have been working very hard to expand the technology infrastructure in the Region to make it possible for Pacific teachers and learners to gain access to the wealth of information resources and instructional materials now available through the World Wide Web and other technology devices. Building this infrastructure has not been easy, nor is the work complete. There are still schools without access to basic technologies, and still more without full access to telecommunications connectivity.

Even as the work to expand technology infrastructure in the Region continues, educators are realizing that adequate infrastructure is not sufficient to assure that all Pacific young people can participate fully in the emerging information age. It is increasingly evident that the best and most complete technology infrastructure possible will not in and of itself improve student performance or increase the quality of life for citizens in a community. Other factors must be prioritized if technology is to make an important contribution to learning.

One of these factors is teachers' ability to use the technology infrastructure once it is in place. A growing body of evidence suggests that the teacher plays a key role in determining not only how but how well technologies are used in classrooms, and thus the extent to which technologies improve student performance. Given the central importance of teachers in the application of technologies for teaching and learning, education policy makers must quickly turn their attention to teachers: their readiness and how best to prepare them to use the technology infrastructure policy makers have been working so hard to create.

* Dr. Dennis Gooler is the Interim Director of the Regional Technology in Education Consortium for the Pacific (RTEC-P) at PREL. Dr. Katherine Kautzer and Dr. Randy Knuth are Instructional Design Specialists for PRELSTAR: A Pacific Islands Distance Learning Program at PREL.

This policy brief focuses on teacher competence in using technologies. The purpose is to identify key policy issues that must be addressed if teachers are to be prepared to capitalize on the investments being made in technology at the local and the entity level. The brief poses and addresses three basic questions:

- What must teachers know and be able to do in order to effectively use technologies to improve learning?
- How can teachers gain the knowledge and skills they need?
- What policy issues must be addressed in order for teachers to avail themselves of opportunities to gain the knowledge and skills they need to use technologies effectively?

What Must Teachers Know About Using Technologies?
Teaching is a complex activity. Competent teachers apply broad, deep, and integrated sets of knowledge and skills as they plan for, implement, and revise instruction. Technology proficiency (including technical skills and instructional applications) is but one dimension of teacher competence. Thus, the question "What must teachers know about using technologies?" should be answered in the context of the different sets of knowledge and skills that effective teachers possess.

A review of research on teacher knowledge and teaching standards suggests that over time effective teachers develop the following skills and behaviors:

1. Teachers know how to plan, prepare for, and design effective curriculum, assessment tools, and instruction strategies.
2. Teachers are skilled instructional facilitators. They make effective decisions and take appropriate actions during instructional situations.
3. Teachers are reflective practitioners.
4. Teachers are professionals committed to lifelong learning.
5. Teachers know how to direct students through course content. They know the most effective instructional strategies for the particular content they teach.
6. Teachers know how to assess and evaluate student work, how to provide effective feedback, and how to apply what they have learned to improve instruction.
7. Teachers know and can utilize effectively a repertoire of instructional and communication strategies.

8. Teachers are effective classroom managers and know how to motivate students.
9. Teachers understand how children learn and develop.
10. Teachers know the subject matter they teach.
11. Teachers are adept at locating, creating, and using curriculum resources and technologies.
12. Teachers embrace student diversity, understand the community context, and know how to identify the strengths and needs of individual students.

With the exception of Item 11, technology skills and knowledge are not explicitly mentioned in the list above. It is understood that the acquisition of technology knowledge and skills must be concomitant with the development of a broader array of competencies. Technology is perceived as a means to an end (improved teaching) rather than as an end in itself.

Early attempts to develop technology standards for teachers were isolated from the broader teacher competencies and were focused primarily on technology skills. Consequently these competencies were largely ignored by teacher-training institutions. Typically, colleges of education simply required a single media course to satisfy accreditation requirements; often, colleges were reluctant to insert yet another course into an already overloaded curriculum.

