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ABSTRACT

These conference papers highlight technology within 21st century teacher education. Part 1, "The Power, Ethical, and Social Issues Related to Technology in Education," includes topics like developing learning communities and ensuring equal access for all students. Part 2, "The Impact of Technology in Changing Our Perceptions of What and How People Learn," includes topics like the growing separation between teachers and learners and technology and the transformation of learning. Part 3, "The Impact of Commercialization on the Education of Teachers and Children," includes topics like schoolhouse commercialism, public and private collaboration in teacher education, and commercializing teacher education on the Internet. Part 4, "Technology and the Roles and Responsibilities of Teacher Educators," includes topics like technology needs of preservice and inservice teachers, connecting technology to content in learning, and the impact of technology on teacher educators' roles and responsibilities. Part 5, "The Redefining of Teaching and Implications for Schools, Colleges, and Departments of Education," includes topics like partnerships, technology, and assessment and understanding 21st century teaching tools. Part 6, "Measuring the Success of Teachers and Teacher Education Programs," includes topics like meaningful evaluation of teachers and teacher education programs and action research as a measure for evaluating technology. (SM)

LOG ON OR LOSE OUT

TECHNOLOGY IN 21st CENTURY TEACHER EDUCATION

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The American Association of Colleges for Teacher Education is a national, voluntary association of colleges and universities with undergraduate or graduate programs to prepare professional educators. The Association supports programs in data gathering, equity, leadership development, networking, policy analysis, professional issues, and scholarship.

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Preface

In September of 1995, the American Association of Colleges for Teacher Education (AACTE) created a Task Force on Technology. The charge to the Task Force was to consider the vast array of issues emerging from the increasing impact of information technology on teacher education and to advise AACTE on how best to deal with these issues. On the recommendation of the Task Force, the AACTE Standing Committee on Technology in Teacher Education was formed in February of 1998 to continue and expand upon the work of the Task Force.

From the beginning of the deliberations of the Task Force, it was felt that AACTE should promote a broad discussion of issues involved with the role of information technology in teacher education—both technical and social. Much of the conversation at the time focused solely on technical and implementation issues; missing from the discussion was a voice to consider the non-technical issues surrounding the use of information technology in schools and teacher education. An AACTE working conference, held at the headquarters of Apple Computer, Inc. in Cupertino, California in November of 1999, provided a forum for the discussion of the broad social issues related to technology in education and teacher preparation. Funding for the conference (and this monograph) was provided by the AT&T and the John D. and Catherine T. MacArthur Foundations.

Entitled *The Future of Schools, Colleges and Departments of Education in the Age of Technology,* the conference followed a model developed by the Institute for Educational Leadership at the University of Northern Iowa. Dr. David Else, director of the institute, facilitated the conference. The working conference format brings together people with a wide range of viewpoints on a particular issue to engage in in-depth dialogue over an

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extended period of time, usually two to three days. Position papers prepared by each participant in advance of the conference help frame the discussion. Trained facilitators guide the discussion groups to see that all viewpoints receive a fair hearing. Participants develop recommendations for each issue area discussed.

This monograph is but one of the outcomes of the conference. It presents the best thinking of conference participants and sets forth broad recommendations for action. It is our hope that the monograph will deepen our understanding of the impact of information technology on teacher education, and that this understanding will promote more informed decision making as we begin to capitalize upon the great potential of information technology.

Thomas J. Switzer
Dean, College of Education, University of Northern Iowa
Co-Chair, Conference on *The Future of Schools, Colleges and Departments of Education in the Age of Technology*

Introduction

Today's technology is affording us new tools for teaching and learning. Schools are acquiring hardware and software for student use, and teachers are exploring ways to use computers in their instruction. But these trends are just the beginning of the technology revolution in education. Within the past decade, technology has fundamentally changed the way we communicate and the way we do business. It also has the potential to change the nature of education. Time-honored conceptions of what constitutes a classroom, how learning occurs, and the role of the teacher are all challenged by the capabilities of new technology.

Schools, colleges, and departments of education (SCDEs) have an opportunity to help shape the impending transformation of education. They can facilitate beneficial changes and address potentially negative consequences of new technologies in education. SCDEs must model for preservice and inservice teachers new kinds of instructional practices and help them identify the ethical and social issues associated with technology in education. They must give teachers guidelines for dealing with the burgeoning commercialization of education, a phenomenon that has grown with technology. Perhaps most important, SCDEs can help create and promote a new paradigm for what constitutes learning, and thus, what constitutes teaching. New paradigms for learning and teaching will ultimately change society's perception of a teacher from that of master and dispenser of knowledge to facilitator of learning. But SCDEs will only be effective in these endeavors if they cross traditional boundaries and work with all of the stakeholders in our education system including politicians, school district administrators, and state departments of education.

This monograph is a collection of papers prepared by over 50 leaders in educational technology in which they share their insights in six key issue areas:

- The power, ethical, and social issues related to technology in education
- The impact of technology in changing our perceptions of what and how people learn
- The impact of commercialization on the education of teachers and children
- Technology and the roles and responsibilities of teacher educators
- The redefining of teaching and implications for schools, colleges, and departments of education
- Measuring the success of teachers and teacher education programs.

Each of the issue areas is organized as a section within the monograph. The authors represent PK-12 education, teacher education, government agencies, private foundations, and corporations. All of the authors participated in a working conference, *The Future of Schools, Colleges and Departments of Education in the Age of Technology,* sponsored by the American Association of Colleges for Teacher Education (AACTE). Prior to the conference, each participant was asked to write a brief paper sharing his or her perspective on the selected issue. During the conference, ideas presented in the papers were shared and discussed, and recommendations for action were developed. These recommendations, included at the end of each chapter, are broad-based; responsibility for their implementation is shared by AACTE, individual institutions of higher education, PK-12 school districts, policy makers, and all other stakeholders in education who want to make a difference in student learning.

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Issue Area One

The Power, Ethical, and Social Issues Related to Technology in Education

In a rapidly changing world culture that is becoming increasingly dependent upon technology, it is incumbent upon educators at all levels to consider the power, ethical and social issues associated with the technology revolution. Like most revolutions, the technology revolution offers potential for both good and bad effects. If current trends continue, our capabilities to communicate will expand, our methods and techniques for storing, retrieving, and managing information will increase, and the resulting growth in the potential for knowledge acquisition may expand human capabilities. There is also the potential for new technologies to constrict or confine our humanity and to create ever widening gaps between segments of society already separated by wealth or other societal distinctions. The papers in this section look at technology-related ethical and social considerations in education.

Social, Ethical, and Power Issues in 21st Century Teacher Education

■ Harlan Else, Ph.D.

For 21 years, I have been a superintendent of public P-12 school districts. Before becoming a superintendent, I spent 15 years as an elementary teacher, principal, and curriculum coordinator. All of my professional experience has been in school districts of fewer than 4,000 students.

While I had little training in the use of technology during my three formal degree programs, I have since staunchly promoted and supported the use of technology in the schools for which I have responsibility and have made significant use of technology in my own personal and professional duties.

The Cheyenne Mountain School District, of which I am currently superintendent, has been a leader in the use of technology for a plethora of educational purposes, including those that directly impact student instruction, such as Internet connections for students' and staffs' use in all classrooms, media centers, and offices; training in keyboarding, word processing, databases, and graphics; and extensive use of digital software for direct instruction, the integration of standards-based curriculum, project-based learning, and teaching scientific concepts through models not otherwise available to teachers and students. We also use technology extensively for somewhat more administrative uses, including both inter- and intradistrict communications between and among all staff members; databases, grading, and reporting; budgeting at both the building and district levels; and student records, including the normal data collected about all students as well as individual education plans for special education and high-risk students.

Social Issues

My experience leads me to distill the social issues that teacher educators need to address to two—the equitable availability and distribution of information to all learners, regardless of socioeconomic standing; and the implications of the use of technology in the establishment and continuation of relationships with others.

I believe that information should be equally available to all learners. Teachers should ensure that information needed to learn a particular con-

cept or complete a project is available to all students, regardless of socioeconomic status or other factors. Because not all students have a home computer to access needed information, teachers must be trained to provide the needed access to all students on school computers during nonschool hours or through alternative sources. These alternative sources may include providing students with information about the availability of computers or other information sources in public libraries or other public facilities.

Although teachers may have the skills and resources available to effectively use technology to communicate with others, it is vitally important that effective instruction and meaningful communication with parents and other staff be based on the development of positive relationships. A popular television advertisement for a particular Internet service states that businesses need their services to establish and maintain "relationships" with their customers. In people-to-people relationships, technology can be used only to make contact to communicate information, not to establish and maintain relationships. Too many people, for example, have begun to use e-mail to communicate information that requires greater personal interaction to effectively connect the information to the person. Tone of voice and body language are essential to the establishment and maintenance of relationships. Therefore, teacher educators need to teach the importance of strong interpersonal skills to establish and maintain relationships that elevate instruction and communications with parents to extraordinary levels of effectiveness.

Ethical Issues

The primary ethical issue with which teacher educators need to deal is helping future teachers understand which information is and is not appropriate for the consumption of students at various ages in school. For example, are filters that restrict specific kinds of information on the Internet appropriate for use in schools, or should students have access to all kinds of information? If filters are to be used, who should make that decision? If filters are not to be used, who should determine which information should be accessible to students and at what ages?

I believe that filters that restrict specific kinds of information on the Internet are not only appropriate but also essential. Schools (and teachers) have an obligation to prohibit the dissemination of information that

could be harmful to students. Information that promotes hatred and violence or contains pornography has no place in schools. I believe that teachers and other staff should be expected to conform to the same restrictions as those established for students when using school-owned technology equipment and software. Teachers who need information beyond the limitations established by the school district can have access to that information through the public library system, which should not have such restrictions, or through their own personal computers and Internet connections.

After receiving input from parents, teachers, and other community members regarding the appropriateness of students' access to various kinds of information, administrators and/or the board of education should determine which commercially produced and/or operated filters best fit their needs.

Power Issues

Teachers' and administrators' sharing power with students, parents, and the community is essential for the establishment of extraordinary educational systems. Having access to pertinent information about the educational system, having input into how the system should work, and sharing outcomes empowers students, parents, and the community to be true stakeholders in the educational process. Therefore, teachers and administrators must fully share information about the curriculum, teaching strategies, and methods of assessing students. All stakeholders, including teachers and administrators, must clearly understand procedures for resolving differences, solving problems, and celebrating successes.

Graduates of today's teacher preparation programs rarely receive formal training in effective ways to share power and thus empower students, parents, and community members. Their training should include an understanding of effective methods for sharing information, solving problems, resolving conflicts, and including all stakeholders in the celebration of successes.

Teacher educators should use technology to have their students complete projects that simulate various aspects of sharing power and involving all stakeholders in making pertinent decisions about the educational system. Prospective teachers need to be taught appropriate ways to share information and data with stakeholders through the use of technology.

Additionally, they need to be taught which information and processes require face-to-face relationships rather than the extended use of technology. For example, it would be appropriate for teachers to use electronic mailboxes that can be accessed by telephone, e-mail, or interactive television to share class assignments, sources of material and information to complete assignments, schedules and deadlines, and assessment procedures for evaluating the quality of students' work. Conversely, prospective teachers need to be taught that they must have much more personal contact to communicate concerns about students' behavior or lack of academic progress, or to celebrate their successes.

Teaching these effective strategies to prospective teachers will empower students, parents, and community members to become more appropriately involved in the educational process—which will in turn improve academic achievement through a participatory system that has the support of all stakeholders.

Summary

Technology has a critical role in improving academic achievement by providing equal access to information that adds value to traditional methods of instruction and sources of information. Additionally, information and data made accessible through the appropriate use of technology, coupled with effective personal interactions, empowers parents, students, and other community members to become full participants in the educational system.

Developing Learning Communities: Teaching and Learning by Example

■ Melissa Hinkson

As a former elementary school teacher, I realize the importance of promoting equity in the classroom. All the fifth grade students with whom I worked had great capacity for learning, yet many lacked the hardware and technical tools that could have extended their learning beyond the school. In my current role as a teacher educator, I realize the urgency to prepare teachers for the 21st century. The preservice teachers that I encounter enter teaching programs with enthusiasm and a strong desire to demonstrate, through their teaching, that all children can learn. I often wonder, however, what happens to these same students' zest for teaching after they complete their teacher education program and enter the workforce. An apparent gap exists between what is taught in our schools and colleges of education and the demands that schools, principals, parents, and the direct clients—the elementary and secondary students—place on these novice teachers. What will help them bridge this gap? It seems almost too obvious that, at least in theory, technology is a viable mechanism to ensure that all children do in fact learn and become productive citizens. In thinking about this challenge, it is useful to mentally envision a bridge. It is this mental picture of a bridge connecting two points that teacher education must transform into a reality. In a general sense, schools and colleges of education must begin to note successes in society at large and, to the extent possible, replicate these theoretical models.

The basic tenet of this paper is that schools and colleges of education must develop learning communities inside as well as outside their organizations if they are to produce the type of teachers who will ultimately survive in 21st century classrooms. This grand task becomes the responsibility of educators as well as those in the private sector who must commit themselves to making technology accessible to a wider audience. Further, it is imperative that educational leaders in these organizations teach by example; they must demonstrate competence in technology through their interactions with their students. Finally, teacher educators must be committed to the goal of preparing competent, caring, and progressive teachers who can facilitate learning experiences for the students they teach.

With these points in mind, teacher educators must address several subcategories, including (but not only) the social, ethical, and political issues surrounding equitable distribution of learning and use of resources.

Public schools, traditional four-year colleges of education and those with five-year liberal arts-based teacher education programs, will serve as the primary source of reference as related to the education of "students." Ensuring equal opportunities for students in teacher preparation programs is an area that must be addressed before we can seek to level the playing field for students in public schools. Therefore, it is appropriate to begin this prescription for change with the social aspects that teacher educators and schools of education must address. Instructional practices that teacher educators employ in teaching and learning settings with preservice teachers are directly affected by (a) the access that teacher educators have to technology, (b) their familiarity with the technology available for teaching, and (c) the training they receive to ready them to facilitate learning experiences using appropriate technology.

According to Senge (1999), if organizational change is to occur, there must be a commitment of time, energy, and resources. Therefore, if colleges and universities are to successfully prepare teacher educators for the 21st century, these teaching/learning institutions must realize that there is a connection between the work that schools do as they serve children and the training that must take place as preservice teachers are prepared to address children's needs. Technology is part of this paradigm and can no longer be ignored. Those who realize success in the 21st century will have expertise in manipulating the technology such that it works to minimize their individual efforts. Collaboration in the workplace will no longer be optional, for the technology will demand that teams work collectively to tackle real challenges. An example of this collective effort is the evolution of knowledge networks. These "virtual communities" serve as hosts for individuals with common interests. They allow "experts" to share their knowledge and explore learning possibilities within an orchestrated community. Additionally, they afford the novice teacher opportunities to share her thoughts with others so as to generate new knowledge; thus, these novice teachers ultimately become the experts.

In keeping with this model, it will be imperative for 21st century teacher educators to embrace such a working relationship with their peers locally, nationally, and internationally. As they teach by example, they will

need to share this vision of collectiveness with their students as they expose them to teaching methodologies and current practices in the field. Implementation of this concept must begin with preservice educators. Ideally, teacher educators should interact with their colleagues across the globe to (a) design and implement teaching and learning models that incorporate a variety of technology-based strategies, (b) develop courses that are taught by a representative body of experts in a particular field so that students are the beneficiaries, (c) include preservice students in real-life experiences in school so they understand the dynamics associated with working in and directing schools and school projects, (d) provide more opportunities for students to experience work with diverse populations so that they are capable of addressing the needs of a wider variety of students once they become practitioners in the field, and (e) promote continuous discussions about teacher education and its changing role. Teacher educators who work toward this end will inspire their students to seek relationships in similar learning communities among their peers. In such communities, preservice teachers will collaborate with other preservice teachers as well as with established teachers in the field. In time, they will begin to create their own knowledge, thus empowering them to serve as change agents. Senge (1999) suggests the most important change initiatives have the following characteristics: (a) They must be connected with improving performance; (b) they involve people who have the power to take action regarding the goals; (c) they seek to balance action and reflection and connect inquiry with experimentation; (d) they are intended to increase people's capacities both individually and collectively; and (e) they focus on learning about learning in settings that matter.

Certainly schools and colleges of education need to serve as the catalyst for change. It is obvious that schools as we know them today are not serving the masses well. When we think of technology as a means by which to maximize learning, to extend experiences, to bridge cultural and social gaps, we will realize the power that technology could afford our schools—and, more important, our students, who are ultimately our future.

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Technology and Educational Opportunity

■ Marcia C. Linn

Educating teachers for the 21st century means ensuring that individuals can incorporate technology successfully in their lives. In a recent report on fluency with information technology (Snyder et al., 1999), the National Academy of Sciences calls on all of us to become lifelong technology learners. This means that researchers, teachers, and students constantly develop their expertise in incorporating technology in their everyday activities. Lifelong learners become more and more proficient in making technology a partner in their own learning by learning new applications when necessary, tailoring technology to their own work, and developing the ability to critique technology developed for their field.

With fluency in information technology as a goal, how can we ensure that equitable opportunities exist for all members of society? Educators need to look to businesses, industry, and government for models of planning for access to technology. Businesses, industry, and government all provide access, regular upgrades, technical support, instruction, and other support for their employees. In contrast, teachers in most schools must get funding for technology, develop their own professional understanding of teaching, provide their own technical support, and use software developed for businesses rather than education. Educators in universities and precollege settings need more infrastructure and support to use technology, and they need software suited to their own fluency. In most precollege settings, there is often no information technology, or the technology available is outmoded, or the support for individuals using the technology is nonexistent. Educators deserve the same opportunities to learn to use technology and to access appropriate software that is available in most workplaces in the country.

It is imperative that we design effective uses of technology that are appropriate to our students' educational goals. We want students to be lifelong technology learners and to incorporate technology effectively in each subject they study (Linn, Shear, Bell, & Slotta, 1999). Designing courses that enable this kind of understanding requires a partnership of individuals with expertise in the discipline, in pedagogy, in technology, and in social interactions. Rather than a business package plus the Internet, we need software

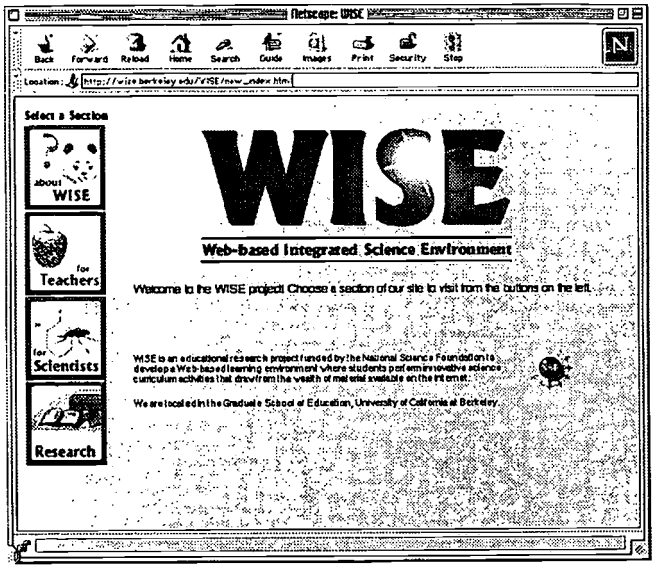

Figure 1. WISE Screen

designed to promote fluency in precollege topics. Creating these effective uses of technology for precollege and university education means that resources must be made available, teams must be formed, and effective instruction must be designed and interactively redesigned for everyone to become a lifelong learner. (For examples illustrating this potential, see http://wise.berkeley.edu, www.cilt.org and Figure 1.)

Technology can also serve as a tool to enable equity and support democratic values in our society. For example, on-line asynchronous discussion has been shown to augment in-class discussion and promote equity. In classes, often only 15% of the students participate in class discussion, and a preponderance of the participants are male. On-line asynchronous discussion, when creatively designed and effectively implemented, typically engages 95% to 100% of the students. In addition, male and females make equally sophisticated and thoughtful contributions. And the on-line asynchronous discussion itself is more sophisticated, involves more careful argumentation, and incorporates a greater amount of evidence to support students' viewpoints (Hsi, 1997; Linn & Hsi, 2000).