The International Society for Technology in Education (ISTE) has actively addressed the technology-isolation problem and has recently released a set of revised teacher technology standards. Developed through a rigorous process of expert and lay-person input, the NETS-T Project (National Educational Technology Standards for Teachers) explicitly describes what competent teachers should know and should be able to do with technology in the context of broader teacher competencies. The NETS-T standards are categorized as follows:
1. technology operations and concepts,
2. planning and designing learning environments and experiences,
3. teaching, learning, and the curriculum,
4. assessment and evaluation,
5. productivity and professional practice,
6. social, ethical, legal, and human issues.

None of these categories, with the exception of technology operations and concepts, contains the term "technology." Moreover, it is easy to align these six categories with the broader teacher competencies presented above. These facts support the generally accepted view that technology should be used as an enabling strategy that supports and extends the various functions of teaching and learning. This approach is also more palatable to curriculum reformers in that it is more relevant to and aligned with the larger work of education-systems reform.

Because of this integrated approach, the revised ISTE standards are now taken seriously. The U.S. Department of Education's PT3 initiative (Preparing Tomorrow's Teachers to Use Technology), for example, is driving a major effort by universities and colleges nationwide to reorganize their teacher-preparation curricula, field experiences, induction programs, and collaboration with arts and sciences departments. The NETS-T standards, especially when aligned with the Interstate New Teacher Assessment and Support Consortium (INTASC) standards, is at the heart of this higher-education reform movement and is generating heightened awareness of the importance and content of teacher standards in general and technology-integration competencies in particular.

Further, the new NETS-T standards are explicitly aligned with the NETS for students. These standards specify what students should know and be able to do with technology as a result of their school's curriculum. To emphasize technology integration, ISTE developed a collection of profiles

and scenarios that illustrate what classrooms look like when technology is integrated effectively and what technology standards students attain as a result.

The vision behind the NETS projects—for both students and teachers—foregrounds learners:

> To live, learn, and work successfully in an increasingly complex and information-rich society, students must be able to use technology effectively. Within an effective educational setting, technology can enable students to become:
> * Capable information technology users
> * Information seekers, analyzers, and evaluators
> * Problem solvers and decision makers
> * Creative and effective users of productivity tools
> * Communicators, collaborators, publishers, and producers
> * Informed, responsible, and contributing citizens
> (ISTE, 2000, *NETS for Teachers*)

In fact, the teacher standards are purposefully intended to help teachers develop strategies that will enable their students to attain the student-technology standards as well as the content standards. Called the "NETS for Students" project, these standards are:

1. Basic operations and concepts:
   * Students demonstrate a sound understanding of the nature and operation of technology systems.
   * Students are proficient in the use of technology.
2. Social, ethical, and human issues:
   * Students understand the ethical, cultural, and societal issues related to technology.
   * Students practice responsible use of technology systems, information, and software.
   * Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
3. Technology productivity tools:
   * Students use technology tools to enhance learning, increase productivity, and promote creativity.
   * Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
4. Technology communications tools:
   * Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
   * Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
5. Technology research tools:
   * Students use technology to locate, evaluate, and collect information from a variety of sources.
   * Students use technology tools to process data and report results.
   * Students evaluate and select new information resources and technological innovations on the basis of appropriateness for specific tasks.
6. Technology problem-solving and decision-making tools:
   * Students use technology resources for solving problems and making informed decisions.
   * Students employ technology in the development of strategies for solving problems in the real world. (ISTE, 2000, *NETS for Teachers*)

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Research over the past decade has also supplied evidence that teachers go through predictable stages of development as they develop technology-integration competence. The Apple Classrooms of Tomorrow research described these stages as:

- entry
- adoption ·
- adaptation
- appropriation
- transformation

It is important to understand these stages since teachers at each stage who are trying to attain higher levels of competence in technology integration need different kinds of support and professional development at each level. Thus a professional-development program must be sensitive to where its teachers fall in this continuum and provide an array of support and learning opportunities aligned with these particular needs.