Many interesting ideas have been put forth to increase equitable access to technology. Ultimately, however, technology will need to be accessible

to individuals in their homes for it to have true impact on education. No matter how much access is available in schools, community centers, and faith communities, the amount of time individuals will need to spend incorporating technology in their everyday practice means that ultimately, like television, technology needs to be accessible when and where individuals do their intellectual work. Universities have carried out a series of experiments, often starting with laboratories and then placing computers in dormitories, usually concluding that it is important to support individuals in purchasing their own technology tools to achieve equity. A similar approach is essential for the precollege population.

A simple thought experiment will convince most people of the need for greater access to technology than can be provided at school sites. If, for example, students have an hour a day of access to technology and the school day is five hours long, that would still be only five hours a week. Yet a school would need one computer for every five students. A student with access at home would get five or six months of experience in a single week. Clearly, access must be provided to individuals and not to institutions. The specific ways that individuals get access to technology also deserve serious consideration. Business, industry, government, and education are all jointly concerned with trying to provide technology in ways that enable users to actually spend time effectively using technology rather than serving as a technology troubleshooter.

In summary, technology is here to stay. There are many effective ways to use technology to enhance learning and understanding, but they need to be designed and not decreed or bolted on to the current curriculum. To ensure that technology plays the role we envision for it, we need to provide access to technology, we need to support partnerships as they design effective uses of technology, and we need to regularly and continuously look for creative new applications of technology to enhance equity and opportunity in our society.

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Ensuring Equal Access for All Students: Preparing Tomorrow's Teachers to Use Technology to Improve the Educational Outcomes of Students With Disabilities

■ Jacqueline Nunn, Ed.D.

Each day technology becomes more and more pervasive in our society and an increasingly common element in the education of students throughout the United States. Over the past 20 years, we have witnessed a rapid evolution of technology in education, from stand-alone Apple IIe computers running basic programming software to high-capacity microcomputer networks with high-speed Internet access. The technology is becoming more powerful almost daily and will be an essential tool for today's students who will live and work in the 21st century. All students must have the opportunity to use technology and to develop the skills needed to be productive, fully participating citizens in the new millennium. For some students, accessing mainstream technology is not easy. But

as leaders in education, it is our responsibility to ensure that every child can use technology to enhance learning and productivity.

Ethical and Legal Mandate for Equal Opportunity and Equal Access

Our nation is built on a foundation that promises equal opportunity for all. Our Declaration of Independence promises every citizen equality, justice, and the right to pursue happiness. Legislated support of technology for people with disabilities can be traced back to Public Law 45-186 in 1879, which awarded the then grand sum of $10,000 to the American Printing House for the Blind for the purpose of producing Braille materials. This legislation stands as a landmark because many of the technology advances that have transformed the lives of people with disabilities would not have been possible without federal support.

Technology has allowed people with disabilities, like most other Americans, to find meaningful work and to take their places as fully enfranchised citizens. Employment provides the income that allows for independent living and freedom from reliance on welfare and disability checks. To be without wages is to be denied access to the cultural events and social experiences known to most Americans and the dignity that comes from financial independence. Equally important, however, is that employment allows full participation in the mainstream culture. To be unemployed is to be isolated from the community and separated from the mainstream of daily events and activities.

For too long, many of our citizens with disabilities remained outside the cultural mainstream of our society. Over the past 25 years, however, we have made great strides in providing equal opportunity in education, employment, and daily living to individuals with disabilities. In large part, the educational opportunities currently available to students with disabilities can be attributed to federal legislation. Three major pieces of current legislation include technology mandates for people with disabilities. The legislation applies to all recipients of federal funds, including local school districts. The three laws are the Individuals with Disabilities Education Act (IDEA), Section 504 of the Rehabilitation Act (Section 504), and the Americans with Disabilities Act (ADA).

The 1997 reauthorization of IDEA guarantees the right of all students with disabilities to a "free and appropriate public education." Further, students with disabilities are to receive educational services in the "least

restrictive environment." Thus, to the maximum extent appropriate, students with disabilities are to be educated with students who are not disabled. Removal of students with disabilities from the regular educational environment is to occur only when the nature or severity of the disability is such that education in regular classes—even with the use of supplementary aids and services—cannot be achieved satisfactorily.

The IDEA amendments of 1997 also require that students with disabilities be given the opportunity to participate and progress in the same general curriculum taught to all other students in the public education system. Students with disabilities are also to be included in the overall student assessment program of the district and state. Because students with disabilities now receive most of their instruction in regular classrooms, this legislation affects regular as well as special educators.

For many children with disabilities, appropriate technology support is a prerequisite for successful participation in mainstream instructional activities and standardized assessments. Fortunately, the IDEA also requires that due consideration be given to a student's need for assistive technology. It specifies that, as part of the planning process for the student's individualized education program, the team must consider whether assistive technology devices and services can help the student meet the educational goals and objectives established.

Section 504 of the Rehabilitation Act states that no person with a disability shall be excluded from participation or denied benefits or otherwise subjected to discrimination because of a disability. Students with disabilities must have equal opportunity to participate in and benefit from a school district's programs and activities.

Section 504 does not explicitly include an obligation that schools provide assistive technology devices or services, but it does require that districts provide nondiscriminatory access to educational programs for all students with disabilities. Nondiscrimination includes the duty of school districts to make accommodations or modifications that enable students with disabilities to benefit from their educational programs.

The provision of assistive technology is considered an accommodation required to assist a student with a disability in benefiting from the educational program. Thus, schools are legally obligated to provide accessible technology so that all students have the opportunity to participate fully in the educational program. For example, if computer tech-

nology is part of a public school's educational programs—which is virtually always the case now—under Section 504 the school is required to provide disabled students with accessible computer hardware and software so that they are not excluded from the activities in which nondisabled students routinely participate.

As public entities, school districts are also governed by another antidiscrimination law—Title II of the Americans with Disabilities Act of 1990. Title II of the ADA is similar to Section 504 in that local, county, and state governments must make facilities and services accessible when needed to people with disabilities.

Knowledge, Attitudes, and Skills Needed by Tomorrow's Teachers

Legislation is in place and powerful technologies are available to allow students with disabilities to participate fully in the regular curriculum. Yet many students with disabilities do not currently have this opportunity because the teachers and other educators in their schools do not have the skills, and in some instances the vision, to transform instruction for their students with disabilities. If teachers are the key to fulfilling the promise, then teacher educators are the locksmiths.

It is teacher educators who will design the programs that prepare the great wave of new teachers who will be required over the next decade. In designing their programs, they must consider the skills needed by tomorrow's teachers to work effectively with students who have disabilities. Teacher educators must ensure that graduates of their programs possess the knowledge and skills required to effectively educate all their students. We propose here five competencies to be included by departments, colleges, and schools of education in the curricula of *all* teacher preparation programs—programs for both regular and special educators and for all educational levels, preschool through high school.

Competency 1. Knowledge of How Technology Can Improve Achievement and Transform Lives

Teachers working in the new century must be aware of how and under what conditions educational technology works to improve the motivation and achievement of students with special needs. In particular, they need to be familiar with the research and effective practices that demonstrate how technology can:

- Significantly raise the academic achievement for at-risk students, for students with learning and other disabilities, and for lower to middle ability students;
- Remediate skill deficits in a shorter period of time than more traditional remedial instruction;
- Contribute to the acquisition of higher order skills and of the technology skills required for 21st century work;
- Improve students' attitudes and increase motivation so that they take more responsibility for their own learning, like school better, and attend classes more frequently;
- Permit students with disabilities to use assistive technology to be more independent in learning, to engage in learning activities that would otherwise be difficult or impossible, and to facilitate their participation in the general curriculum and inclusive classrooms.

The last point is critical. All teachers must understand that for some students with disabilities, technology is not merely a tool for raising academic achievement or improving students' attitudes toward school; for students with severe disabilities, technology has the power to reveal untapped potential and transform lives. Assistive technology that gives a child a voice through synthesized speech or that permits mobility through use of a wheelchair guided by a mouth-activated joy stick can make a huge difference. It is the difference between a life of total dependence, isolation, and dissatisfaction, and a life of productivity, autonomy, and joy.

Competency 2. Knowledge, Attitudes, and Skills Needed to Advocate Effectively for Assistive Technology

All practicing teachers need to be well informed about the legal right of students with disabilities to have appropriate assistive technology. Specifically, teachers need to be familiar with the IDEA, Section 504 of the Rehabilitation Act, and the ADA.

Beyond that, teachers need information about the resources that exist within school districts and the procedures for accessing those resources. While this was once the exclusive purview of special educators, it is no longer the case. All teachers must have a basic understanding of their responsibilities in the process. They must also possess the communication and problem-solving skills necessary for guiding students and their fami-

lies through appropriate channels to obtain the needed services. For example, it is often the teacher's responsibility to initiate a request to the principal or other designated person to set up a meeting to review a student's progress if s/he feels the student is not benefiting from his or her educational program.

Finally, teachers must understand that it is their ethical and professional responsibility to personally advocate for an assistive technology intervention if they believe a student needs it to benefit from the educational program. They also need to understand that school districts cannot legally consider cost in their decisions about providing technology for students with disabilities and that they need not yield to a decision that it based primarily on economic pressures.

Competency 3. Knowledge of a Range of Assistive Technologies and How They Can Be Used to Address Individual Student Needs

Teachers should enter the classroom with knowledge about the range of technologies that are available and some of the ways that technology can help them better meet the individual needs of their students. To many people—even those familiar with special education—the term *assistive technology* is limited to high-tech equipment, augmentative communication devices, and switches that allow access to computers. In fact, assistive technology, as defined in the IDEA, is much broader than that. It includes a range of technologies from low to high tech and includes the software for these technologies as well as any service a child needs to use the device.

The IDEA defines an assistive technology device as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." It defines an assistive technology service as "any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device." Such services are usually delivered by special education teachers and related service providers.

Though specially trained professionals are typically involved in decisions made about assistive technology, it is important for all teachers to realize that in many cases there will be a range of assistive technologies that can help to accomplish the desired result. Teachers should understand that identifying appropriate assistive technology for a particular stu-

dent requires consideration of the full continuum of equipment available. For example, for students who have low vision, there are a number of ways of making print accessible. Possible assistive technology solutions might include using a simple handheld magnifier (low tech), using a CCTV system to enlarge the text and increase contrast (medium tech), or scanning the text and using speech synthesis for output (high tech) (Nunn, Rein, & Pierrel, 1999).

Competency 4. Knowledge of the Universal Access Features of Computer Hardware and Software

Much of today's computer technology incorporates features or allows add-ons so that people with disabilities can use it. The previous discussion of assistive technology addresses what is acquired for use by an individual student for that student to meet the educational goals specified in an individualized education plan. For students with some severe disabilities, dedicated equipment will always be needed. With good planning, however, the technology used by the general school population will also be accessible to most students with disabilities—particularly those students with learning and other mild disabilities who make up the greatest portion of students identified as having special educational needs.

The federal government has encouraged schools to purchase educational technology with built-in access, technology that is compatible with add-on access products, and add-on access products themselves. General education technology funds can be used to acquire universally accessible technology, supporting the current IDEA requirement that students with disabilities be given the opportunity to participate and progress in the same general curriculum taught to all other students. It also promotes the kind of access to educational programming required under Section 504 of the Rehabilitation Act: If computer technology is part of a general public education program, the school district is required to provide disabled students with accessible computer hardware and software so that they are not excluded from participation.

Teachers should also be aware that a considerable amount of software and other instructional materials are being designed with an eye to meeting the needs of an increasingly diverse student population. The term often applied to such materials is *universal design,* an expression originally used to describe architecture that was accessible to individuals with physical disabilities.

Buildings designed for universal access allow all people to enter and participate in the activities that occur there. Similarly, universally designed curriculum materials allow all students to acquire the essential learnings of a particular instructional unit (Orkwis & McLane, 1998). Such materials allow the learning goals to be achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember (Meyer & Rose, 1999).

Competency 5. Skills in Integrating Technology Into the Curriculum to Promote Achievement of All Students, Including Students With Disabilities

Under the IDEA as reauthorized, it is a requirement that students with disabilities have access to the general curriculum taught to all other students in the educational system. Lou Danielson, director of the Research to Practice Division in the U.S. Department of Education's Office of Special Education Programs, points out that "as general education classrooms become more inclusive, strategies for providing access to the general education curriculum are needed so that students with disabilities are actively involved and progress within the curriculum in these classrooms" (Council for Exceptional Children, 1999). This kind of full participation can be facilitated by assistive technology chosen to accommodate the individual learning needs of particular students and by instructional materials that are designed for universal access.

Knowing about the technology available is necessary but not sufficient for increasing students' achievement. Teachers must also be able to apply the technology appropriately in the instruction of students—which means not only understanding how technology can be integrated into the curriculum in general but also how it can support students with a wide range of disabilities. Teachers will need to possess some basic understandings to use technology effectively with their students who have disabilities.

- *Teachers need to understand that each child with a disability is unique and that a technology strategy that works for one student identified as having a particular disability may not be effective for another student identified as having the same disability.* For example, some students with learning disabilities have great difficulty acquiring basic skills such as math facts and spelling. One way in which technology can be helpful is by providing a tool that allows them to circumvent the problem—for example, a calculator to compensate for weak computation skills or a hand-held spellchecker to

help students produce accurate written work. Another approach, complementary to the first, is to continue to work on building the skills through the use of computer-assisted instruction. Other learning-disabled students may have good memory and basic academic skills but have great difficulties with fine motor control that affects handwriting. For some students experiencing this kind of difficulty, a relatively inexpensive portable keyboard might be provided for completing written work quickly and neatly (Nunn et al., 1999). Other students with handwriting difficulties may not benefit from this approach. For some, a word processor may require more long-term memory than the child is capable of—for example, remembering the placement of letters on the keyboard—making word processing less efficient than handwriting. In this case a pen or pencil with an adaptive grip might be more satisfactory (Lahm & Nickels, 1999).

- *Teachers need to know that students' technology needs will change over time.* For example, most students with severe communication disabilities can be aided by picture communication boards, which are often used as a first step. Students communicate by pointing to or gazing at pictures on the board that the teacher has created. Also available are a wide range of augmentative communication devices, ranging from very basic to quite complex and powerful. As students' language and communication skills develop, they can move to more and more sophisticated augmentative communication devices that allow them to interact with others and participate to a greater extent in classroom activities (National Association of State Boards of Education, 1999).
- *Teachers need to understand the power of technology to motivate students who have fallen through the cracks.* Some students, as a consequence of their disability, have not been successful in school and, after years of failure, have been turned off. The opportunity to use technology can sometimes turn them back on—engaging them and encouraging them to continue learning. The most successful applications for this purpose are those that involve students in doing meaningful work and producing valued products. For example, activities such as using the World Wide Web to conduct research and producing a multimedia report will sometimes hook students who have disabilities as well as other students in the class (Nunn et al., 1999). Such activities are also useful in developing the skills that are being demanded of students who will soon join the 21st century workforce.

- *Teachers need to know how technology can support students' success on assessments including standardized tests.* Technology can not only help students learn more but also assist them in demonstrating what they know in standardized assessments. This factor has become extremely important now that the IDEA requires that students with disabilities be included in statewide assessments. All teachers must be knowledgeable about the ways in which technology can assist students in testing situations and allow them to practice using technology accommodations in ongoing assessment in their classrooms. Many accommodations are permitted for students with disabilities. For example, students who have difficulty reading can have the test items read to them from a tape recorder. Students with visual impairments can be provided with a large-print version of the test generated by a computer. Students with coordination difficulties can enter their responses to test items using a computer. By having ongoing opportunities to use such accommodations, students with disabilities will be better prepared to perform well on the high-stakes assessments now becoming common.

Changes Needed in Teacher Preparation Programs

Ensuring that all teachers attain the five competencies in their preservice programs will require systemic change in most teacher preparation programs. It means breaking down the barriers between regular and special education that have existed in many institutions of higher education as well as in most public schools. Public schools are changing, and the institutions preparing tomorrow's teachers for them must follow suit. All graduates of teacher preparation programs must be equipped with the skills needed to use technology effectively to promote the achievement of students with disabilities. Change will not be easy, but it is an important and therefore worthwhile endeavor—one that warrants close collaboration between regular and special education teacher preparation faculty. Change will be required in the following areas:

- *Curriculum and pedagogy.* Faculty leading teacher preparation programs must define the specific competencies and skills they believe their graduates should possess. They will then need to operationalize this vision by reshaping the scope and sequence of their programs so that activities to build the desired competencies are infused into required coursework.

- *Faculty development and support.* Professional development of the faculty is a critical component in the integration of technology skills in teacher preparation programs. Before faculty can train aspiring teachers, they must become proficient in the use of the technology and familiar with the instructional strategies that have proven effective in increasing the achievement of students with disabilities.
- *Technology resources.* Departments, colleges, and schools of education must invest in technology resources. Assistive technology devices and products that incorporate universal access and design features should be available to both faculty and aspiring teachers. Faculty will use these resources both for their professional development and in providing instruction to aspiring teachers. Aspiring teachers, in addition to using the technology resources in classroom instruction, will learn through independent opportunities to explore and work with varied technologies.
- *Performance measurement.* Ongoing monitoring is important of the degree to which the desired modifications in instruction are taking place and to determine whether aspiring teachers are acquiring the needed competencies. The system put in place will provide feedback that will inform future modifications to the program, opportunities for faculty development, and technology resources available to faculty and students.

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Technology and the Commons

■ Michael D. Waggoner

Preparing leaders for our schools and colleges, be they in classrooms or conference rooms, is a multifaceted process involving reflection and the attainment of knowledge, skills, experience, and wisdom. One critical area of this preparation involves developing an understanding of and engendering a commitment to "the commons" and the place and use of technology in it. The double edge of technology in service or harm of humankind has long been the subject of pundits and prophets. It is even the stuff of our science fiction. And while little has changed in the general litany of trade-offs of progress and its costs, the accumulating detritus of the social consequences of our choices continues to confound optimistic scenarios for our future. Some say that American society has grown increasingly selfish. Those among us contributing to this condition have done so, in part, as a consequence of mediating more and more of our experience by technology—creating personal boundaried environments that serve self—interest by carefully limiting our interactions with the public. This paper argues that the American tendency toward radical individualism can be abetted by technology-mediated experience, thereby undermining commitment to the common good and, consequently, our democracy. And it can happen subtly and with the best intentions in pursuit of apparently worthy goals. These tendencies can, however, be arrested and countered by vigilant orientation to the commons and by understanding the roles technology may have in undermining or supporting the commons.

Orienting to the Commons

A continuing concern through the history of the American democracy has been the striking of a balance between individual rights and the requirements of a common life in a republic. An early observer of our democratic experiment saw the possible seeds of its erosion in the extreme forms of freedom it sought to guarantee—in its lifting up the ideal of unmitigated individualism.

> Individualism is a calm and considered feeling [that] disposes each citizen to isolate himself from the mass of his fellows and

withdraw into a circle of family and friends; with this little society formed to his taste, he gladly leaves the greater society to look after itself. (Tocqueville, cited in Bellah, Madsen, Sullivan, Swidler, & Tipton, 1996, p. 37)

More recent commentators extended this critique. Among them, Garrett Hardin in a 1968 *Science* article entitled "The Tragedy of the Commons," notes the deleterious effects on the commons (which in his discussion includes national parks, pollution, and population control) of unconstrained operation of things in the interest of individual freedom. And he recalls Charles Frankel's injunction that "responsibility is the product of definite social arrangements" and Hegel's admonition that "freedom is the recognition of necessity" (pp. 1247-1248).