Strategies for Preparing Teachers to Use Technologies

Given the importance of well-trained teachers for technologies to be effective in enhancing learning, what might education policy makers do to support and encourage appropriate strategies for training teachers? No single approach to professional development will meet the learning needs of all teachers seeking to develop skills and knowledge in the integration and application of technology. As stated earlier, the research suggests that teachers progress through a series of five predictable stages as their expertise in technology adoption and integration evolves. It is likely that within a school, and certainly within a district, teachers will exhibit varying levels of expertise and therefore a variety of different professional-development opportunities will be required. To the extent possible, it is desirable to provide a continuum of professional-development opportunities so that the learning needs of teachers at all stages in the continuum will be met. This is easy to say, but hard to do with the limited time and money available for training. So what are the alternatives?

A comprehensive approach to providing professional development includes both formal and informal opportunities for teachers. Formal approaches to professional development encompass those activities that occur largely under the direction of an educator or trainer who assumes the role of mediating the learning. Under these circumstances, the instructor is likely to be responsible for identifying learning objectives, determining appropriate formats and instructional techniques, and establishing evaluation criteria (Merriam & Caffarella, 1991). Formal learning typically involves some sort of organizational or community sponsorship.

In contrast, learning that occurs outside the confines of programs provided by institutions is considered informal learning. Informal learning, sometimes referred to as self-directed learning, typically occurs in the learner's "natural setting" and is initiated and conducted independently (Merriam & Caffarella, 1999). The learner determines his or her own objectives, the manner in which learning will take place, and the appropriate resources. Self-directed learning does not necessarily mean learning alone. Adults often interact with other people and even groups of people in their self-directed learning pursuits.

Policy makers may want to consider both kinds of approaches. A brief overview of the kinds of possible training strategies follows.

Formal Approaches to Professional Development

Conferences, Institutes, and Workshops. There are occasions when well-designed workshops or conferences are an appropriate method of professional development. These activities are useful methods

for introducing specific skills to a learner audience, such as how to use a particular software application or how to navigate the Internet, particularly when follow-up support will be provided. Thoughtfully designed conferences and workshops are structured so that they provide opportunities for participants to interact and collaborate, learning together and from each other. They can also provide a venue for learners to meet their electronic mentors, colleagues, and/or instructors in a face-to-face setting, thus sustaining professional development that is conducted at a distance.

Courses and Classes. Enrollment in a program of study provided by an institution of higher education is another traditional approach to professional development. Teachers may enroll in classes to advance their professional growth and at the same time accumulate graduate credit that facilitates salary-schedule movement. According to the National Research Council (1999), "for the most part, teachers take graduate courses in education rather than in the subject matter of teaching because of the lack of disciplinary graduate courses that are offered after school hours or during the summer" (p. 180).

Action Research and Study Groups. Action research is an approach to professional development in which teachers typically spend one or more years engaged in classroom-based research projects. Loucks-Horsley et al. (1998) describe action research as a process in which teachers examine their practice and associated student learning, engage in meaningful conversations about their reflections with their colleagues, and share their findings in descriptive written reports.

The National Research Council (1999) claims that "action research contributes to sustained teacher learning and becomes a way for teachers to teach other teachers. It encourages teachers to support each other's intellectual and pedagogical growth, and it increases the professional standing of teachers by recognizing their ability to add to knowledge about teaching" (p. 187).

As a professional-development activity, action research can be tailored to the level of expertise and the learning needs of individual teachers. When action research is conducted collaboratively, it fosters the growth of a learning community.

Distance Learning. Technology plays a significant role in transcending some of the constraints associated with traditional modes of formal professional development. Distance learning allows an instructor and students to interact with one another, independent of space and time, by utilizing interactive computer conferencing, video and/or audio tape, conventional reading materials, radio, the Internet, or any combination thereof.

Professional development delivered at a distance enables teachers to enroll for credit courses at universities located around the world. Although many of these programs continue to follow traditional university format where learning is instructor-centered, new models of instruction are emerging. Technology changes the way that people teach and learn, not only in K-12 classrooms but in virtual higher-education classrooms as well.

Distance learning offers the advantages of flexibility in time and location and provides teachers with a vast array of resources. Furthermore, participation in professional development that is electronically delivered enables teachers to interact with peers that bring with them a rich diversity in culture, perspective, and experience.

Informal Approaches
Professional Development that is Embedded in the Practice of Teaching. "Informal and job-embedded processes are essential to support and extend learning that takes place in workshops and in clas-

ses" (Grant). Teachers learn from their daily practice. According to the National Research Council (1999), "teachers gain new knowledge and understanding of their students, schools, curriculum, and instructional methods by living the practice experiments that occur as part of professional practice" (p. 179).

Observation is an example of an informal and job-embedded approach to professional development. Observation is a process that is mutually beneficial to the person being observed and the observer. The individual being observed learns from the feedback provided about instructional practice and classroom management; the observer also learns from this process by viewing and reflecting upon the strategies and techniques employed by a colleague. Communication between the teacher being observed and the observer contributes further to the professional-development activity.

The disadvantages of utilizing this approach to professional development include the need to hire a substitute to cover the time spent out of the classroom engaged in observation. In order for this exercise to be truly beneficial, the observer needs to be somewhat conversant in the strategy or technique being modeled so that accurate and constructive feedback may be rendered. It is also important that the observer is cognizant of appropriate methods for providing feedback that is constructive and encouraging rather than disparaging.

Mentoring. Mentoring involves pairing teachers who are skilled in a particular instructional technique or strategy with one or more novice teachers. In order for mentoring to be an effective professional-development activity, careful matching of partners is required instead of haphazard pairing. And, of course, the person doing the mentoring must have knowledge and skills that can be passed on.

In order to be effective, a mentor must have the necessary time to devote to the mentoring relationship. Mentors can provide advice, reassurance, encouragement, and technical assistance (NFIE). Because of their expertise, mentors are able to serve as role models and to provide objective feedback. To benefit from this approach to professional development, mentees must be willing to accept assistance.

Mentors also experience professional growth by engaging in reflection upon the questions asked by their mentees and upon the knowledge that they bring to the task, by formulating a response that is relevant to the context, and by exercising leadership. Recognition, compensation, and professional development in the area of mentoring provide incentives for individuals to accept mentoring roles.

Mentoring can take place at a common site or at a distance utilizing technology. Long-distance mentoring can be accomplished using e-mail, written correspondence, and telephone conversations. However, occasional face-to-face meetings are critical to the success of a mentoring relationship.

Teacher Networks and Online Communities. Teachers can also join professional networks to communicate about important issues, to gain troubleshooting assistance, to obtain alternative perspectives for problem solving, to share reflections, and to trade resources. Local networks and electronic networks both have the potential to break the barriers of teacher isolation and to establish a community of practice. The virtual nature of electronic networks can eliminate barriers of position and status that might otherwise be inhibiting in face-to-face interactions (NFIE). They also provide the opportunity for teachers to model online networking for their students.

As an effective approach to professional development, online networks are characterized by regular communication, collaborative problem solving, and skilled facilitation. The literature suggests that the creation of temporary strands around topics of interest is the most effective way to organize elec-

tronic forums (NFIE). Increases in bandwidth and advancements in the development of networking software suggest that the use of online communities will continue to evolve as an approach to professional development in the Pacific region.

These are some of the strategies a district or entity might consider in preparing its teachers to use technologies. Some of these strategies might be appropriate in some districts, while others are just not feasible. These are matters policy makers must decide. But regardless of which strategy is selected, there are some general characteristics of effective professional development.

Some General Characteristics of Effective Professional Development
Professional development is increasingly designed with intent to establish collegiality, encourage experimentation and risk-taking, and promote discourse, reflection, and collaboration. There are a number of commonly held beliefs about the characteristics of effective professional development.

- The ultimate goal of high-quality professional development is to improve student learning. Professional development should focus upon enhancing student academic achievement. The development of teacher proficiency in the integration and application of technology must be linked to student learning of the subject matter and satisfaction of state and local content standards.