Sociologist Robert Bellah and his colleagues (1996) explicated the evolution of this tendency most thoroughly in *Habits of the Heart: Individualism and Commitment in American Life.* They argue that two strains of individualism evolved as variations of this underpinning of the democratic ethic. *Utilitarian individualism* characterizes the view that in "a society where each vigorously [pursues] his own interest, the social good would automatically emerge" (p.33). *Expressive individualism* involves the idea that "the ultimate use of America's independence [is] to cultivate and express the self and explore its vast social and cosmic identities" (p. 35). One common result of these strains of individualism has been Americans' self-selection into "lifestyle enclaves," groupings in private life based on social, economic, and cultural similarity (p. 72). It is here, the authors argue, that we choose to spend much of our time outside work. As a consequence, public life becomes a secondary concern, if that. Whereas lifestyle "is fundamentally segmental and celebrates the narcissism of similarity," community emphasizes "an inclusive whole, celebrating the interdependence of public and private life and the different callings of all" (p. 72). Societal leadership for the public good, they posit, has operated for enlightened self-interest alternating between two ethics.

An establishment seeks its own good by working for the good of the whole society (noblesse oblige), whereas an oligarchy looks out for its own by exploiting the rest of society. . . . In American history we have had establishments—most notably in

> the founding generation and the period after World War II—but we have also had oligarchies. It is not hard to see what we have today. (p. xiii)

There are, however, new calls to common cause.

The notion of the commons has been given fresh expression in *Common Fire: Lives of Commitment in a Complex World* (Daloz, Keen, Keen, & Parks, 1996). The commons is "a place where the diverse parts of a community could come together and hold a conversation within a shared sense of participation and responsibility" (p.2). Picking up from the analysis of the American condition offered by Bellah et al., these authors offer a vision of commitment to the commons to counter the gravitational drag of individual interest. They reiterate and extend Garrett Hardin's earlier call: Technical solutions to social problems will emerge only from the coalescence of the morally committed. From the study of such committed people, the authors evolved "habits of mind" to temper the "habits of the heart" that Tocqueville earlier noted as shaping American individualism. These "habits of mind . . . steady them [effective people] in turbulent times and foster humane, intelligent, and constructive responses to the complex challenges that we face.

- "the habit of *dialogue,* grounded in the understanding that meaning is constructed through an ongoing interaction between oneself and others;
- "the habit of *interpersonal perspective-taking,* the ability to see through the eyes and respond to the feelings and concerns of the other;
- "the habit of *critical, systemic thought,* the capacity to identify parts and the connections among them as coherent patterns, and to reflect evaluatively on them;
- "the habit of *dialectical thought,* the ability to recognize and work effectively with contradictions by resisting closure and by reframing one's response;
- "the habit of *holistic thought,* the ability to intuit life as an interconnected whole in a way that leads to practical wisdom." (Daloz et al., 1996, pp.107-108)

The pressures of modern life breed stress and anxiety for individuals at the same time they complicate our public life. While it is not surprising that we retreat from anxiety into our lifestyle enclaves, we do so at the

jeopardy of our common life. Leaders must be aware of these undercurrents in the development of the American psyche and recall us to our responsibilities to the commons. And in this connection they should note that technology can reinforce and support radical individualism and lifestyle enclaves or it can be turned to the service of the commons.

Technology at Work in the Commons

Technology is the very muscle and sinew of the consumer society that has grown up to satiate the requirements of radical individualism in American life. Certainly, science and technology have given us modern miracles in medicine and agricultural productivity; they have also produced horrific weapons and toxic environments. But technology has become part of our lives in more subtle and transparent ways. This is not to suggest that it is a bad thing, only that we should be aware of how our attitudes and actions are influenced.

We are increasingly saturating our lives with technology-mediated experience. We can choose our entertainment and a particular slant on the news through myriad cable programming coming into our homes. We can tailor the stream of information coming to us through the Internet so that we read only certain topics from selected sources or interact only with particular sets of people. College residence halls, apartments, and homes become technococoons from which we occasionally emerge. And all this is occurring in a context of affluence that separates us from much of the commons. (For example, National Public Radio reported on October 20, 1999, that only 50% of Native Americans on reservations have telephone service.)

The flurry of activity in which we engage and the range of sources and people with whom we interact can lead us to believe that we are immersed in an active public life when actually we have only extended our participation into work or lifestyle cyberenclaves. Further, as this communication is all mediated by technology, it is absent that important dimension of communication—physical proximity—that can call forth fuller human interaction. We must also recognize that the increased pace and exchange of information made possible through technology puts additional pressure on face-to-face meetings related to those exchanges, thereby heightening the importance of group process skills.

The opportunities for improved productivity can draw us into the web

of technology-mediated experience. At the same time, the stresses of life can drive us into lifestyle enclaves (physical or cyber). Either condition (and particularly both) can keep us from the uncomfortable physical proximity and engagement of public life in the commons. Technology-mediated communication can be an important supplement and augmentation to interaction, but it cannot substitute for the relationship that is possible with face-to-face conversation. Leaders must be cognizant of the ease with which technology can slip between people, isolating them and creating distance. They must understand, on the other hand, the potential of these media to support and develop relationships as a way of advancing the interests of the commons.

Technology can create new space—a cybercommons—that in association with more conventional gatherings or organizations may contribute to the public life. Numerous such organizations with complementary presences can be found on the Web. Common Cause (www.commoncause.org) is a "nonprofit, nonpartisan [citizens'] lobbying organization promoting open, honest and accountable government" (www.commoncause.org/about/fact.html). The site contains links to numerous other sites and groups operating in the public interest. The Communitarian Network, for example, operates on the premise that "individual liberties depend upon the bolstering of the foundations of civil society: our families, schools, and neighborhoods. It is through these institutions that we acquire a sense of our personal and civic responsibilities, an appreciation of our rights and the rights of others, and a commitment to the welfare of the community and its members" (www.gwu.edu/~ccps). It offers a listserv on public issues as well as listing links to other resources. The Center for the Common Good (www.commongood.org), an organization serving San Francisco and the East Bay area, "promotes an environment that values cultural pluralism and fosters consensus-building in public policy" (commongood.org/mission). It too offers resource links and conversation space.

Many other groups exist only on the Web. One, thehungersite.com (endorsed by the United Nations), facilitates sending a meal a day to places of need for each time (once per day) a person clicks "donate" on that Webpage. The site is supported by several sponsors at a time that rotate occasionally, which underwrites the costs of the donations. Another site helps make our consumer proclivities work for the commons.

WWW.greatergood.com is a shopping service that donates at least 5% to a nonprofit of your choice that can be identified on the Website. While there are other far-reaching and worthy examples, these two illustrate the potential partnerships and creativity we can turn our energies to if we so choose.

As is true with so many other aspects of life, a thing may be turned to good or ill depending on the user's intent. Benign neglect may be another outcome as a result of assuming that individualist mores and technological media are neutral or inherently good. We must choose a broader engagement in pursuit of a common good, and it is an act of the will. A leader in the commons must turn hands toward employing technology in ways that foster engagement rather that isolation, that broaden understanding rather than reinforce narrow self-interest.

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Recommendations for Action

1. Individuals in an educational enterprise should be able to articulate a vision of the purpose and objectives of the enterprise, understand the power dynamics of the situation and their place in it, and where possible, exercise their power on behalf of the common good.

2. Prospective and practicing teachers and administrators should be encouraged and taught to appropriately use technology to establish and maintain personal relationships based upon the individual needs of students and staff, understanding the increased potential for both positive and negative consequences.

3. Prospective and practicing teachers and administrators should be inspired with the beliefs and taught the skills which enable them to empower all stakeholders to ensure equal opportunity to learn for every student.

4. Policymakers, educators, and the private sector must work together to bridge the digital divide. These groups must exercise their political will, financial commitment, and the creative application of information technology to develop a learning environment within and without the confines of the classroom.

5. Every person in an educational enterprise should cultivate an awareness of how they may mediate the identity development of those with whom they interact. They must model and promote a balanced life that includes acting with integrity; demonstrating the skills of managing commitments; and of evaluating, understanding, and appropriately integrating the stimuli from our technologies.

6. Teacher training programs should emphasize the issues of equity and availability of technology outside of the classroom to students within their classes. Collaboration between schools and communities should be promoted to provide increased learning opportunities using technology. Modes and models of learning, which encourage and capitalize upon student access to information outside the classroom, should be built to create natural bridges of relevance between activities in the classroom and the world outside.

Issue Area Two

The Impact of Technology in Changing Perceptions of What and How People Learn

Fundamental to the role of technology and how people think and learn is a paradigm shift from a focus on instruction to a focus on learning. Technology has the capacity to facilitate a shift from didactic to interactive learning, from teacher-centered to learner centered, from memorization to inquiry and invention, from quantity of memorized facts to understanding. In addition, technology is a tool that enables boundary-spanning—both in content education and the politics of resources and assessment. The papers in this section investigate how new technologies are changing perceptions of how learning occurs.

From Scaffolds to Freestanding Structures

■ Patricia Kennedy Arlin

I have often thought that we need to have an applied developmental psychology of education through which to frame questions of teaching, learning, instruction, and technology and their interactions. Learning is fundamentally an active developmental process, despite the fact that numerous theories and practices have tried to treat development and learning as distinct phenomena. First and foremost, learning and development imply change. Both changes occur across time, though some learning can occur in a millisecond and some forms of development occur across many years. Learning and development are related from the very first moment of life.

Learning is active and constructive. Shulman (1999) describes learning as a dual process: "The inside beliefs and understandings must come out and only then can something outside get in. . . . These two processes alternate almost endlessly" (p. 12). I would modify this description slightly and describe the processes as alternating/interacting almost endlessly. Shulman says further: "The first influence on new learning is not what the teacher does pedagogically but the learning that is already inside the learner" (p.12). I think that this description of learning is translated wonderfully by a middle school teacher I interviewed as part of an ongoing study on wisdom and expertise in teaching: "A teacher's job is to offer more experiences for the child and to set up those experiences in a way that will be logical to the child and will help the child progress. In this way the teacher sometimes becomes a learner. . . . People have a concept of a teacher as up front doing the thinking for the kid instead of the teacher being a participant in the child's learning. You should be in it together."

Both Piaget and Vygotsky were very aware of this intimate relation/interaction between learning and development. An often overlooked complementarity between Piaget's structural/constructivist view of the course of cognitive development and Vygotsky's social constructivism is contained in Vygotsky's description of the Zone of Proximal Development, which follows closely on his observation that "a well known and empirically established fact is that learning should be matched in some manner with the child's developmental level" (Vygotsky, 1978, p. 85). This observation begs the

question of how one determines the child's developmental level to specify the relation between the processes of development and learning capabilities.

To do this, Vygotsky requires us to determine two developmental levels: *the actual developmental level*—"the level of development of a child's mental functions that has been established as a result of certain already completed developmental cycles—those things . . . the child can do on [his] own," and *the zone of proximal development*—"the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 85).

It should be noted that Vygotsky believed that when a child's mental age was determined by using tests, we "are almost always dealing with the actual developmental level" (p. 85). I would like to suggest that a much more productive way to describe the child's actual developmental level may be not through such tests but through a careful Piagetian or neo-Piagetian analysis of the child's actual competencies in the domain of interest. Simply put, a substantial amount of Piaget's work can be used to determine actual developmental level. On this basis, more effective zones of proximal development can be established though pedagogy, technology, and social interaction.

This is not an invitation to revisit stages either "hard" or "soft" but to take the words of Flavell, Miller, and Miller (1993) seriously: "It appears that young children are more competent and older children less competent than Piaget thought. Consequently the cognitive changes across childhood may be less stagelike and dramatic than Piaget imagined. . . . Still Piaget does seem to have captured important developmental trends that ring true" (p. 132).

I think that it is time, particularly when we are considering the impact of technology in changing our perceptions of what and how people learn, to revisit these developmental trends. We need to take a hard look at what the child can actually do with the technology and what the child can potentially do when scaffolds are provided through the interaction of the child with the teacher and peers in a technologically created and enhanced environment. Technology may blur boundaries rather than sharpen them as we try to remove the scaffolds and give free form to the child's knowledge construction.

Developmental trends and levels describe the ways knowledge construction takes place. Analogously, they can also be used to describe the ways that adults construct knowledge when they encounter a really new experience or discipline. First, one has to come to know the "stuff," the objects and the artifacts that are essential to the discipline. Often they involve physical properties. Then one names and labels these objects and artifacts. Through language, one begins to attach names and specify relations among and between the objects. Out of these constructions, a logic of classes and logic of relations emerge as well as other distinctive properties and features. Then simple, well structured problems present themselves for which solutions are doable. Facility with presented problems leads gradually to new experiments and the formulation of new problems that, in their highest form, lead to the creation of new knowledge. A simple example can be drawn from one's own personal experience of using a computer for the first time.

The teacher, other students, and the multimedia interactive environments all support the child's knowledge construction and provide scaffolds for that construction. Piaget (1970) suggests that cooperation among the students themselves is as important as actions on the part of the adult: "It is such cooperation that is most apt to encourage real exchange of thought and discussion, which is to say, all the forms of behavior capable of developing the critical attitude of mind, objectivity, and discursive reflection" (p. 180).

Haroutunian-Gordon (1991) observed that too often "teachers come to class as the 'authority,' rather than seeking help with a question whose resolution is uncertain" (p. 4). Those questions themselves are scaffolds despite the sophistication of the technologically created learning environment. They are keys that across time will lead to gradual removal of scaffolds and the student's development of a solid freestanding well constructed knowledge base.

The role of the teacher is enhanced then, rather than being diminished. The teacher ceases being a lecturer and transmitter of knowledge. She becomes a mentor stimulating initiative and research. The teacher organizes the learning experiences. She questions, offers counterexamples and challenges, and through conversation creates experiences and learning environments that stimulate knowledge construction.

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The Growing Separation Between Teacher and Learner: Reversing the Trend

■ Michael Dickson

There is no doubt that information technology is having an impact on what and how people learn. Pick up any magazine, journal, or newspaper; the evidence is presented in irrefutable fashion. Watch any evening news broadcast and see dramatic proof. Search the World Wide Web, and the impact of information technology always surfaces as a topic of conversation or research. And ask the classroom teacher: The current pace of information technology development we, as educators, are facing is an unprecedented challenge. Isn't it? Is it the pace at which information technology is advancing that is the challenge, or is it something else? What is the cause, and what is the effect?

It is important to know that this "unprecedented challenge" is neither recent nor unique. The importance of this perspective should not be underestimated. The perspective from which we view the current impact of technology should be informed and influenced from past experience. By viewing

our current situation as new or unique, we deprive ourselves of earlier perspectives and lessons learned. All too often, we seem to lose sight of the recent as well as the distant past when analyzing our current situation. The fact is that the impact of developing information technology is hardly unique to the current generation, nor should it have taken us by surprise. Indeed, the development of information technology for the last 40 years has been marked by the convergence of many small or incremental developments rather than a single dramatic development or technologic shift. In short, the development of information technology has been generally predictable. The problem has been that too few educators were paying attention, let alone participating.

Many key or pivotal points of technological development have fundamentally changed what and how we learn. The development of movable-type printing first changed the way books were produced, moving the process from an art to a mechanical process. The result was a change in not only the economics of books and printing but also the content. The handwritten religious texts and works of an earlier technology competed with not just cheaper books but also books of wider ranging content. The impact certainly lessened the power of the church and the religious institutions that had enjoyed a virtual monopoly on printed works. The church did not change or adapt to the change, and although society prospered, the church withdrew and declined. This process or decline was not immediate, and indeed it took some time for its impact to ripple through society.

The decline in the influence of the church as it lost its monopoly did not mean that the power of communicating ideas and information through the printed page declined. In fact, as more people had access to the "technology," the relative value of the technology increased. The lesson is simple and consistent: The more people who possess and use an information technology, the more valuable it is and the greater its impact. Conversely, the more closely an information technology is controlled or limited in its access or use, the more power it concentrates in the hands of the controllers and the less its overall value to society. These lessons would seem simple and obvious from the perspective of history, but they appear inconsequential and unrelated to those overwhelmed by the crisis of their time. We as educators should consider this example as we contemplate our educational institutions and methodologies.

Numerous examples of this process or struggle in democratizing information technology exist throughout the history of education. The example

of the essay written by the president of Harvard University in the late 1840s questioning the advisability of allowing students to own and use books without proper supervision comes to mind. The heart of the essay is really not whether students should own and use books but "what and how they should learn." The president was not alone among educational leaders and experts in his convictions or his alarm at the challenge that academia and society faced. The basic premise of the education institution was being challenged by information technology. The premise was simple—the central or supreme role of the teacher/academic in both the creation and teaching of knowledge. The teacher determined both what and how students learned. The teacher/academic created and disseminated new knowledge. Can you imagine what the president of Harvard would have thought about giving students laptop computers to use in the classroom?

Every new information technology of the 20th century has both promised to revolutionize (or at least change) teaching and learning and threatened the stability of our society and the teaching profession. The telephone, while thought of exclusively as a communication technology, was seen by its creator as an information technology with broad educational applications. Society and educators were outraged at the intrusion. Edison touted the phonograph as a way to capture the wisdom of the ages for future generations to hear and share. Educators and society were horrified at the idea of recording a lecture and the informal and impersonal nature of learning that might take place—if indeed it were possible to actually learn in such a manner. Motion pictures suffered the same fate as the phonograph for many of the same reasons. When motion pictures were adopted as a teacher-centered medium, they survived until the 1970s. Who can forget his or her first Coronet Film lesson?

The radio as an information technology presented a new set of dangers for society and educational institutions. For the first time, an information technology could overcome the obstacles of both time and distance. Radio was in fact the first live distance education medium, and, although it did enjoy wide use, it quickly became teacher centered and controlled. The history of television as an information technology and instructional medium enjoyed only slightly more success than radio. Despite its initial promise, it did little to change the classroom or the fundamental relationship between teacher and learner. Many scholars of the 1950s and '60s seriously studied the question of whether television even worked as

an instructional medium. If it did work, was it as effective as the classroom teacher? And we are still studying the effectiveness of the medium. How ironic that television has been blamed for the decline of society and education throughout its 50-year history. Its powerful ability to influence public opinion, social mores, and purchasing is muted when it crosses the threshold of the classroom door. Perhaps it is the absence of the teacher?

The development and introduction of the personal computer as an information technology in education is no longer a recent development. It began in the late 1970s. The educational community, much like the business community, did not readily adopt the personal computer but instead adopted the mainframe, and the personal computer came into education through the back door. School administrators were wary of the loss of control, and it was teachers and computer experts who first saw the potential of the technology. Many teachers saw it as a drill and practice machine that alleviated work for them. Computer experts saw the machine as a cheap surrogate teacher and savior for the overcrowded classroom. But students saw precious little of the computers, and the classroom changed very little. In fact, computers were not even placed in classrooms but in labs, where they remained until recently.

Today we have belatedly acknowledged that we have not done a good job in the use of computers in the classroom. The computer should be moved back into the classroom and connected to networks (the Internet and Intranet). Its use as a drill and practice machine has been discredited. It is now recognized as a tool to be integrated into the curriculum and the relationship between learners and teachers.

But something seems to be askew in the generally accepted premise that we should just integrate technology into our teaching. This premise seems to suggest that our current teaching approach or methodology is both adequate and compatible with technology. I would suggest it is not. This approach is exactly the same we have generally taken with every new information technology. We tend to simply graft whatever the latest technology is onto or into our current institution, classrooms, and methodology. This approach has not worked well in the last 100 years, and precious little evidence exists that it will work today or tomorrow.

I believe the evidence shows that the time has come to fundamentally examine the relationship between the teacher and the learner. The role of information technology in what and how we learn becomes clearer and

more effective when this relationship is redefined. It is time to examine the very basics of not just teacher education but our educational institutions. The current "crisis" is less about the introduction of information technology and more about an educational system that is increasingly in conflict with learners and with our rapidly changing society.

The learner and the teacher are becoming increasingly separated or disassociated. For the most part, students today cannot remember a time when there were only three television networks, when television was black and white, and when VCRs did not exist. Children are growing up with choices not just in television channels but also in information and entertainment technology. They are increasingly sophisticated consumers of not just entertainment but also of information and the technologies that convey it. They are not just comfortable with information technologies: They increasingly define their life and expectations with it and their ability to use it.

How revealing is it when a teacher jokes about being unable to properly set the clock on his/her VCR? We have all heard the one about the computer that came not with an instruction manual but a 10-year-old to set it up. Students generally know more about how to set up and use information technology than their teachers, and they instinctively realize that information technology plays a different role in their lives. How many teachers do you know who know what the hottest computer game is, let alone how to play it? During a recent baseball season, I observed a friend's son getting up in the morning, turning on the computer, and getting not just the scores from the previous night's games but also box scores, statistics, and a play-by-play description. When he was done with the baseball scores, he checked the weather forecast, ate his toaster breakfast, and left for school. His father, a teacher, pored through the morning paper for the same information and then listened to the radio as we drove to school. As teachers, we tend not to have the same fluency in the use of information technology as our students.

Some would say that this situation is temporary, just a demographic blip. As our teachers become younger, they will identify more with students and assimilate more information technology—and the "digital divide" will disappear. I am not optimistic that the problem will correct itself, however. We tend to underestimate the resistance to change ingrained in our teaching and educational institutions. We have proven

remarkably adept at avoiding change and at moving away from being teacher-centered to becoming learner-centered. Many teacher training institutions have embraced change only when threatened with extinction. Even then, we often do not embrace learner-centered teaching or instruction. Tests based on fixed knowledge and classroom lectures are still molding tomorrow's teachers at many teacher training institutions. We teach as we have been taught, and we are merely replicating these same values and traits in a younger generation of teachers.

What should we be teaching, and how should we be teaching? If the development of information technology has changed anything, it is the amount of information to be learned. It took almost 50 years for the amount of information to double in the first half of the 20th century. Today information doubles in fewer than four years by current estimates. And this explosion of information shows no signs of slowing for the foreseeable future. What then can we teach that has enduring and empowering impact? Simply put, we must teach students how to learn and how to develop critical-thinking skills, and reinforce in them the need to be a lifelong learner. To do so, we must model these same traits and values in our teacher training institutions.

How we teach may well prove to be as important as *what* we teach. The classic model of the classroom teacher as a lecturer and font of all knowledge is no longer functional. The traditional classroom with rows of neatly spaced desks and the teacher as the central focus must be replaced. To learn learning skills and critical thinking, students must become more active participants in the process. They are not rote skills but require both application and guidance from the teacher. Recent cognitive research bears out the ancient Chinese proverb, "I hear and I forget, I see and I remember, I do and I understand."

For the last five years we have watched the emergence of an approach to teaching and learning called *engaged learning.* Developed in part from constructivist theory, it has gained momentum in elementary schools and is now being introduced into secondary schools. The model that has been articulated by Barbara Means and championed by research from the North Central Regional Educational Laboratory is learner-centered. Several indicators or tenets of engaged learning have tremendous implications. The role of the teacher in engaged learning is that of facilitator and not dispenser of knowledge. In this setting, it is permissible for the

student to be not just the consumer of information but also the discoverer, organizer, and creator of new information and ultimately new knowledge. The teacher is even permitted to be a colearner in this setting. This relationship between the student and the learner is fundamentally different. It appears to be much more compatible with technology as well as the long-range demands society is placing on our educational institutions.

How we teach will ultimately be influenced by how we were taught. In 1997, the National Council for Accreditation of Teacher Education stated that most teacher preparation programs were falling short of what needed to be done. Not using technology much in their own research and teaching, teacher education faculty had insufficient understanding of the demand on classroom teachers to incorporate technology in their teaching. This judgment was hardly tempered by a 1998 survey of 416 colleges of education by the International Society for Technology in Education. ISTE found that college teacher preparation programs in general do not provide future teachers the types of experiences they will need to be prepared to use technology efficiently in the classroom. The study concluded that although schools of education have adequate technology infrastructure, faculties do not use technology or integrate it into classes. These testimonials are not exactly the kind that will endear us to the public or to politicians.

As teacher educators we are often not very effective or credible at presenting ourselves as the solution. Our challenge is to embrace real and fundamental change, not just the popular easy solutions imposed by the politics of education. We must convince our faculty, students, and the public that we are not just part of the problem but also part of the solution. To do so, we must refocus as learner-centered teacher training institutions and reconnect to our constituency, the P-12 community.

Over the past 25 years, teacher preparation programs have become ever more isolated from the real world of the classroom; I believe this isolation has contributed to the current situation. Whether it can be attributed to the demise of lab schools or the general malaise in the teacher education job market is immaterial. The simple fact is that just like the business community, we must invest in and understand our customers if we are to be successful. Whether we reconnect through community-based professional development schools, distance education technology, or more traditional means, we must reconnect to survive. The P-12 schools should provide us our markets and testing grounds as well as our product endorsements.

Technology and Learning: A Complex, Interactive Dynamic

■ Helen L. Harrington

A complex interaction occurs between our perceptions and conceptualizations of new technologies and our understanding of how humans think and learn. Where once it might have been suggested that computing technologies were modeled on the human brain, we now suggest that our understanding of the brain and how people learn is influenced by our understanding of how computing technologies are designed and operate. To go too far in either direction, however, would be a mistake. It is attention to how each informs the other that may be most powerful. Technology may provide a deeper and more sophisticated understanding of what and how we learn. At the same time, those revised conceptions may lead to the development of more sophisticated technologies.

We need, however, to be cautious. We should be sensitive to how our perceptions may act as barriers to our conceptions and how our conceptions may limit our perceptions. Although technology may prompt more sophisticated perceptions and conceptions, we should always approach our uses of technology with critical attention. We should be attentive to the consequences of our uses of technology, to the ways in which it may limit as well as enhance understanding (Harrington, 1993). We should also be attentive to the differences between the effects *of* technology and effects *with* technology (Salomon, Perkins, & Globerson, 1991).

One of the ways in which technology may be used to enhance as well as prompt attention to evolving understandings is to design applications that can serve as intellectual mirrors (Schwartz, 1989). Applications designed and used in this way reflect the user's thinking and the consequences of their thinking. They reflect barriers to deep understanding, including false assumptions, misconceptions, and naive understandings. The constructed, evolving, and transformative nature of learning is illuminated. To develop applications that serve as intellectual mirrors requires a deep understanding of the intellectual domain in which applications are grounded. For technological applications designed for use in teacher preparation, it means a deep understanding of teaching and learning—and, specifically, what learning to teach encompasses. (A discussion of the

serious limitations in our understanding of how teachers learn to teach is found in Ball and Cohen (1999), who argue that if we hope to prepare teachers who can foster deep, meaningful learning in students, we must first have a clearer understanding of what learning to teach entails.)

Applications for teacher education designed as intellectual mirrors will allow us to capture and reflect prospective teachers' cognitive and professional development. We can then use that information to further foster their development, particularly in ways that current reform efforts suggest are essential. They may be used to enhance what and how our students know in ways we have been unable to do previously; they may be used to support and challenge our students' current ways of making meaning. At the same time, new technologies designed to reflect how children learn can be incorporated in teacher preparation programs to provide prospective teachers with a deeper understanding of how their students learn and how technology can be used in their future work with students to enhance learning.

Either use requires an understanding of learning and development across the life span and a focus on how software can be designed to support and challenge learners to more complex ways of thinking and understanding. Although we are moving in this direction in applications for K-12 schools (see, e.g., Krajcik, Soloway, Blumenfeld, & Marx, 1998), little has been done in teacher preparation (although Lampert and Ball's (1998) development of multimedia materials for teacher preparation provides opportunities for students to develop deeper understandings of teaching and learning, the materials do not capture students' learning and development). Learning lies at the heart of teaching. It is reflected in the complex, interactive dynamic between students and teachers. Without a deep understanding of what and how students learn, teachers' role in that learning, and how a teacher's approach to learning interacts with what they will be able to accomplish, prospective teachers will be limited in the understanding they are able to foster in their students. They need to understand both their own learning and how their students learn.

Although applications can be designed to foster these understandings, design alone will not be sufficient. Teachers also need to develop deep understanding of the theories supporting applications and develop pedagogical approaches aligned with the objectives of given applications and the theories grounding them. Schwartz and Perkins (1995) talk about a "'peda-

gogy of understanding' wherein students would develop a genuine comprehension of key concepts, an improved ability to formulate and solve problems, and an overall grasp of the nature" of what is being taught (p. 257). This kind of pedagogy is crucial to teacher preparation if we hope to prepare them in the ways suggested here. To implement a pedagogy of understanding, we would need to identify the concepts we want prospective teachers to learn and design learning opportunities that help them develop the ability to formulate and solve the problems of teaching while illuminating, for them, the nature of teaching and learning. New technologies also seem especially suited to helping us develop a pedagogy of understanding, particularly if we incorporate applications that serve as intellectual mirrors of students' developing understanding of teaching and learning.

New technologies will do so when they are designed to focus on the learning and development we hope to foster, illuminate the cognitive and conceptual barriers to that learning and development, provide opportunities to move beyond those barriers, take advantage of all that we know about how to best foster learning, and illuminate his or her learning for the learner. Other applications can then be designed to build on those developing understandings and provide students of teaching with opportunities to engage in the problems of teaching. In doing so, these applications provide students with a deeper understanding of and experience with teaching's complex, interactive, ambiguous, and challenging nature. The design of these technologies will require the involvement of learning and developmental psychologists, teacher educators, teachers, and software designers.

> The challenge for education is to design technologies for learning that draw both from knowledge about human cognition and from practical applications of how technology can facilitate complex tasks in the workplace. These designs use technology to scaffold thinking and activity, much as training wheels allow young bike riders to practice cycling when they would fall without support. Like training wheels, computer scaffolding enables learners to do more advanced activities and to engage in more advanced thinking and problem solving than they could without such help. (Bransford, Brown, & Cocking, 1999, p. 202)

It is time for students of teaching to receive that help. By designing applications as intellectual mirrors and embedding them in a pedagogy of understanding, we are closer to that goal.

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Technology and the Transformation of Learning

■ Kathy Klock

As people discover the power of technology, it changes how they learn. For the first time, they have an organization and retrieval system that allows them to systematically store information for future use. They also have access to information that no other generation has experienced. The Internet provides a base of knowledge for human interaction that was only science fiction a few years ago.

Cognitive psychologists say that knowledge is based on small chunks of information woven together in a contextual framework. Children, from infancy, explore building concepts based on their need to understand the world. As they become students and throughout their adult life, they continue to build on that framework. Now technology adds the possibility of more complex understanding for all.

Often, learning can be slow as students find concepts difficult to grasp in abstract form. Technology gives the learner the opportunity to work with more concrete models that illustrate the same abstract concepts. Learners can view and manipulate pictures, videos, graphics, and other data. A greater understanding and breadth of knowledge are possible with these new tools for learning.

The Internet opens the door to learning at any hour of the day. With a modem and a computer, people can find multiple resources on almost any topic. Learners must now become evaluators of a wealth of information. Skills such as authentication, comparing and contrasting, distinguishing fact from opinion, and determining the accuracy of a source have renewed significance in the learning process.

The Internet gives learners access to researchers who are leaders in their fields of knowledge. The novice benefits by interacting with these experts. They have the opportunity to hear and react to the reasoning and thinking required in that discipline. They begin to grasp the concepts necessary to build their own understanding. This interaction and access to experts was unavailable before technology linked our world.

Interaction with experts is not the only exchange that occurs on the Internet. Learners engage in discussion and share ideas. They have an

opportunity to look at relevant problems from different views. Projects based on local experience can be shared with other learners, and together they can build models and analyze data. People-to-people exchanges are more active and engaging than merely reading a textbook. The conversations offer more divergent viewpoints and levels of expertise. The information becomes part of the individual knowledge base as concepts are formed based on the learner's view of the world. Students see the work in school as real and need little motivation to be engaged learners.

As people learn, they need to organize information, whether it is simply gathering facts, summarizing, or reflecting on their own thinking. Technology gives the learner tools such as word processing, databases, and spreadsheets to display and save this information. It can be stored as a foundation for new projects or used for building presentations, another tool provided through technology. The information can easily be revised, ending learning tasks that were previously tedious and often inaccurate.

The computer becomes a powerful tool for the learner. Besides organizing information, the learner now spends more time wrestling with complex ideas. One illustration is the university statistics class. Instead of spending time on mathematical equations, students can now concentrate on analyzing and synthesizing research studies. A simple graph that took an hour for young students to create is now completed in a few minutes. Students can instantly change the graph to view it differently, choose the best method for display, and analyze the chart they have created. More visual representations are possible, so more students can reach understanding tied to their experiences.

Technology provides the opportunity for feedback that immediately verifies learning. Feedback in its simplest form occurs when students use drill and practice programs that immediately inform them of incorrect responses. On a more sophisticated level, the real potential is feedback from peers or others with more expertise. Technology makes it easy to invite others to review students' work. As students think about the questions and ideas posed by reviewers, they revise, add new ideas, and begin to form the reflective thinking necessary to reach higher levels of achievement. This formative assessment process is already shown to have an effect on students' performance (Bransford, Brown, & Cocking, 1999).

Classrooms across the nation are transformed as students and teachers use technology for learning. Everyone in the classroom becomes a learner.

Collaboration is part of the daily routine as students help each other. They make decisions and accept responsibility for their own learning. The opportunity to engage in real work increases as students manipulate models or participate in complex simulations. Interactions in projects that link learners in the same room, in the same schools, across the nation, or throughout the world make learning relevant and rewarding. Schools are connecting to homes and the community and engaging more adult learners. Technology is truly changing how we learn and making the potential for what we learn an almost impossible prediction for the future.

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Leveraging the Power of Learning Theory Through Information Technology

■ James W. Pellegrino

Many educators agree that the learning environments of the 21st century will function and look very different from classrooms of today (see, e.g., Cognition and Technology Group at Vanderbilt, 1996; Dede, 1998; Hawkins & Collins, 1999; Means, Olson, & Singh, 1995; Means, 1994), a perspective reinforced by prominent individuals from the technology community (e.g., Gates, 1995). One of the major differences involves ubiquitous information technologies to support students' learning. Determining what we know about learning, its interaction with information technologies, and the implications for teacher education are the major matters of concern. Fortunately, several recent reports from the National Academy of Sciences provide a strong foundation for state-of-the-art knowledge about learning and ways to enhance it (e.g., Bransford, Brown, & Cocking, 1999; Donovan, Bransford, & Pellegrino, 1999; Pellegrino, Jones, & Mitchell,

1999; Snow, Burns, & Griffin, 1998). This knowledge also provides a powerful set of guidelines for using existing technologies and developing new ones that can help teachers significantly enhance their students' learning.

Four Components of Effective Learning Environments

How People Learn: Brain, Mind, Experience and School (Bransford et al., 1999; see also Donovan et al., 1999) synthesizes the last 20 years of research on learning and cognition and its implications for teaching. It provides a useful framework that highlights four components of effective learning environments—components that overlap with one another and must be balanced to make learning most effective. The components of this framework apply to the learning of K-12 students, prospective teachers, and teacher educators (see especially Chapter 6) and have implications for thinking about effective and powerful uses of information technologies across multiple learning settings.

- *Effective learning environments are knowledge centered.* Attention is given to what is taught (information, subject matter), why it is taught (to support "learning with understanding" rather than merely remembering), and what competence or mastery looks like. Research discussed in *How People Learn* shows clearly that expertise involves well-organized knowledge that supports understanding and that learning with understanding is important for the development of expertise because it makes new learning easier (i.e., supports transfer). Learning with understanding is often harder to accomplish than simply memorizing, and it takes more time. A knowledge-centered environment provides the necessary depth of study and assesses students' understanding rather than factual memory. It incorporates teaching of metacognitive strategies that facilitate future learning.
- *Effective learning environments are learner centered.* Educators must pay close attention to the knowledge, skills, and attitudes that learners bring to the classroom, including preconceptions about subject matter and a broader understanding of the learner. Teachers in learner-centered environments pay careful attention to what students know as well as what they do not know, and they continually work to build on students' strengths. Learner-centered teachers present students with "just manageable difficulties"—challenging enough to maintain engagement but not so difficult as to lead to discouragement. They must therefore understand their students' knowledge, skill levels, and interests

(Duckworth, 1987). An appreciation of the personal and cultural backgrounds of students is especially important for finding ways to meet their needs and build on their strengths.

- *Effective learning environments are assessment centered.* Especially important are efforts to make students' thinking visible through the use of frequent formative assessment, permitting the teacher to grasp students' preconceptions, understand where students are on the "developmental corridor" from informal to formal thinking, and design instruction accordingly. Such assessments help both teachers and students monitor progress. An important feature of assessment-centered environments is that they are learner friendly and provide students with opportunities to revise and improve their thinking (Vye et al., 1998). Thus, they help students see their own progress over the course of weeks or months and help teachers identify problems that need to be remedied.
- *Effective learning environments are community centered.* This component includes the development of norms for the classroom and school and connections to the outside world that support core learning values. The norms established in the classroom have strong effects on students' achievement. Clearly, if students are to reveal their preconceptions about a subject matter, their questions, and their progress toward understanding, the norms of the school must support doing so. Teachers must attend to designing classroom activities and helping students organize their work in ways that promote the kind of intellectual camaraderie and the attitudes toward learning that build a sense of community. In such a community, students might help one another solve problems by building on each other's knowledge, asking questions to clarify explanations, and suggesting avenues that would move the group toward its goal (Brown & Campione, 1994). Cooperation in problem solving (Evans, 1989; Newstead & Evans, 1995) and argumentation among students in such an intellectual community enhance cognitive development (Goldman, 1994; Habermas, 1990; Moshman, 1995).

Teachers must be enabled and encouraged to establish a community of learners among themselves (Lave & Wenger, 1991). These communities can build a sense of comfort with questioning rather than knowing the answers and can develop a model of creating new ideas that build on the contributions of individual members. They can engender a sense of the excitement of learning that is then trans-

ferred to the classroom, conferring a sense of ownership of new ideas as they apply to theory and practice. Teachers must also be encouraged to link classroom learning to learning in homes and the larger community (e.g., community centers, after-school programs, and local businesses). Teachers who understand the importance of community centeredness realize the need to break the isolation of the classroom and connect learning opportunities across students' day.

Technology Tools to Support and Enhance Learning

A variety of tools are available to support one or more of these critical components of learning environments. For example, knowledge-centered components are supported by simulations, visualizations, video-based problem solving, and tools such as calculators, spreadsheets, concept mapping programs, and graphing programs that help students learn important content with understanding rather than merely memorize facts (see CILT.org; Bransford et al., 1999, Chapter 9; and Cognition and Technology Group at Vanderbilt, 1996, for examples). These same technology tools also affect the degree to which classrooms are learner centered and assessment centered by allowing students to learn with dynamic visual images and simulations, by making students' thinking visible, and by providing chances for self-assessment (see Goldman, Williams, Sherwood, Hasselbring, & Cognition and Technology Group at Vanderbilt, 1999). Other technology tools such as Classtalk (Bransford et al., 1999) enable students in large classes to answer questions asked by the instructor and see a graph of the class distribution (anonymous with respect to responders) displayed almost instantly. The instructor and the students therefore know what the students are thinking, and all can respond accordingly.

Additional examples that support formative assessment include exciting new technology-based methods such as the Diagnoser software for physics and mathematics (Hunt & Minstrell, 1994), latent semantic analysis for scoring essays (e.g., Landauer, Foltz, & Laham, 1998), the IMMEX system for providing feedback on problem solving (Hurst, Casillas, & Stevens, 1997), the curriculum-based measurement system (Fuchs, Fuchs, Hamlett, & Stecker, 1991), "knock knock" environments (Cognition and Technology Group at Vanderbilt, 1998) for feedback on literacy skills to young children, and many others. Other software pro-

grams use small portable devices such as Palm Pilots to help teachers assess presentations and other kinds of activities. Electronic portfolio software can help students (as well as teachers, parents, and others) see records of their progress in particular areas over time (see CILT.org).