- Professional development is most effective when the learner has an opportunity to participate in decision-making that concerns its design and delivery. Often, even in a content or skill area that is new to her, a teacher is in the best position to determine what his or her learning needs are and how best to engage in that learning. This recommendation is consistent with the adult-education literature. Adults possess a self-concept characterized by a need to be self-directed. Therefore, adult learners, including teachers, often resent and resist those situations, including professional-development activities, where they believe that others are imposing their beliefs—or their training—upon them (Knowles, 1990).

  The National Staff Development Council suggests that professional-development activities associated with technology often produce anxiety in teachers who recognize and worry about the disparity in skills and knowledge between themselves and their colleagues. When teachers are involved in the development of training programs, it diminishes their anxiety and ensures that their own personal learning needs will be met.

- High-quality professional development is rigorous and sustained over time. Historically, professional-development offerings have been delivered in a "one-in-a-row" format that prevents any cumulative or significant learning outcome. The mastery of technology integration requires repeated cycles of professional development that keep pace with advances in technology and research.

  Teachers need time to reflect upon what they have learned, to integrate new knowledge into practice through experimentation, to reflect upon the outcomes of changes made in their practice, and to make further adjustments as needed (Schon, 1983). An effective professional-development program, according to Corcoran (1995), provides "sufficient time and follow-up support for teachers to master new content and strategies and to integrate them into practice."

- Professional development is most effective when it addresses authentic problems that teachers face when integrating technology into their classrooms and when technology is linked with broader reform goals of school or district improvement. Adults are motivated to engage in learning to the extent that they perceive the activity enabling them to better

perform tasks or manage problems. Adults acquire new knowledge, skills, and attitudes most effectively when they are able to learn within a context that is congruent with that of their own practice (Knowles, 1990). Consequently, professional development for teachers is most effective when it is relevant to their subject matter and/or grade level. This also means that while engaging in a professional-development activity, teachers should utilize the same technology that they will be using when they teach their students.

Professional development that is designed to elevate teacher proficiency in the integration and application of technology is most effective when it is not conducted as an isolated initiative. Minimally, professional development aimed to elevate teacher technology competencies should be offered as an integral component of the school technology plan; optimally, it should be offered as an integral component of school or district reform initiatives to facilitate improved student academic achievement.

- High-quality professional development contributes to the establishment of a collegial and collaborative culture. The National Foundation for the Improvement of Education suggests that effective professional development is characterized by the development of learning communities where staff work toward commonly held goals, colleagues exchange ideas and knowledge and provide constructive feedback and encouragement to their peers, and innovation and accomplishment are publicly acknowledged.

- Effective professional development incorporates evaluation to ensure that each activity is meeting the learning needs of its participants. The North Central Regional Educational Laboratory (2000) describes three types of evaluation that should be built into every professional-development program: performative evaluation, formative evaluation, and summative evaluation. A variety of methods of data collection should be employed and multiple sources of information should be consulted. Collectively, these three forms of evaluation contribute to the ongoing assessment of a professional-development program, providing data to inform adjustments that ensure that the program is meeting its objectives.

What Policy Issues Need to Be Addressed?

What are the specific policy issues this discussion raises? For education policy makers in the Pacific region, the need for trained teachers to capitalize on investments in technology infrastructure is obvious but not so easily accomplished. The policy issues to be considered include the following:
- What policies will encourage teachers to acquire the necessary knowledge and skills in the use of technologies?
- What policies will sustain support for teachers to use technologies?
- How will teacher use of technologies be evaluated?

Encouraging Teachers to Acquire Necessary Skills. For many teachers, having access to technologies is not viewed initially as a benefit. Teachers may consider technologies yet another demand on their time, a set of tools they did not ask for and do not know how to use. Some teachers feel they are already doing a good job in the classroom and wonder how technologies will contribute to improvements. Still other teachers, of course, welcome the technologies and are eager to learn how to use them.