The community-centered aspects of effective learning environments are facilitated in multiple ways through appropriate uses of technology. For example, multimedia technologies can help classes create group products (PowerPoint presentations, videos, architectural designs, brochures, etc.) they can share with outside audiences. Networked and Web-based communications technologies such as e-mail, listservs, and more sophisticated knowledge building software such as Speak Easy (Linn & His, in press) or Knowledge Forum (Scardamalia, Bereiter, & Lamon 1994) can also help students form a community around important ideas. Such technology helps capture ideas that otherwise can be ephemeral, and it supports communication that is asynchronous as well as synchronous.

Implications

Extremely powerful information technologies will become ubiquitous in educational settings, fundamentally changing the nature of learning environments at all educational levels. We can foresee some of those changes and hypothesize about their consequences for children, teachers, policy makers, and the public, but much is beyond our speculative capacity. For example, a decade ago contemporary developments related to the Internet were largely unimaginable. We can be sure, however, that technology will significantly affect both what and how people learn as well as how they can and should be taught. It is also clear that teachers will need to have mastery over multiple forms of information technology as well as principled understanding of subject matter areas and how learning occurs in those domains, and they will need to know how to use technology effectively in support of pedagogy and student learning (see, e.g., Bruer, 1993; Cognition and Technology Group at Vanderbilt, 1996; McGilly, 1994; Vosniadou, DeCorte, Glaser, & Mandl, 1996). If information technology investments are to pay off in improved education, future teachers must be technology-proficient educators who know learning theory and how to use modern learning tools to help students meet high standards. The challenge is to imagine and design the kinds of learning environments needed to develop, support, and sustain such a professional teaching force.

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Learning in Our Schools: Where Are We Heading?

■ Harvey Pressman

The Teacher Led Technology Challenge (TLTC) is a bold 5-year experiment designed to demonstrate how technology tools can be integrated into classrooms for grade 8 and below. Functioning in a small urban school district with a school population of about 10,000 that is about 65% minority and about 40% eligible for free or reduced lunches, the TLTC operates an extensive in-service technology staff development program that has very little in common with preservice preparation programs for future teachers, with in-service training programs in other school districts, or, for that matter, with what we proposed to do when we wrote the proposal that garnered us a federal Challenge Grant of $6.5 million to support this program.

During our first three years of Project Operation, we learned a great deal about the impact of technology on our perceptions of what and how middle, elementary, and prekindergarten students learn and about what really works in the preparation of teachers for teaching in an age of technology. Because elements of our project are being replicated in some 14 other California school districts with state Literacy Challenge funds, we have also been able to learn how some of these ideas play out in a cross-section of other districts.

Our project's experience shed some light on some important issues related to technology and learning.

How Is Technology Currently Influencing Change in Our Schools?

From the point of view of a school district that has made a firm commitment to higher achievement for the most disadvantaged of its students, what we see around us suggests that what public schools frequently do with technology can potentially have negative consequences, particularly in preschool, elementary, and middle schools. Consider the following points:

- *The digital divide.* The rapid ascension of technology in our society, according to many recent reports (see, e.g., Nussbaum, 1998), is producing, as an unhealthy byproduct, a digital divide (some also refer to a "racial ravine") between poor people (and people from a variety of different minority groups) and the rest of society. Unfortunately, what schools do and do not do with educational can unwittingly deepen this digital divide. Innovative educational technology projects supported by federal and state-operated Challenge funds, for example, rarely deal directly enough with the problems of struggling students, future dropouts, and the like, especially in the lower grades, and so often have the opposite effect from the intended goal of supporting disadvantaged learners. Female students, especially those from certain minority groups, also consistently get the short end of the technology stick.
- *Tons of cure, no ounces of prevention.* Children below the age of 8 who probably need, deserve, and can benefit most from the educational boost that technology can provide (Haugland, 1999) end up getting the least. A study by the Abecedarian project is only the most recent example of studies that conclude that good early childhood education has a powerful influence on poor children that lasts into young adulthood, affecting things like skill in reading and mathematics (Wilgoren, 1999). However, in the state of California, funds that were originally designated for disadvantaged populations grade 3 and below were reallocated exclusively to grades 4-8.
- *Reality bytes.* Although technology may not make things worse, it may be because it is just an increasingly expensive irrelevancy. Half a decade ago, Larry Cuban warned that it will be decades before technology has any meaningful impact on what, or how, children learn in the place where all the important skills are learned: the regular classroom (Cuban,

1995). In a recent debate with Cuban, I tried to point out that it will be decades before technology has any meaningful impact on teaching and learning *only if* we continue to do the unnecessary things we technology policy makers and teacher educators do in this field. But I was hard-pressed to come up with good evidence that policy makers and teacher educators are getting any smarter in the way they deal with technology. And as Cuban asked in a recent *Education Week* article, "Why should very busy teachers who are genuinely committed to doing a good job with their students listen to experts' changing advice on technologies when they have to face daily, unyielding working conditions; internal and external demands on their time and stamina; unreliable machines and software; and disrespect for their opinions?" As a member of the audience pointed out, "The smart money's on Cuban."

- *The sage-on-the-stage/guide-on-the-side mythology.* We can find many references in the literature to the ways in which the use of technology in the classroom moves teachers away from comfortable but ineffective habits of full-frontal teaching (Fisher, 1996; Dede, 1998), but we can find little hard evidence that it is happening in any more than a handful of situations. Nor is there much evidence that teacher educators are doing much to help young people entering the field learn the small-group coaching skills they need to have to maximize the effectiveness of classroom teachers as technology-using educators. Unless and until we challenge, with some serious data, the comfortable fiction that the presence of technology in the classroom somehow magically makes coaches out of full-frontal teachers, we will not be able to get anybody to make the effort to teach these skills directly to teachers.
- *The focus on diversionary sideshows rather than on the main events.* PowerPoint and HyperStudio and the Internet, and even Microsoft Office, are admittedly appealing diversions to the more technologically sophisticated among our teacher educators and technology policy makers, but they have little to contribute to the way in which struggling young learners learn to read, write, and compute or the way at-risk middle schoolers can mount an educational comeback.
- *Governmental nostrums.* The technology prescriptions that emanate from Washington and other government centers are not always grounded in sound educational research. Stories abound in California of the state school board appointee who did not believe in computers

for kids under 9 and stubbornly blocked the allocation of state and federal funds intended for disadvantaged populations from reaching the young people who might benefit from them most. In federal, state, and local jurisdictions, politicians offer the Internet panacea for our public schools as though students who lack basic reading and writing skills could benefit from trying to navigate this confusing environment and as though all but a handful of classroom teachers know how to integrate Internet activities into meaningful core subject lessons.

Is Technology Really Changing Our Perceptions of How or What Students Learn?

In the Berkeley schools, and in many other schools that are part of our TLTC replication network, technology does not seem to have any major influence on how students learn the basic skills and core subjects, or on how teachers organize classroom instruction in these areas. A lot of people write about the implications that technology has for changing how students learn and how teachers teach (Papert, 1993; Means & Olson, 1995; Dede, 1998; Dwyer, Ringstaff, & Sandholtz, 1991; U. S. Congress, 1995), but we see little of that in actual classroom situations.

Rather, what we see in Berkeley are teachers using classroom technologies (digital cameras, scanners, computers, etc.) as tools to facilitate children's learning what they have always learned in ways that are pretty similar to ways they have always learned them. What changes are the levels of engagement in the learning activities of the classrooms in general and of certain students in particular. Where we are most successful, we see students who have been labeled discouraged, disengaged, or struggling learners participating more actively, showing more interest, performing more successfully. But everything we hear suggests that our projects and its adapters are among the few who are consciously trying to use technology tools for the specific purpose of reaching struggling learners in the classroom. And we know that unless we set it as a specific, targeted objective of our staff development and teacher support activities, it rarely happens.

With respect to what K-8 students learn, technology does seem, in the school systems we interact with, to have a marginal impact in grades 4-8. We see middle school students spending significant chunks of time learning to use Hyperstudio and using it to prettify papers they obviously do not know how to write (we think learning to write clearly and cogently is still a bit more important); we see students learning Internet skills and

going on Internet quests that are marginal at best to what the curriculum says they are supposed to be learning and that seem most often to be diversionary add-ons to an already too full curriculum.

What are teachers being taught about the Web? Very little that has to do with truly integrating Web quests into the core curriculum and a great deal about how to find lesson plans that also do not usually address the use of technology in the classroom, with precious little benefit ever trickling down to the students. Many teachers are still afraid to exploit the great learning potential of the World Wide Web because of liability issues over what children might find in the darker regions of the Web, when in fact teachers can be taught some very simple strategies that would eliminate the risk. All these add-ons and marginal activities, which are accomplished at considerable cost in time, money, and teachers' energy, seem to us to communicate a trivializing message: Technology does not help teachers deliver the meat and potatoes of the curriculum; it is simply an attractive add-on to the curriculum.

What does our program do in grades 4-8? We mostly try to show classroom teachers how to use technology tools to make sure that more students master prealgebra skills, that fewer students move from elementary to middle school with inadequate reading and writing skills that doom them to do poorly in most middle school subjects, that students studying history get engaged more actively in tasks that deepen their understanding of what happened and why. What we are trying to do is perhaps at once more modest and more difficult: to show classroom teachers how to use technology tools to benefit the students they usually do least well with—struggling learners, disaffected and disengaged students, children with reading and learning disabilities, and students with dominant intelligences and learning styles that do not mesh with the styles usually addressed in typical classrooms.

Although at ground level we see few visible signs that technology is changing many practitioners' perceptions of how students learn, we believe that technology may well be creating the possibility of responding more creatively to new insights into how children learn. In a recent reframing of his original Frames of Mind theories, for example, Howard Gardner attempts to offer practical guidance on the educational uses of his multiple intelligence theory without providing very much practical information on the role technology might play (Gardner, 1999). In the

Berkeley TLTC, we are attempting quite overtly and concretely to show teachers how to use technology as a diversity accommodation tool, that is, as a tool that can help them respond to the many different dominant learning styles, intelligences, and/or learning levels that inevitably exist among the students in a single classroom.

Framing classroom technology as a diversity accommodation tool (Pressman & Dublin, 1995; Dublin, Pressman, 1994) serves a number of practical purposes. It helps us, first, to connect the use of technology in the classroom with the central unresolved problem faced by most school systems: how to help struggling disadvantaged students become more successful in mastering the 3 R's. Second, it provides us with a vehicle to communicate to teachers about uses of technology that may be considerably more significant, in their minds, than the uses they are more familiar with: drill and practice on math facts or doing fun slide shows or teaching the children who will grow up in a new age of voice-activated word processing the rapidly obsolescing skills of keyboarding. And, finally, it helps us to break through the stereotypes that many teachers (and other educators) have of what classroom technology is for (Pressman, 1994), which often enables them too easily to compartmentalize technology into a category separate from the teaching of reading or prealgebra skills or other important core curriculum subjects.

What Technology Is Developmentally Appropriate for Pre-K Classrooms? What Are the Implications for Teacher Preparation Programs?

In the TLTC, we are training all our prekindergarten classroom teachers to integrate technology into the emergent literacy curriculum that is at the core of the prekindergarten program. It is a task made more difficult by the relative paucity of developmentally appropriate commercially available materials, and so we have had to develop a number of the methods and materials we use most frequently in our own staff development workshops. What we are doing has, I think, important implications for the preservice educators of future prekindergarten teachers, especially those who still work with disadvantaged populations (Haugland, 1999).

Here again, it is a question of not sending people out into the field with all the tools of their trade, including those 21st century tools that might help them succeed with educationally disadvantaged children. And it is a question of sending them out with some of the most basic, ground-level

tools that fit the core of the early childhood curriculum rather than with fringe or frill ideas that confine the computer to the corner for "enrichment" activities. Researchers from Stanford who have observed and interviewed some of our computer-using prekindergarten and kindergarten teachers have been surprised at the extent of the use and impact of technology tools among some of our more computer-savvy early childhood teachers. We believe that the low-income families who are the ones primarily served by our prekindergarten classrooms deserve to have teachers who know how to use technology to serve the needs of their children and that we should expect as much from those who are preparing the next generation of early childhood teachers.

Are Large Corporations Distorting the Process of Technology Use in Our Schools? Can We Do More to Ensure the Quality of Teacher Education in a Commercialized Environment?

It is no surprise that big technology corporations try to influence educational policies involving the use of technology in our schools. It is cause for concern, however, to observe how successful corporations have been in influencing the ways we use technology in our schools.

Technology decision makers in our schools must question whether these corporations are stimulating demand for the wrong kinds of technology solutions or for more expensive solutions than are necessary. Few question whether so much of the "one kid to one computer" activity may have been influenced by Apple's ACOT "research" or by IBM's early Write to Read promotion. School technology coordinators frequently promote the use of business productivity tools with younger and younger students to the ultimate profit of corporations, but not necessarily to the benefit of young students who are struggling to learn to read and write. The idea of one-on-one "instruction" in computer laboratories and much of what happens in them have the ultimate effect of trivializing or marginalizing the value of educational technology.

Is What Colleges of Education Do With Technology Making Their Curricula Even Less Relevant to the Realities of Real Classrooms in Real Schools?

The conclusions from David Moursund's recent survey are striking: Most faculty do not model instructional technology skills in teaching. Most institutions have instructional technology available in K-12 class-

rooms for student teaching, but it is not used routinely during field experiences (Moursund & Bielefeldt, 1999). In other words, future teachers are not seeing technology integrated in their own instruction or learning how to integrate technology in their own classroom teaching (Rosenthal, 1999). The reports we hear from new teachers is that their experience in schools of education is still one of full-frontal college instructors preparing future teachers for full-frontal teaching (Lieberman & Miller, 1991; Tyson, 1994).

One of the failures of our colleges of education is that they fail to help future teachers learn how to organize and operate classrooms so that struggling and disadvantaged students learn more successfully. Yet as evidence mounts that most technology initiatives introduced into public schools inadvertently deepen the digital divide, future teachers are not even aware of it or know how to counteract it.

What happens in those rare but significant cases when learning-savvy *and* technology-savvy people gain influence over the teacher education curriculum? In a number of cases, such folks prepare their students to integrate technology into an approach to learning that reflects current best practices (Bransford, Brown, & Cocking, 1999), but that then raises two embarrassing questions: What will these new graduates do when they find that the kind of technology they need to put into practice what they have learned is not available in their classrooms? And what will they do when they discover that their school system, their superintendent, their curriculum, and their principals are riding a resurgent wave of back to basics that leaves little room for the kinds of practices that new learning discoveries are validating?

What Does the In-Service Staff Development Technology Program in Berkeley Look Like?

Berkeley, California, is known for many things—and relatively few of them could be called "mainstream." But the TLTC is first and foremost a mainstream effort: The focus is entirely on learning in mainstream regular education classrooms; reading, writing, and arithmetic are at the core of the subjects emphasized; and the overwhelming majority of the teachers in our in-service staff development programs are people who are veterans of the classroom but bare beginners with respect to technology. What Berkeley is learning with respect to what works in its in-service staff

development activities is thus quite relevant to the core challenge facing most American school systems: Once we have developed a small cadre of sophisticated computer-using educators, how do we deal with the less technology-sophisticated teachers?

The project is one of the very few National Challenge programs to focus so totally on technology integration in regular classrooms and to focus so heavily on the early years when children learn (or fail to learn) basic skills. And, to our surprise, what we have ended up doing in staff development is light years away from what we proposed to do when we wrote our original grant proposal. The program now emphasizes activities that we did not even have a name for three years ago: Prep Shops (on-site consultations and collaborative lesson planning and lesson implementation in classroom technology integration); Grade Level Workshops (all-day collaborative hands-on activities with colleagues from other buildings who teach the same curriculum in the same grade); Quickshops (15- to 25-minute on-site after-school minilessons in a clearly demarcated "miniarea" of technology); and Resident Expert Workshops (in which a classroom teacher from each school building becomes its "expert" in the ways to integrate a particularly flexible and valuable piece of software into a variety of subjects at a variety of grade levels).

The TLTC project has not abandoned some of its earlier staff development components (after-school, hands-on workshops; a 2-week summer institute; a 2-day annual conference on implementing classroom technology integration; etc.), but they have become part of a smorgasbord of in-service offerings in which the newer components represent most of the main courses. This pragmatic approach takes the entry points of real teachers as its starting points and weaves a staff development program around the interventions that they vote for with their feet.

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The Technology Revolution in the Classroom

■ Diane Reed and Linda Roberts

Recent advances in bandwidth and the power of computers are transforming learning. "Today's students will live longer, use more information, interact with more people of other cultures, and witness rapid increases in change at unprecedented levels—all because of technology. Students must now use technology effectively to access, organize, analyze, and evaluate information and to communicate with others in meaningful ways using information of all kinds that is provided through multiple sources" (Fulton, 1999, p. 33). Students will construct knowledge in response to problems and information at hand.

Technology makes it possible to present content in ways previously unavailable or undreamed of and to create learning environments where students can learn by doing, receive immediate responses, refine their understanding, and use tools to enhance learning. "Programs once available only to 'gifted students,' for instance, would be available to all depending on their proven ability to reach a higher level of competency" (Fulton, 1999, p. 15). The use of simulation software can enable children to learn

difficult concepts. James Kaput's work teaching calculus to middle school children illustrates this point. SimCalc MathWorlds provides animated worlds in which actors move according to graphs (Kaput, 1999). Using games to engage them, students are taught the central ideas in calculus.

Technology can enhance inquiry-based learning, and students can become active and independent learners with access to more information than ever before. The Internet brings an unprecedented number of primary sources and ongoing research to the classroom.

Sites such as the Virginia Center for Digital History (http://www.vcdh.virginia.edu/projects.html) enable students to examine newspapers, letters, diaries, and maps of the period. The Valley of the Shadow project, a story of two cities during the Civil War, allows students to explore the lives of the families of Civil War soldiers and reconstruct true life stories. Technology has the capability of bringing the world into the classroom and is dramatically changing the way we teach history.

Students can also become involved directly in scientific data collection. For example, GLOBE (Global Learning and Observation to Benefit the Environment) involves students from more than 80 countries who collect and share scientific data with scientists from all over the world. Rarely have students been able to interact with scientists, artists, and businesspeople because their coming to classrooms was not possible. Literally dozens of projects are available to engage students and experts in critical thinking, explore topics in depth, and increase the authenticity of learning, not just for gifted and talented students but for all students.

Students and teachers have used telecommunications tools to collaborate with colleagues or do research using resources located elsewhere. The technology now allows large-group discussions such as Web conferences or videoconferencing. Two or more classrooms in different parts of the country or the world can collaborate on a common topic. These global classrooms allow innovative cross-curricular projects. Experts in various fields can make "electronic appearances." NASA's Ask-the-Scientist videoconferences (http://space.rice.edu/hmns/dlt/videosched.html#next) allow students to communicate directly with scientists on different topics. "Cyber Mentors" can connect experts from universities, business, and government with students.

ESTRELLA (http://www.estrella.org), a U. S. Department of Education project aimed at children of migrant workers, puts laptop computer tech-

nology and telecommunications directly into the hands of migrant students. University students provide encouragement and act as role models. They share information about the transition to postsecondary education, while the technology enhances the younger students' communication, social, and collaborative skills as they interact with others through E-mail. Consequently, these students stay connected through high school and graduate, seeing themselves with a whole new set of possibilities.

Sharing information on a global scale has other benefits as well. In the process, students are critics of shared information as well as creators of resources that are valuable to other learners. KIDPROJ, a part of KIDLINK, has students building databases and organizing information through a set of activities among teachers and world group leaders. These projects for children ages 5 to 15, such as International Engineering and Robotics Apprenticeship, Services allow students to design a bridge, roller coaster, glider, aerodynamic kite, or racing car (http://www.kidlink.org/KIDPROJ/).

Funding and geography may limit productive curriculum-based field trips for many schools, but "tele-field trips" can replace traditional ones and open doors to locations that even the most affluent schools could not obtain. These Web trips provide rich cross-discipline, virtual experiences for students.

Although learning from a distance is not a new phenomenon, no one could have predicted the proliferation of Web-based, on-line K-12, postsecondary, and college courses, much less advanced degree programs. Internet-based delivery allows students to learn at their own pace and access resources at a time that is convenient for them, and provides education to remote and busy adults who would not be able to travel to a classroom. More important, we are seeing the development of new ways to support individual learning styles. The important changes include a shift away from classroom lectures to more self-directed and collaborative student learning.

Advances in technology are also making it possible to develop new tools for assessment that can change how we monitor students' progress. Researchers at SRI International envision "systems . . . to permit documentation of student accomplishments over time, in a Lifelong Learning Portfolio" (Fulton, 1999, p.12). New software will allow immediate feedback to students as they work through problems. For example, geometry tutors can follow a student's progress in completing a proof and help when the student falters (Anderson, Boyle, & Reiser, 1985).

The impact of technology on learning has the potential to revolutionize the classroom in many ways. Students are learning new skills that would not have not been possible without the technology. It is increasingly important that we prepare tomorrow's teachers to use the technology in their classrooms. But far too many teachers are only at the beginning stage. Although 75% of teachers report using the Internet (Becker, 1999, p. 4), only 20% of teachers think they are well prepared to integrate educational technology in the subject they teach (National Center for Education Statistics, 1999). We can expect more teacher-friendly resources, more compelling Internet-based materials, and more computers and on-line connections in classrooms, enabling more teachers to improve their teaching (or change their teaching) to challenge their students and help them reach 21st century standards and the full range of their abilities. Until teacher preparation programs change, however, we will be only halfway there.

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The Impact of Technology on How We Learn: Implications for Teacher Education

■ Elizabeth Moore Rhodes

Technology has dramatically changed traditional views of how one learns, which has major implications for teacher education in America's institutions of higher education. Those responsible for preparing teachers for our nation's children must recognize that paradigm shifts have occurred in learning, views of the learner, and learning theory since the emergence of the Information Age. The ubiquitous nature of computing, the changing economy of our nation, the growing interest in the privatization of education, and the shift toward distributed learning environments call for a serious consideration of the Information Age's impact on universities in general and the teacher education units within them.

This position paper was written on the brink of the new millennium, a time when the old computer culture of calculation has transformed into a culture of simulation. E-mail, e-commerce, and e-travel are becoming common words in our communities. Education reform movements will take place in a culture of anytime, anyplace learning that can occur with sophisticated networks, telecommunications, and digital multimedia and can be delivered over the World Wide Web.

Learning Theory

Social learning theory, and particularly situated learning, provides a new and excellent framework in which to discuss how technology has influenced learning. "[Emphasizing] the whole person, and . . . viewing agent, activity, and world as mutually constitutive give us the opportunity to escape from the tyranny of the assumption that learning is the reception of factual information. ... Learning is a process of participation in communities of practice, participation that is at first legitimately peripheral but that increases gradually in engagement and complexity." (Lave & Wegner, 1991, p. 1). Wenger (1998) says that "learning cannot be designed—it can only be designed *for*—that is, facilitated or frustrated. Ultimately, learning belongs in the realm of experience and practice. It follows the negotiation of meaning; it moves on its own terms. Learning happens, design or no design" (p. 229).

Colleges of education that adopt this conceptual framework as their modus operandi would probably find little purpose in methods courses taught in university settings. These courses, taught out of context, characterize much of the current professional coursework in teacher preparation programs. Designing for learning in colleges of education may very well mean putting and directing all talents and resources in the design of social infrastructures that foster learning. This may translate into communities of practice within cohorts of preservice teachers, teacher education faculty revamping all coursework peripheral to K-12 schools, and the university itself engaging in learning communities. At an extreme, it could also mean envisioning schools of the future that look and feel nothing like what we have come to call school. "Teacher educators must consider an organizational design, or school, from the perspective of an architecture of learning based on engagement, imagination, and alignment" (Wenger, 1998, p. 242). If not, teacher training institutions will fall behind in the Information Age.

Learning theory, as does all theory, must have valid applications in practice. A further examination of paradigm shifts that have occurred under this new framework for learning, and a new view of the learner, will help to substantiate the validity of the theory that describes learning as communities of practice.

Paradigm Shifts in Learning

Mears (1994) asserts that the paradigm shift in the education reform movement from traditional views of teaching and learning to new concepts is more compatible with the early visions of technology's promise. In other words, the influence of computers in the classroom enables a shift from didactic to interactive learning, from teacher centered to learner centered, from fact teller to collaborator, from memorization to inquiry and invention, from quantity of memorized facts to quality of understanding. "Technology can stimulate and facilitate the introduction of project-based activities, student and teacher collaboration, and cross-disciplinary work" (p. 172).

Tapscott (1998) adds the following views to the shift in learning paradigms resulting from the growth of the Internet. He describes a shift from linear to hypermedia learning, from instruction to construction and discovery, from absorbing material to learning to navigate and learning how

to learn, from school to lifelong learning, from one size fits all to customized, self-directed learning. Turkle (1997) extends further the influence of the Internet:

> We come to see ourselves differently as we catch sight of our images in the mirror of the machine. A decade ago, when I first called the computer a second self, these identity changing-transforming relationships were almost always one-on-one, a person alone with a machine. This is no longer the case. A rapidly expanding system of networks links millions of people in new spaces that are changing the way we think, the nature of our sexuality, the form of our communities, our very identities. (p. 9)

The views of these three authors demonstrate how the influence of technology at various stages of advancement has impacted our views of schooling, learning, communicating, and even our own identities. Many projects can document the effective uses of computers in classrooms, beginning in the early 1980s with the Apple Classrooms of Tomorrow to the sophisticated computer networks of today's Virtual High School. These progressive notions of learning have brought us to a definition of learning that at its basic level could be termed *interactive learning.* It is interactive learning that is most in keeping with communities of practice and social learning theory. Interactive learning could be described as access to the Internet enabling dynamic, less static learning where direct exposure to experts in the field is possible, where multimedia sources facilitate various learning styles, and where the learning model of transmission is replaced by a distributed learning model. The distributed learning model is the model of the Internet and the World Wide Web.

View of the Learner

There is much in current educational literature describing the students of the future as diverse learners. The definition of diversity must include growing numbers of students who have used computers as learning instruments, much like the baby boomers of a generation ago learned from television. Today, teachers who facilitate learning communities are forced in many classrooms to be the "mature" apprentices to the naturalized masters of information technologies—that is, the students. Tapscott

reports that children (the Net Generation, as he refers to them) are using digital media for entertainment, learning, communicating, and shopping. It is the Net Geners in our schools today who are by and large the computer experts. Educational technologies can only be further enhanced with software designs that shift more of the control of the technology—and responsibility for learning—back to the student. The "stand-alone" student is a new view of a learner, one who can self-direct and use his or her interest to guide him or her to appropriate communities of practice.

Implications for Teacher Education

A report commissioned by the Milken Exchange on Education Technology (1999), questioning whether new teachers will be ready to teach in a digital age, reveals that "in general, teacher-training programs do not provide future teachers with the kinds of experiences necessary to prepare them to use technology effectively in their classrooms." Moreover, "today's students live in a global, knowledge-based age, and they deserve teachers whose practice embraces the best that technology can bring to learning" (p. i). Not many teacher education faculty would disagree with that statement. Alternatively, probably not too many teacher education faculty share Todd Oppenheimer's (1997) opinion of "the computer delusion" and think of computers in the classroom as a "dubious nostrum." Leaders in education must articulate a vision that the majority of teacher education faculty can embrace as the true impact that technology has on learning. For teacher education institutions to survive in the present climate of privatization of once sacred public educational institutions, teacher education faculty are charged to reconsider a theoretical and practical framework that is in keeping with the new learner.

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Perceptions of Technology and Learning

■ Charol Shakeshaft, Ph.D.

The Role of Perceptions in Thinking About Technology

If the topic of perceptions is taken seriously, then we should begin with our previous beliefs, opinions, and attitudes that color what we see and what we think we understand. The use of technology in our own lives has often been disconnected when we think about learning.

- *Telecommunications and work.* Most of us are beginning to acknowledge how profoundly telecommunications has pushed work into previously private space and time. Cell phones in cars, fax machines at home, beepers in purses, e-mail everywhere. Increased accessibility has expanded time on task and moved work into our family/personal/reflective time. Work has come to our homes, our cars, our leisure locations. Might learning come to the home?
- *Video games.* When we see children play video games, about all we perceive is on-screen violence and adolescent twitch speed. We miss the player's hypothesis testing and the deeper learning that goes on when the monster changes attack patterns because the computer has adjusted for the child-player's previous response.
- *Watching TV.* Recent British research indicates that 15-year-olds are better able to recall character, content, and story line when they watch *multiple* TV shows simultaneously than when they watch a single show. Why should multitasking be limited to computers, particularly when a lifetime of telecommunications interaction may have created new capa-

bilities? If children are better able than previous generations of children to multitask and if they are able to retain more in a multitask situation, what does it say about our traditional face-to-face "turn to page 19" teaching strategies?

- *People versus machines as caregivers.* A dissertation for Teachers College, Columbia University, documents that at-risk early adolescent girls disclosed their personal problems more completely and sooner with a CD-ROM program made to mimic the early-stage data collection of a therapeutic encounter than they did with live guidance counselors. Our research indicates that e-mail connections between students and teachers have increased intimacy and caring rather than isolating people from each other, as many have contended.
- *E-mail and anger.* Marshall McLuhan was an early thinker about the impact of technology on people. The irony is that he is no longer read, although the world he wrote about is now largely reality. McLuhan theorized that the media as a form of communication was "cool," especially compared with face-to-face interaction. We demonstrate the validity of the insight every time we use e-mail to send messages that we would find unacceptable face to face.
- *A new style of learning.* Robert Kittman, now the president of AOL, ignited a firestorm of editorial criticism when he suggested that "video kids" might actually have different learning patterns and new capabilities. But is that true? The fact is we have more preconceptions than good science.

I do not believe I would win a vote endorsing the positive effects of video games or television or the sometimes superiority of machines over people as caregivers. But why not? If technology is the extension of human capability, why do we resist entertaining the possibility that it might, in fact, do that even in schools? After IBM's Deep Blue, international chess grand masters no longer dismiss the capability of machines.

The impact of technology on how students learn is largely speculative. We do not have as many studies that focus on outcomes, achievement, or efficiency in relation to technology as we might like. Much of the data we rely on are anecdotal. Much is wishful thinking about what might happen if we used technology in creative and supportive ways. Much of the research avoids hard questions because we fear to offend hardworking school people.

The reality of technology use in most schools is somewhat less glamorous. We spend precious learning hours teaching students word processing programs, office management programs, HyperStudio, and PowerPoint. While these tools might lead to more interesting presentations by students, we have little evidence that spending time on these programs increases achievement, learning, or interest in school.

How People Learn

Diminishing Race, Gender, and Ethnic Discrimination

Setting aside the important access issues of the digital divide, it is undeniable that computers are indifferent to the color, gender, religion, family background, or even deportment of the children in front of the monitor. This gain is huge but one not yet fully harnessed to public purpose. Our studies of the relationship between computer use and achievement indicate that girls are highly likely to report that if they have the option of learning from a computer or learning from a teacher, they would choose the computer. Why? They get quicker and more consistent feedback, more attention, and more respect.

Individualization

It has never been logistically possible for one teacher to individualize instruction to 20 students. Nor is it possible to individualize learning as long as student:computer ratios are other than 1:1. One barrier is money. Low-cost Internet appliances hooked to enterprise-wide networks deal with that. Nevertheless, learning materials that respond to students' skills and their individual growth in those skills are much more likely to move more children forward than is whole-class instruction. Programs that respond to different learning styles are more likely to be successful. Both approaches free time for teachers' direct interaction with students.

The Four Any's

Learning technology makes it possible for any learner to acquire any fact any time (24/7) and any place. The transforming consequences of that possibility are only dimly perceived, especially by the employees of the brick and mortar teaching citadels. Learning means going to the learner. For some that is a compelling opportunity, for many a threat.

The Role of Play

Early childhood educators and coaches but few other school people honor the maxim that "play is a child's work." Technology can connect work and play for children.

How Teachers Teach

Changing the Locus of Control

It is common to observe that instructional technology "forces" teachers from a role as dispenser of knowledge to one as coach of learning. For example, the more Internet computers in a classroom, the smaller the fraction of what is learned that can be controlled by "the teacher"—the salaried professional. The surmise is worthwhile but it is equally important to understand that no one "forces" anything in schooling. Teachers are and are likely to remain the ultimate (institutional) arbiters of which children learn what with what effect. This reconfiguration of learning authority (not "teaching authority") is sometimes expressed as the instructivist to constructivist shift.

Assessing Learning

A recent story on NPR reported a school district that has instituted *hourly* grades assigned to every student in subject matter mastery, attentiveness, and behavior. At the end of each day, teachers compile an hourly log for each child for those three dimensions and read the report onto the school's voice mail system. Parents access the daily report by phone with a password. Teachers' initial resistance has changed to an appreciation of how the information enables parents to be learning partners. And it also solves the dinner-time dilemma of asking the fruitless question, "How was school today?"

Remarkably, the data are collected by paper and pencil and communicated by telephone. Networked learning would make the data capture unobtrusive and costless and make the reporting easy. The technology exists for much finer grained analyses of learning needs than we have the political will or economic resources to support.

Although our first reaction to this strategy might be overkill shock, few school districts offer teachers consistent and frequent opportunities to assess their work by understanding how students are doing. Technology allows for frequent and reliable assessment without much or any data collection on teachers' part—freeing the teacher to use the assessment results to shape the curriculum or learning opportunities to students' needs.

Adding Homes to Schools, Adding Parents to Teachers

If e-commerce brings goods to the home, e-learning will bring education to the home. Telecommunications is a natural for this exchange.

What People Learn

The Shifts From Fact Learning to Search Learning to Learning to Value

Schooling has always been based on facts, a premise made obsolete if not harmful by the doubling rates of knowledge. The stock of knowledge and the half-life of empirically supported knowledge have forced a partial shift from facts to search. But even that change is unlikely to last as the world-wide store of knowledge shifts the task of finding facts to search engines.

The charge for the future is twofold: learning to learn and knowing what to value. Both are staples of the always embattled vision of "liberal education." But they remain important although poorly done—and perhaps accessible to learning technologies.

Technology and Official Curricula/State Standards

A bureaucratic part of the "what children learn" question has to do with state standards. As states press to increase their lawful presence in guaranteeing that particular facts, skills, and attitudes are learned, the regularizing role of instructional technology can be enlisted.

Teaching, Learning, and Technology

■ Thomas J. Switzer

Technology has the capacity to change how we think about teaching and learning. At no time in our history have we had such potential to think in fundamentally different ways about the nature of schooling and its relationship to how learning best occurs. Although this great potential exists, progress has been slow in changing American schools and universities. Critics of the advent of information technology continue to see technology as part of the

problem and not as the solution to problems that have plagued schools for decades. Newspapers from the *New York Times* (Mendels, 1999) to the *Waterloo/Cedar Falls Courier* (Stanton, 1999) continue to stress to the public that information technology has its limits and poses a threat to the good old days of schooling. Critics frequently paint an extreme scenario of the specter of technology eventually replacing all personal contact in education.

There is no doubt that we have not reached the potential that information technology provides for rethinking schooling and learning. Part of the problem, it seems, is that we continue to apply technological solutions to a paradigm of schooling and teaching stressing the delivery of instruction. Barr and Tagg (1995) pointed out several years ago that our schools and universities are conceptualized and then structured around a paradigm for the delivery of instruction. Learning occurs within an instruction-driven model, but the system itself is not driven by the desire to promote learning. It is driven literally by a desire to provide instruction.

A system built around a learning paradigm is not, of course, contingent on the application of information technology for its success. It is clear, however, that crafting a system from the standpoint of promoting student learning would use technology in quite different ways from one crafted to deliver instruction. Developing a teacher-dominated lecture with the aid of a PowerPoint presentation represents no basic change in the nature of instruction. The lecture may be assisted by the use of visuals and may aid the visual learner, but basically the instructional paradigm remains the same. Providing students with a database and allowing them to ask questions and find answers before a teacher or text suggests them, however, is a quite different paradigm focused on students' learning. The learning paradigm is much more compatible with the inherent assets that information technology brings to the education environment. And until we move our educational structures to a learning paradigm, we will continue to minimize the impact that information technology can have on promoting students' learning.

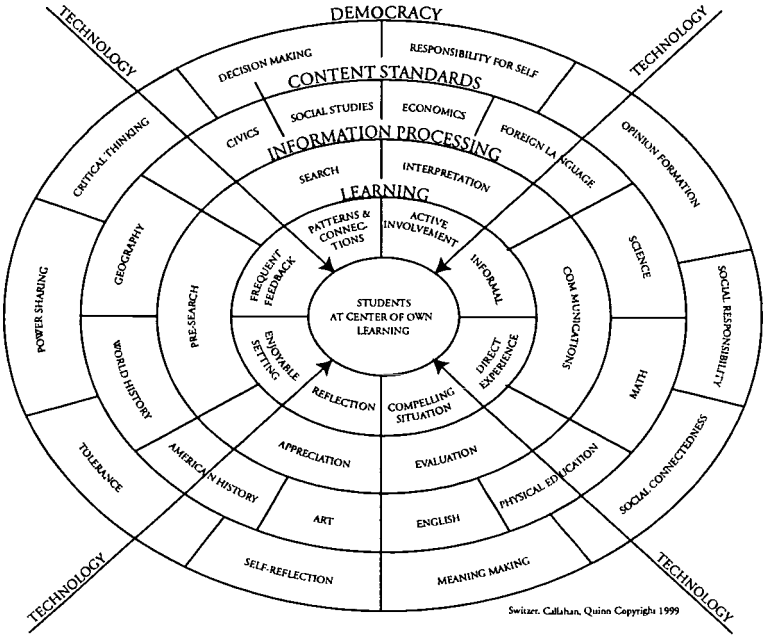
Another limitation of the use of technology to support learning is that models have not been developed to support the full integration of technology into the curriculum. Without such models, teachers become confused and the implementation of technology becomes sporadic or project based at best. A headline in the *New York Times* says, "Though School Computers Gain, Teachers Can Remain Befuddled" (Steinberg, 1999). The article reports that, although computer access in elementary and sec-

ondary classrooms is expanding rapidly, many teachers remain confused about how to incorporate them in their instruction. For example, at a recent meeting in Washington, D.C., where teachers were illustrating how they had achieved full integration of technology into their classrooms, two teachers from a western state discussed how they had students use the Internet to find information on a unit they were doing on China. Although having students draw information from the Internet for such a purpose is likely a good thing to do, it is a far cry from full integration of technology into the curriculum. It was apparent that these good teachers had no model for how they would integrate technology throughout their curriculum and thus were losing much of the power that technology can bring to learning.

A model currently being developed at the University of Northern Iowa may help teachers think more holistically about the use of technology throughout the curriculum (see Figure 1). The model includes five major dimensions: (a) students at the center of their own learning; (b) principles of good learning; (c) aspects of information processing; (d) standards from the content disciplines; and (e) tenets of effective citizenship in a democratic society (Switzer, Callahan, & Quinn, 1999).

The model sees students as becoming independent learners capable of directing their own learning. It sees learning opportunities crafted around the best principles of what we know about how to promote learning. It sees students developing the skills and dispositions of information processing. It conceives of students as learning solid content as defined by the disciplines. Finally, it sees students learning and practicing the tenets of democracy necessary for leading productive and contributing lives in a democratic society.

What is the role of technology in this model? Technology is seen as the essential vehicle for implementing the model. The multiple perspectives on a particular learning activity can occur only in the context of modern information technology. The various combinations and access to resources necessary for student inquiry can be achieved only by the use of contemporary technology. Using this model, teachers can craft an integrated curriculum and use to the fullest extent the value of information technology in facilitating delivery of that curriculum. Thanks to a sizable grant from the U. S. Department of Education, we will now develop this model and test it with teachers in real classrooms. Our premise is that, when properly used, technology can contribute to creating the conditions that optimize learning.