In general, policy makers may wish to consider a variety of ways to motivate and support teachers to gain technology competencies. One way is to mandate that all teachers gain these competencies. This mandate might be accomplished in several ways, including making the acquisition of needed knowledge and skills a part of teacher certification, or a prerequisite to pay increases. It might be possible to require new teachers to demonstrate technology competencies before they are hired.

Policies that mandate activities such as acquiring or demonstrating technology skills do work in some circumstances. In the Pacific, a number of entities are reviewing their current licensing and credentialing policies, so it may be a good time to add requirements pertaining to technologies. On the other hand, it may prove to be a challenge to mandate technology skills if new or continuing teachers have no convenient way to gain those skills.

Policy makers may wish to consider establishing policy that makes it convenient and feasible for a teacher to learn about technologies by creating conditions under which professional development for teachers is more available. This will most often become a financial issue as professional develop-ment costs money. There are several possible ways such policy might be enacted. For example, an entity may set policy that a minimum number of professional-development days be established, some of which are to focus on technology applications. Or teachers might need to be paid to take online courses pertaining to technology applications. An entity may wish to employ a person or persons with technology training and experience to tutor teachers in technology use.

Policies that either mandate or provide opportunities will cost money, but without the establishment of policy that mandates or provides professional-development opportunities (or, ideally, both), teach-ers are unlikely to acquire the skills they need to use the technologies available to them, thus negat-ing the potential benefits of the investment that has been made in infrastructure.

Providing Sustained Support for Teachers' Use of Technologies. As argued above, it is very impor-tant for teachers to acquire knowledge and skills in how to use technologies. But once teachers begin to acquire such skills and begin to use technologies, there is a need to provide means of continuing support to teacher use of technologies. That is, initial training of teachers is not likely to guarantee that the technology infrastructure will continue to be used.

Policy issues pertaining to sustained support for teacher use of technologies include the following:
- Through what means can teachers find examples of good instructional practice using technologies? That is, how can teachers be connected to a body of information about effective practices that may have relevance to their classroom practice?
- How will an entity support ongoing connectivity charges, so that teachers feel they can regularly use the resources available on the Internet, for example?
- What policies need to be in place to maintain the structure and operation of the technolo-gy system itself, so teachers feel they can rely on the system as a dependable instruction-al tool for the classroom?
- What kinds of continuing professional education will need to be available to teachers if they are to increase their skills in using technologies?

Evaluating Teacher Use of Technologies. The issue for education policy makers here concerns the extent to which a teacher uses technologies effectively can or should be an important criterion in evaluating a teacher's performance. This is a complicated issue for policy makers. On the one hand, to encourage use of technologies, it may be necessary to create policy that recognizes quality perfor-mance using technologies, and at the same time reflects negatively on those who do not use tech-nologies. On the other hand, it must be recognized that good teaching (and good learning) is not nec-essarily dependent on technology utilization. The education system does not want to penalize highly effective teachers who do not use technologies.

This general issue is complex in part because of divided opinion on how important technology use is to the future well-being of individual citizens in a given entity, or to the entity as a whole. There are many writers who make the argument that neither an individual nor a state or nation can hope to sur-

vive or prosper unless they are very familiar with technologies. Others dispute this claim and worry about the survival of traditional cultural values in a technological age.

Given this deeply-rooted controversy, establishing policy according to which teacher performance will be judged is of critical importance. An entity that rewards teachers who use technologies, and penalizes those who do not, is making a statement about what is valued in the society or community. And this kind of policy will dramatically affect what is taught in classrooms, by whom, and how. The evaluation question thus becomes larger than the immediate issue of judging the performance of an individual teacher. Rather, it reflects some very fundamental values about what education should be in the future in a given community.

These are but a few of the issues policy makers must address as they commit to build technology infrastructure for their communities or entities. Teachers are central to the effectiveness of technology infrastructures that serve education. How teachers acquire the skills they need to use technologies and how the technology is actually used and to what ends, are critical policy domains that must be carefully explored. Hopefully, issues of this nature will be considered as decisions are made about technology infrastructure, and as educators make decisions about the future shape of their schools.

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