Much is yet to be learned about the use of technology to promote students' learning. The outlook for the future is, however, very encouraging. Professional associations across the country are seriously considering how best to promote learning. Access to technologies in schools and universities is increasing rapidly. Technology continues to decrease in price while becoming more powerful. Federal and state governments are committing huge sums of money to expand the use of technology in schools and in teacher education. Scholars are involved in the development of models to facilitate the integration of technology in the curriculum. Although it will be difficult to turn institutional structures from a focus on delivery of instruction to a focus on learning, at least the conversations have begun. Some institutions have even made tiny steps in the right direction. The trend must continue.

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Recommendations for Action

1. A major advertisement campaign is needed to change the thinking of publics (individuals, organizations, and institutions) as to what constitutes learning.

2. An advocacy campaign is needed to influence state and federal policymakers to broaden their view of learning, what should be assessed, and how it should be assessed.

3. Dialogue is needed among the key stakeholders, including but not limited to: key college and university leaders, faculty, and students; K-12 education state, district, building, and classroom leaders; teachers and students; parents; and political leaders.

4. Resources must be reallocated and individual reward structures created to encourage individual action at all levels.

5. Existing models that illustrate the integration of technology that supports learning and a learning environment must be identified and analyzed, and new models must be researched and promoted.

6. Technology must be used to capture and communicate the existing models and to demonstrate the potential of future models.

7. On-going professional development must be recognized as a shared responsibility between higher education and the teaching profession.

8. Funding is needed to promote the articulation of the shared responsibility for learning and development between K-12 and higher education.

Issue Area Three

The Impact of Commercialization on the Education of Teachers and Children

From advertisements on billboards in the school stadium to banner ads on Web sites viewed in class, commercialization in education is growing. As schools struggle with tight budgets and a lack of resources, educators and administrators are looking for ways to fund innovative programs and curriculum delivery systems. For-profit organizations are offering alternatives to traditional school-, college- or department of education-based teacher preparation. The papers in this section look at trends in the commercialization of education.

Schoolhouse Commercialism: The Billboarding of American Education

■ Jane Nissen Laidley

In 1989, Chris Whittle introduced Channel One to public schools across America, reigniting the debate surrounding the role of commercial interests in education and sparking a storm of controversy. Whittle promised free TV monitors in exchange for a commitment from schools to broadcast his daily 12-minute news program, including two minutes of commercials advertising a variety of products targeted at Channel One's young audience.

Although higher education has always maintained close ties to commercial entities (principally in terms of research funding), Whittle's venture launched a new era of commercial involvement in K-12 education. In the face of fierce criticism (see, e.g., Kuttner, 1996), school districts across the country have signed agreements with commercial entities providing everything from money to technology hardware to computer training. This paper assesses the implications of commercial involvement in K-12 education: its viability as a solution to school funding problems and its effects on the education enterprise.

Public concern about the commercialization of education is by no means a recent phenomenon. As early as 1929, the National Education Association created the Committee on Propaganda in the Schools in response to growing concerns about the influx of private funding—and the strings to which it was attached—to the public schools. Recently, however, the trend seems to be on the rise:

- One hundred fifty school districts across the country have brokered deals with soft drink companies such as Coca-Cola and Pepsi to help meet their budgetary requirements—up from 46 in 1988.
- In 1998-99, an estimated 100 public schools were being run by for-profit firms.
- Merrill Lynch predicted private companies could be running 10% of all public schools within 10 years and noted, "The education industry represents, in our opinion, the final frontier in private participation in public programs."

In fact, says Alex Molnar, professor of education at the University of Wisconsin-Milwaukee and author of *Giving Kids the Business: The Commercialization of America's Schools,* "Commercial activities now shape the structure of the school day, influence the content of the curriculum, and may determine whether or not a child will have access to a variety of advanced learning technologies" (Center for the Analysis of Commercialism in Education, 1999).

Excluding the emergence of for-profit education ventures such as the Edison Project, commercial involvement in K-12 public education falls into two categories: commercially sponsored educational materials, and exclusive agreements and incentive programs. The following paragraphs examine some of the pitfalls associated with each one.

Commercially Sponsored Educational Materials: A Faustian Bargain?

A corporation's offer of free educational materials to a school strapped for cash can be very seductive. Too often, however, the strings and conditions attached to such offers render them Faustian bargains at best. For example:

- In return for Channel One's offer of free television monitors, schools must guarantee that 90% of their students will watch the 12-minute news program 90% of school days. That translates to a total of 36 hours—or about six school days—of TV watching per student per year, including 6 hours of commercials per year.
- Zap Me! another commercial sponsor of educational materials, profits from the push to connect schools to the Internet. Founded in 1998, Zap Me! provides participating schools with a completely equipped computer lab, a range of educational software, and access to the Zap Me! Netspace, a proprietary subset of some 10,000 selected Websites—all free of charge. In return, participating schools must guarantee that each computer in the lab will be in use at least four hours per day and must provide access to the lab after school to Zap Me! and its corporate partner, Sylvan Learning Systems. Zap Me! funds its program by selling advertising space on Netspace, its Web portal, collecting and selling aggregated student data (including family income figures), and organizing promotions targeting students.

Exclusive Agreements and Incentive Programs: The Caffeinating of America's School Children

The largest category of commercializing activity in schools involves exclusive agreements and incentive programs with corporate vendors such as Coca-Cola and Pepsi. Typically such agreements involve promises of cash in return for a school district's commitment to offer only that company's products for sale on its premises. Too often the deals require schools to blatantly promote the product to reap the full financial benefit of the agreement. For example, one school administrator sent a memo to district principals reminding them that students needed to consume 70,000 cases of Coke products for the district to receive the full financial benefit of its exclusive sales agreement with the company (Center for the Analysis of Commercialism in Education, 1999).

Districts using corporate-sponsored educational materials defend their actions by claiming that teachers are capable of evaluating materials for commercial bias and using them in appropriate ways. Some may even use such materials as opportunities to teach media literacy. And regardless of corporate bias, many teachers prefer the sponsored materials to what the district is able to offer. Said one middle school teacher, "If it's free (and good), it's for me. Great, glossy, up-to-date, motivating materials . . . are a heck of a lot better than the 1966 textbooks that many teachers are refurbishing to pass out each September" (Herzog, 1999).

Taming the Tiger

In an era when the education enterprise has become increasingly competitive, families decide where to live on the basis of local schools, and teachers are increasingly accountable for students' achievement, it is to be expected that educators should turn to the commercial marketplace to help them survive in the education marketplace. There's nothing wrong with that—corporations *should* be involved in education. It is, after all, from the ranks of today's students that they will draw tomorrow's employees, managers, and executives. And the fact is that corporate dollars can bridge the gap between schools' educational goals and what public funding enables them to achieve.

But such dollars must be free of incentive-laden conditions. Corporations must be compelled to have their brand identified with equal educational opportunity and public service, and not with profit.

Schools have the corporate tiger by the tail, and they cannot afford to let go. How, then, do they tame it?

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Public and Private Collaboration in Teacher Education: Hedging the Risk in the Age of Technology

■ Jiang (JoAnn) Lan

Beyond the rare air of a community of scholars living a life of the mind while discovering knowledge and sharing it with students, the university in the western world has been assigned by society the role of gatekeeper to the professions and the more general function of screening for fitness those whom society will accept as "educated" men and women. Competence without credentials is a fact and a problem, perhaps first recognized by the federal government with the advent of the agricultural extension divisions of the A&M colleges established by the Agricultural Extension Act of 1914. It was a massive attempt to bring science to farmers. Industrial and trade schools followed. Later, educators saw television as a means of educating students beyond the uni-

versity's walls. The British Open University provided degrees at a distance. Stanford's Instructional Television Network was perhaps one of the most significant efforts (Barley, 1999).

The last decade of the 20th century saw unparalleled development in technology and with it a surge toward the commercialization of education. Digital technology has greatly accelerated the means for delivering education beyond the traditional campus, an interest long existing outside the traditional academic community. The emergence of the Internet and the World Wide Web has created a way of transcending many of the limitations in the earlier forms of distance learning. Text, data, images, audio, and video can be delivered on-line; synchronized and asynchronized communications can overcome the temporal and spatial constraints of human exchange. Because computers are so prevalent in U. S. workplaces and homes, learners can access learning materials and each other with convenience and flexibility.

Institutions of higher education are expanding their market. In 1995, the Western Governors' University was established with the purpose of delivering higher education to students across state and campus boundaries. Measured in number of students, the University of Phoenix has become the second largest private university in the U. S., with an enrollment exceeding 31,000 (Green, 1997). Players that offer degrees via the Internet include new names, including the Mind-Extension University (www.meu.edu), CSIU Academy in north central Pennsylvania (www.csiuacademy.org), and household names such as Stanford University.

Corporations and government agencies are also marching into education. Faced with the increasing need for continuous job training to maintain a competitive advantage, corporations such as Motorola and Sun have established their own "universities" for their employees. The U. S. Department of Energy has developed Web-based training for workplace safety (www.orau.gov/tmsd/trade/siginfo/att/ebtrain.htm).

Among the zealots are companies with specific technical expertise. Lotus Institute, for example, not only offers distance learning software (LearningSpace) but also assists in skills assessment, curriculum design, and certification. Agency for Instructional Technology (AIT), developer of the Learning Odyssey, which offers a complete curriculum for grades 4-9, describes the Learning Odyssey as the replacement for schools. AIT asserts that learning need not to be school based and that schools must "reinvent

themselves as institutions with a far greater purpose, or cease to exist" (Sullivan, 1998). With colleges racing to offer on-line education, companies specializing in on-line learning such as Blackboard, Convene, Embanet, and Real Education are moving vigorously to prepare themselves for the new market by hiring top executives and more sales staff and offering free Websites for on-line courses and to improve customer support.

The challenge and the promise of the Internet raise many new questions. The most vexing for the university is how and where to adjust traditional practice to resist or assist the commercialization of education in the age of technology. Although some decisions to pursue on-line education arise legitimately from the institution's missions or students' needs, others have ambiguous purposes such as keeping up with the Joneses or bowing to pressure from commercial companies or governing boards. For example, Connecticut State University signed a 3-year contract with Real Education after its trustees had expressed a wish for the system to use technology to make education more widely available throughout the state (Blumenstyk, 1999).

The commercialization of higher education in the age of digital technology has raised concerns in the academic community. Representing the critics is Canadian professor David Noble, who sees the commercialization of higher education as the systematic conversion of intellectual activity into intellectual capital and, hence, intellectual property (Noble, 1998a). Noble describes two phases of this transformation. The first, which began in the mid-1970s in the wake of the oil crisis and intensifying international competition (and is still under way), has transformed the research function of the university, largely in scientific and engineering knowledge, into commercially viable proprietary products that can be owned, bought, and sold in the market. The second, which we are witnessing now, entails the commercialization of the education function of the university, transforming courses into courseware and the activity of instruction itself into commercially viable proprietary products that can be owned, bought, and sold in the market.

In Noble's view, tension is mounting between faculty and university administrators over the administrative impulse toward high-tech commercialization (Noble, 1998b). Corporations seek indirect public subsidies for product development; academic research, formerly pursued as an end in itself or as a contribution to human knowledge, is now intended

for commercial ends; faculty employment is turning into money making for universities; universities are going into businesses as producers and distributors of commercial instructional products. Issues are raised about controlling copyrights for course materials, the faculty role, autonomy and integrity, future employment, and the quality of education (Shneiderman, Herman, Agre, & Denning, 1998).

Although it is necessary to be cautious about new possibilities digital technology brings into education, an entrepreneurial attitude about education can be helpful to draw the best among institutions. Technology works, but nothing works for every purpose, every learner, and all the time. Commercialization of higher education, including teacher education, works for some populations in some topics and under some conditions, but that statement is true of most pedagogy (Mann, 1999). The pragmatic question is What is the optimal pedagogical, political, and economic reality for the commercialization of teacher education? And how do we hedge the risks?

- *Pedagogy.* One inevitable concern is for the quality of teacher education. Few dispute that the best teacher has always been a person, not a machine. A leading psychologist has called for slowing the rush toward computing. Other critics of technology have argued that well implemented simulations and conceptually driven programs may improve learning—if a good teacher is in charge (Healy, 1998).

  What is known about the learning efficacy of such general features of American education? The 770-square-foot classroom box? The 180-day school year? We accept and even urge a critical review of instructional technology that is seldom applied to the implacable regularities of traditional American schooling. "That leads to a paradox in which technology from the last generation has been proven inadequate and that from the next generation is unproven. With either negative data or none, the field is left to those who promptly make the next generation of technology the worst enemy of the current generation as in, 'next year it will be cheaper, faster, smaller or even more constructivist. So let's wait'" (Mann, 1999).

  As educators we understand there are multiple sources of learning: parents, teachers, peers, friends (and even enemies), textbooks, successes, mistakes, life experiences, TV programs, and computers. Learning outside the school is widely acknowledged. Research has found that

30% of children's educational achievement comes from their experience in school and 70% from other experiences, especially families, cultures, media, and peers (Coleman, 1966).

In a collaborative culture, private and public, commercial and academic sectors communicate ideas and work together on real problems, put their collective knowledge into action, and experience a reciprocal relationship between theory and practice. This model of collaboration has given birth to many successful innovations, including the Internet. It has the potential to benefit all sides of the relationship: The academic may also learn from the commercial sector. Again, the question is how to hedge the risks.

- *Politics.* Politics is the process through which values are authoritatively distributed to a society. Whatever its interpretation in the popular culture, politics has deep implications for the choices made by government. Consider a choice among three options. What would advance teacher education more: to increase pay for already employed faculty, to spend the money to hire more faculty, or to spend the same amount of money on technology?

  The political interest in what works in teacher education goes beyond university campuses. National data project that 2 million new K-12 teachers will be needed in U. S. schools over the next decade as a result of increased student enrollments, smaller classes, and accelerating retirements in an aging teacher population. More than one-third of these new teachers will be hired in poorer urban and rural school districts, many in inner city public schools with large minority student populations (Recruiting New Teachers, 1999).
- *Economics.* Private and public decision makers' interest in what works drives investment decisions. Economic decisions can be illuminated by data about learning outcomes. The public benefits from private investment in education. We cannot deny that in a capitalist society the engine of innovation—and sometimes improvement—is the profit motive. Remember that the Internet started in the 1960s as a Defense Agency experiment to connect weapons labs. The exponential development of the Internet came after it became available to private industries. The Food and Drug Administration supervises clinical drug trials of privately developed pharmaceuticals on behalf of the public interest. It is the world's most advanced life-saving industry. It would not be

unreasonable to hope that successful models of private and public partnership can help to revitalize American teacher education as well as to strengthen K-12 teaching.

For many in western culture, the university is seen as a secular church, an arbiter of educational standards, to be sure, but also a monitor of society's standards of integrity and civil morality. In a broader context, public education is the handmaiden of democratic ideals and process. Without a broadly educated public, democratic principles are at risk. Although technology seems to be the last best extender of human potential, it does not possess the human potential to make value judgments about good and evil, right and wrong, unless it is programmed in a given context. Not all teachers do it well, but the best teachers validate humanity.

Technology adds new dimensions to the existing concept of schooling. The creation of the common school required learners to go to the site of learning and study under the knowledge masters. Dependency makes learners vulnerable to the potential political, ethnic, class, and gender prejudices. (On the plus side, it also makes them subject to discipline.) Perhaps commercialization of teacher education could offer beneficial alternatives. Digital learning can be any learning, any time, any place, and for any one (Mann, 1999). The democratizing impacts of that liberation would be heartening, but the outcomes are not clearly perceived or well documented. The consequences for schools and universities, conceived of as physical and intellectual places with societal roles beyond learning, require much more study before we throw out the baby with the bathwater.

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Commercializing Teacher Education on the Internet

■ Robert F. McNergney

I view teacher education from a university perspective. I am not particularly interested in whether commercialization of teacher education using the Internet is a good idea or whether it will happen. An open market could not possibly harm the enterprise—although some safeguards might be wise. Commercialization could provide a welcome breath of fresh air. There have always been efforts to move teacher education out of schools, colleges, and departments of education; there will surely be more that are Internet related, and they will be accompanied by commercial interests wanting to get into the business by earning legitimacy from recognized authorities. I want to know whether people will pay for teacher education delivered in some electronic fashion. If so, who and how much? It is time

to consider some of the less obvious but important obstacles to selling university credits on-line.

Does a Market Exist for Distance Education or Web-Assisted Instruction Offered to Teachers?

To gain a toehold in the higher education market, distance education and Web-assisted instruction must be able to pay for themselves, despite the fact that many existing traditional courses do not have this requirement. Nonetheless, to get policy makers to see electronic courses as viable, such courses must avoid the appearance of being forever dependent on institutional or grant support. This means somebody must be willing to buy them. Although we have had some success in this regard, it is not at all clear that a pent-up desire exists for teacher education delivered electronically.

If there are no budding markets for electronic curricula or courses in teacher education, then it seems that it would be wise to develop them. As older faculty fade from the scene, they will be replaced by younger people who have grown up with the Internet and the Web. They will be more likely to use technology to prepare teachers. And there is always the unforeseen opportunity lurking out there: Universities and companies with interests in teacher education cannot afford to stand still with regard to technological development, or they will miss new opportunities as they arise.

What Obstacles Exist to Commercializing Teacher Education via the Internet?

The following points are not ranked in terms of importance or influence. They all seem to militate against blending technology and teacher education to produce financially viable on-line offerings. They need to be removed or minimized if commercialization is to occur.

- *The belief that electronic curricula and instruction will be cheaper than traditional practice.* Despite protests to the contrary, some college and university administrators continue to believe that electronic offerings will yield a higher rate of return for every dollar invested. When they learn that this is not the case, they will back away from future efforts.
- *The belief that new electronic teacher education offerings should be held to a higher standard than traditional approaches.* People seem to accept implicitly that what happens now is better than what might be done on-line. We do not even know what happens now, as program evalua-

tion is not sensitive enough to provide good estimates of quality. Yet new electronic offerings will be subjected to severe scrutiny.

- *Overselling the power of technology.* With any innovation comes zealots, and the use of technology to educate teachers is no exception. Promising too much and delivering too little is common practice that inhibits overall advancement.
- *Organizations' energy and capacity to offer teacher education on-line.* Using technology to educate teachers is tremendously demanding. Both development and maintenance can sap the energies of people who are successful just as much as they do those who are unsuccessful. We need to figure out how to nurture people who want to innovate.
- *Failure of older faculty to promote electronic offerings.* In fact, they may be more likely to block younger faculty who want to try innovative technology. Curriculum committees largely comprise older, more conservative faculty. They are less likely to be willing to approve, let alone champion, new approaches. This attitude dampens both the willingness to develop coursework and the demand for it. We must also recognize that arts and sciences faculty are an integral part of teacher education. We need to consider their willingness to participate in or at least recognize the importance of Internet and Web approaches to teaching teachers. When it comes to using technology to educate teachers, many appear reluctant if not recalcitrant.
- *States not recognizing credits earned in other states.* Electronic offerings cross boundaries of all kinds. States must recognize credit from other states for teachers to get involved. This is a large obstacle to commercialization.
- *Programs not recognizing credits earned in other programs.* This problem is the same as the previous one, except that it pertains to institutions of higher education and to boards of education that approve lane changes on salary schedules. This one is probably even more difficult to solve, however.
- *The skepticism of accreditation and professional associations.* Although some accreditation agencies (e.g., NCATE) and some associations (e.g., AACTE) are making visible efforts to encourage teachers to acquire technological skills, none that I am aware of actually encourage on-line teaching and learning for teachers.

- *The dilemma of setting reasonable prices.* How should institutions and companies decide what to charge for electronic offerings? Old formulas at universities are based on the idea that three credits are taught in rooms that use lights and heat and that have a professor standing at the front. They also include, at least implicitly, estimates of what students must spend to drive, park, and eat lunch or dinner. New electronic offerings do not include these costs, but they include others—server space, sophisticated software for content development, machine maintenance, asynchronous and synchronous feedback, and the like.
- *Accounting for this labor-intensive work in traditional promotion and tenure cases.* This question assumes, of course, that college and university people will be involved in commercial ventures. Existing guidelines for promotion and tenure may inhibit the involvement of just the faculty who are most likely to be interested. Perhaps institutions of higher education are even less likely to be leaders in the area as a result.
- *The fit of institutional financing structures with new ways of delivering instruction.* It may not make sense to give a school or department of continuing education the lion's share of revenues from electronic offerings when they have so little to do with electronic operations. Central computing facilities may have a greater stake in these ventures. It may not make sense to fill the positions of faculty who retire or move with new people in the same program area. They might be better shifted to new areas. Certainly issues of intellectual property will concern faculty involved in commercializing teacher education via the Internet. Old organizations are using old rules to deal with new approaches to teaching and learning; they constrain the development of new approaches to teaching and marketing.

The Common Good and the Commercialization of Education

■ Rhonda Taylor Richards

Seldom are the words *good* and *commercialization* paired, particularly if those commodities having financial profit as the primary aim are also embedded in the vested rights of individuals in a democracy, such as the right to a free and public education. Yet we are in the throes of an era where ideas have economic value and pure enlightenment is more than a being that moves itself (Illich, 1975). The modern world propels persons who are equipped with certain tools to move beyond thoughts and forward into learning events that are no longer the sole province of public institutions. More important, these tools can be bought and sold, an exchange of goods that presents challenges to public education.

It is not surprising that issues and questions related to the common good emerge as more opportunities for learning are grounded in commercial markets. Can the common good be served by these encroaching entities, or is the common good compromised unfairly through these vendors of learning?

What Is the Common Good in a Technologically Charged Era?

Access to Knowledge (Goodlad & Keating, 1994) states that what is truly good in the long run for each individual citizen comes about when people choose the common weal (an overarching public good) as their first priority in making decisions about the schools and other social issues rather than considering only what will benefit their own group the most. According to Goodlad & Keating, common schooling, or public education, has always served special self-interests, but the time has come when people must realize that their own self-interests must be joined productively with the self-interests of others so that self-interest and the common interest become one. If this merging of shared interests does not occur, people may discover that their present and future are being shaped in their absence.

Shared interests are not static, however. In an era of rapid technological change, an era when public education is being reformed, renewed, and reconceptualized, an era in which commercial education ventures may be

traded as casually as computer chips, an era in which the equal access to knowledge looms larger than equal access to schools, the common weal itself becomes a slippery phenomenon.

Perhaps the answer lies buried deep in the phenomenology of Martin Heidegger, who posits that just as the essence of technology is not the technical, the essence of schooling is not the school. And perhaps schooling, or better yet education, is a slippery phenomenon that transcends walls and institutions. If this is the case, the kind of schooling created for a technologically driven future—that also serves the common good—necessitates unleashing education as a vested right best funneled through public institutions and acknowledging the potential merit in the commercialization of learning.

Commercialization of Education: Creating Partnerships for the Common Good

It is not easy to acknowledge that there might be nontraditional avenues for reaching a goal that are as effective as more traditional routes. It may be particularly true among those who perpetuate the long-rooted traditions and practices of public education. A more modern view, however, may define education as the simple transfer of knowledge from point A to point B through the most efficient, low-cost link possible. The value-added elements in an education of tomorrow may be the degree to which learning is low cost, flexible, user friendly, and "just-in-time."

Given the time-honored bureaucratic structures of public educational systems, commercial providers of education have the edge in responding to the educational needs of tomorrow, becoming masters in the art of transferability while promoting modern technologies as their tools of choice. *Flexible, just-in-time,* and *user friendly* are neon bright words that flash for the next generation in the marketplace, not the public school.

Commercial providers, ever quick to respond, realize that the transfer of information is less important than the transfer of knowledge and have worked diligently to ensure the latter. In a technological era, the intended transfer of knowledge streams through a proliferation of digital content, both in software and in on-line materials. The growth of digital content, just one area of educational profiteering, is prolific. From 1996-1998, annual sales of software and on-line materials for instruction increased by 21%, from $473 million to $571 million (Zehr, 1999). Schools of all types

have been quick to adopt digital content that augments traditional instruction, with the emphasis on the acquisition of technological tools shifting to how these tools are best infused into the curriculum.

Educators, however, have not organized themselves to communicate to commercial vendors and developers what kinds of digital content they want. And as Goodlad has stated, if sharing interests does not occur, people (in this case educators) may discover that their present and future are being shaped in their absence. Succinctly stated, educators have simply not pooled their opinions to try to set an agenda for the software industry as a whole (Zehr, 1999). To serve the common weal, educators must partner, in meaningful ways, with commercial software providers to ensure that the digital content marketed and promoted to students is appropriate and relevant, and prepares them for life in an increasingly complex society.

Commercial, for-profit providers of on-line education, such as software developers, often view students as customers and, as a result, seek to circumvent bureaucratic structures that might interfere with their clients' satisfaction. For example, Pamela Pease (1999), president of Jones International University, the first regionally accredited virtual university, has identified several marketplace drivers for education: continuous and lifelong learning; cost-effectiveness; bringing education to the "customer"; a content- and quality-centric model; a convergence of knowledge, media, and the Web. Using these drivers and a technology that is transparent to the learning process, Jones International University has emerged as the largest distance education provider in the country (Pease, 1999).

Although traditional public institutions have responded to the needs of modern, mobile, increasingly nontraditional students, the movement has been slow. Trapped by state guidelines for program approval, costs, lack of faculty expertise, and other constraints, they are frequently left behind in the wake of for-profit schools.

> New information technologies and the organizational efficiencies of privatization can lower the cost of producing higher education enough that for-profit schools can compete with existing nonprofit and public colleges and universities by offering students a better deal and still making a profit. Or they'll produce an education that students deem more appropriate, improving

quality from the consumer's point of view. So, costs and prices will be lower, or the education will be different and better, or both. (Winston, 1999, p.13)

The Common Good

The time is now for rethinking the role of traditional education and engaging in meaningful discourse that addresses how commercial providers of educational services and the more traditional public educational institutions can merge for the common good. It just may be that partnerships with commercial providers may be the best route for guaranteeing that more citizens receive access to education that is flexible, low cost, just-in-time, and client centered. As Negroponte (1995) has said, digital information and content will become more of a boutique business, with its marketplace being the global information highway and its customers being people (students). Public educators need to be mindful of this view.

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Commercialization in Education: What Are the Issues and Implications for Teachers and Students?

■ Lynne Schrum

Slaughter's (1998) observation that the economic functions of higher education have moved to the foreground and the educational functions to the background (p. 209) appears accurate, and it is also true for the K-12 educational system. To discuss commercialization in education, we must place it in the current social and economic context. We are living in a world of commercialization—everything has a price tag and conspicuous consumption appears to be the way of the western world. The media and politicians, even our president, remind us that our educational system must prepare our students to be competitive in a global economy. "The primary reason public schools are so focused on economic goals is the widely held assumption that schooling is preparation for future employment" (Boyles, 1998). One result has been partnerships between schools and corporations, which have grown over the last 10 years. We may disagree that this is the way things should be, but the fact is they are, presenting a challenging conundrum for educators. This situation raises several questions.

What Is the Current Status of Commercialization in K-12 Schools?

Two significant trends have converged to influence the commercialization of education. The first comes from the perceived reduction in funding for educational institutions in a time of rising costs—or perhaps rising expectation. Overall, higher tuition did moderate the declines in institutions' primary revenue source—state appropriations—which came at the same time as reduction in the share of revenues from the federal government (Slaughter, 1998). Universities are being told to find their own funding, and reduced resources have led to administrators' becoming fund-raisers. The same situation is true in K-12 communities.

At the same time, the federal government moved to change student loans from grants to institutions to loans to students. Moreover, research universities appear to have "responded to the changed environment for

academic science by shifting resources to departments close to corporate markets, federal research markets, [and] markets for high-end professionals in private practice" (Slaughter, 1998, p. 235). It is an understatement to say that colleges of education are not close to corporate markets. Put more succinctly, these institutions have responded to reduced funding by "inadvertently adopting a higher education version of supply-side economics" (p. 210).

The second trend has more to do with the nature of marketing in America. Young people have large amounts of discretionary funds to spend, and they directly influence spending by others. As it has become more difficult to target young audiences because of the vast number of cable channels, video games, and programming on demand, schools have become attractive as an avenue to this largesse.

> By coupling marketing practices with the promise of advancing teaching goals (such as encouraging literacy or providing direct support for school programs), marketers become important partners in American education. In turn, the schools become partners in the increasing commercialization of American youth. (Wartella, 1995, p. 451)

In public K-12 education, the situation is disturbing. Many individuals and groups raised questions about the effects and ethics of using "captive public school audiences to advertise products in return for schools receiving money or equipment" (McCarthy, 1995, p. 5), even before Chris Whittle introduced Channel One. John McLaughlin (1994) concluded that it is not a passing fad, and he is correct. The relationship between public education and private companies "is more than school-business partnerships; it is a manifestation of the new alignment of the American economy" (p. 5).

This situation has gone far beyond the "labels for computers" programs, which have their own problems and critics. Now we can find companies driving curriculum in many ways, most of them done in the name of "partnerships" or through free curricula. This is not to imply that all partnerships are meant to exploit. Many examples can be found of companies selflessly giving time and money to solve schools' real problems. But consider these examples:

- Eli Lilly representatives discussing Prozac with high school students in Washington, D. C.
- Procter & Gamble sponsoring oral hygiene classes in elementary school in return for distributing samples of Crest.
- The National Soft Drink Association providing a poster titled "Soft Drinks and Nutrition."
- The M&M Mars candy company declaring the nutritional value of their candy (Kaplan, 1996; Molnar, 1996).

If these examples were not alarming enough, new companies exist to create curricular activities based on client companies' products. These materials may be lesson plans, posters, or videos, but they share a goal: to put the sponsor's message in front of students and to do so disguised as pure education. Consumers Union collected and evaluated examples of these materials and found that 80% contained biased or incomplete information. And more than half the materials were found to be commercial or highly commercial (Center for Commercial-Free Public Education, 1998).

What Are the Implications for Teacher Education?

Future educators are currently buffeted by the prevailing winds of commercialism and calls for improvement from political and business communities. Students are urged to enter the education profession with improved techniques and skills rather than improved and innovative pedagogy based on praxis and reflection. Meanwhile, colleges of education are struggling to meet state certification requirements, increase "credit hour production," and satisfy students' demands for getting their money's worth (Boyles, 1998). Additionally, colleges of education are being challenged by the proliferation of commercial postgraduate educational opportunities given the availability and user-friendliness of electronic networks and regional for-profit universities.

As future teachers spend more time in practical experience in schools, they witness the increased commercialization of the curriculum. In one case, corporations have encouraged challenges to scientific evidence in the school science curricula by supplying "educational materials that promote clear-cutting of forests [while] casting doubt on phenomena such as global warming and ozone depletion" (Beder, 1998). Unless these events are

discussed in their university classes, future teachers will have little understanding of the impact, or the power, of these educational materials.

Besides influencing K-12 curricula, the same influence is prevalent in colleges of education. Some might say that at least the preservice educators are adults and have chosen to be in these classes, but others note that the same objections to commercialization are relevant. Companies that provide free software are obviously hoping that students will choose to purchase it when they are teachers. Although such examples can be found throughout university departments, other professionals do not make decisions that have significant influence on young learners.

How Can We Live With This Situation?

The situation that we find ourselves in is not new, but should we be concerned about them? "America has always been at war with itself. We have always dreamt of community and democracy but always practiced individualism and capitalism" (Bennis, 1990, p. 102). It is not enough to recognize the dilemma; it will take a loud and constant voice to change the way this trend is growing exponentially.

What can be done? One step was taken in September 1999, when Representative George Miller introduced a bill to ban the collection of any information in school from any student under 18 for commercial purposes without first getting written permission from a parent. But colleges of education can make a strong statement by encouraging a dialogue about the circumstances and by including some of the following suggestions:

- Reintroduce the topic of information literacy to the K-12 curriculum, including search and evaluation skills for all students, to assist them in understanding the influences of marketing strategies.
- Encourage the examination of the curriculum from multiple perspectives, including biases presented or voices not represented.
- Create criterion-based rubrics that evaluate acceptance of "free" materials.
- Engage all stakeholders in this discussion, including parents, policy makers, and students themselves.

"When business enters education, . . . it sells something more important than the brand names of its products. It sells a way of looking at the world and at oneself" (Kozol, 1992, cited in McCarthy, 1995, p. 15). As a society, we must decide whether this is the way we wish our children to

grow up, or whether we can influence them in another direction. Put another way, do we want public schools to be promoting concern for the public good, or for materialistic attitudes? (McCarthy, 1995).

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Books, Brands, and Pipelines: Three Types of Commercialization in Education

■ Bill Tally

To understand the dilemmas posed by the commercialization of education and what schools of education should do about it, I think it is useful to distinguish among three types of commercialization: (a) the marketing of educational materials to schools by suppliers (of books, bricks, uniforms, computers, and more); (b) the marketing of noneducational material, and particularly of "brands," in schools (Nike, Pringles, Nickelodeon, 90210); and (c) the commodification and marketing of education itself with the help of digital technologies (such as for-profit schools, on-line courses, and electronic universities).

In dealing with the first type of commercialization, educators have always operated with a certain limited degree of professional autonomy. Developments in the second and third types of commercialization, however, now threaten even that limited degree of autonomy. My thesis is that teacher preparation needs to give new teachers opportunities to understand the dilemmas posed by the three types of commercialization, to clarify their own relationship with them, and to address them directly with their students through instruction in "media literacy."

Selling Books

That education has long been a large and lucrative market for makers of textbooks, tests, curricula, computers, and school lunches is clear. Professional school people have always had to confront difficult decisions over the choice of these goods and services, decisions with important consequences for students. In doing so, they have turned to a variety of professional, governmental, and industry standards. Textbooks have been edited for age appropriateness, curricula have been aimed at state adoption criteria, and school lunches and buildings have had to meet government safety requirements. In theory if not always in practice, educators and public officials have made these decisions based on *educational criteria,* and vendors have had, at least partially, to heed these decisions.

Selling Brands

If in the traditional type of school market vendors are competing for school budgets, in the second type of market they are competing for something else altogether: students' current and future brand loyalty. Often these marketers give away their "product" for free or for very reduced prices. It might be a science curriculum (Lilly), athletic equipment (Nike), video equipment (Channel One), or Web resources (ZapMe!). They do so because their real product is *the brand. Place-based advertising* is one name for this kind of marketing, because it is based on the idea of assembling captive audiences for commercial messages to forge, through repeated exposure, lasting brand associations. As has been noted often, schools are ideal places for such messages, because in them the state takes on the burden of assembling the audience—for free.

An intensification of this kind of commercialization is now under way, fueled by three trends. First, dramatic increases in young people's discretionary spending make them a highly attractive market, but they are now harder to reach in an era of cable channels, remote controls, and the Web. Schools and their captive audiences look even more appealing to marketers. Second, many schools feel under chronic financial pressure to provide a growing menu of academic, artistic, technological, and extracurricular opportunities for students, and few have budgets that keep pace with the rising expectations. Faced with equipment shortages, outdated science books, and deteriorating athletic facilities, many schools find it difficult to say "no thanks" to free computers, a cutting-edge science curriculum, or new basketball backboards. So what if they come with a little advertising or a little ideology? Third, media and technological developments are blurring the boundaries between editorial and commercial content in nearly all media. The Web is now another place where brand images can be hung before captive school spectators. A company called Campus Pipeline, for example, now provides Web services for 420 colleges and universities in exchange for putting advertisements in front of undergraduates each time they check their e-mail. And ZapMe!, a California-based company, provides free computers and network connections to K-12 schools that agree only to use its customized, advertisement-laden browser frame when using the Web. One result of all these developments is that educators now have much less autonomy in making decisions about the selection and use of materials and technologies. Contractual

obligations or built-in software firewalls, for example, can prevent teachers and students from accessing video or Web resources other than those the vendor provides.

What are teachers to do? One thing they can do is to be clear about their criteria for accepting, or rejecting, "free" materials and, in doing so, reassert some measure of professional autonomy. But saying no or rolling over are not the only options. The other option is the pedagogical one—to teach media literacy to students. Media literacy, which has been defined as the ability to access, analyze, and produce meaning in a variety of forms, has not taken hold in U. S. curricula as it has in every other major English-speaking country, possibly because American mass media are so deeply interwoven in all aspects of American life that they are nearly invisible and unquestionable, the water we swim in. But it is likely to continue and grow in another guise—as a movement for "digital literacy" as public concern over the information anarchy of the Internet intensifies. Yet the narrowing of media literacy, which includes interrogation of media institutions, aesthetics, and values, to digital or "information literacy" focused on the rationalistic evaluation of information sources, would be a loss. After all, school commercialization of the kind we have been discussing is just one fragment of the commercialization under way throughout society and in nearly every sphere of students' lives. Reading and critically negotiating the endless and complex pitches in the media environment is an important lifelong skill.

In fact, one thing that the school commercialization dilemma alerts educators to is the power of brands in children's lives and the need for helping them gain critical distance from them. Here lessons can be learned from the school marketers themselves, who typically spend a far greater amount of time and money researching young people's attitudes toward brands than they do in developing putatively educational content. The main lessons from market research are two: that brands represent complex emotional and cognitive investments for young people, deeply connected to their emerging sense of individual and group identity; and that taken as a whole, the universe of commercial imagery in which young people grow up can be understood as a language, one that youngsters are deeply familiar with and even literate in, meaning that they are in command of a complex set of codes, meanings, and references and can sometimes use them for their own ends. Indeed, some literacy theorists specu-

late that to better induct all children into the culture of print literacy, we can and should use their "native" literacies—including their competence with oral, visual, and media discourses—as scaffolds. Educators and parents who fight to keep schools commercial-free zones are making an important point about the need for a learning environment free from the subtle coercion of marketers' messages. But if the choice also means continuing to ignore students' powerful investments in and competencies with mass media and popular culture, educators could be missing opportunities to build more multiply literate, active citizens.

Selling Education Through Digital Pipelines

The third type of commercialization—that of education itself through for-profit schools, on-line courses, electronic universities, and the like—I will deal with only briefly. My interest is in the way new technologies are involved in this process as they become more effective pipelines for rich content and dialogue and interaction. That profit-oriented enterprises that leverage new technologies to deliver education are on the rise seems clear, and the reasons for it are political, economic, and technological. These enterprises are making people in traditional brick and mortar settings nervous, even as they struggle to take advantage of them.

Should we be nervous? Not necessarily. The delivery of education may not be as susceptible to commercialization as has been commonly thought. One important reason is economic: Schooling is interaction- and labor-intensive, more like running a theater or an orchestra than it is like running a burger chain or a software company. Unlike more capital-intensive enterprises, education is not susceptible to the technology-based productivity gains that have driven decades of growth in other sectors of the economy. You cannot reduce the players in a string quartet to save money; if you do, it is no longer a string quartet. Many efforts to use technology to reduce the costs of delivering education have run aground on the same problem: What they deliver is not education in the same way.

In fact, many researchers looking at efforts to integrate technology in schools have found the opposite to be true: Introducing technologies into the educational equation usually requires more staff time and more effort and interaction when compared with prior methods. Of course, it could simply be a function of their novelty; when people get used to managing technology tools and when design advances make them easier to use, it

might be argued, they will be less labor-intensive and more cost-effective than in-person instruction. My own experience running on-line faculty development projects for K-12 teachers and librarians suggests that this may not be true and that, in fact, when use of e-mail and Web conferencing becomes routine for a group of professional educators and when rich Web resources are central to what they do as teachers, teaching is more difficult, more demanding, more time-consuming, and more complex. It is also, of course, more stimulating, more rewarding, and from most indications, more rigorous and effective for students.

Let me be clear: The selling of on-line courses is happening, and it means big business. It could be that traditional schools, even as they take advantage of digital tools to augment their ways of reaching students, will suffer a loss of market share to these enterprises. In the context of eroding confidence in public schools and growing trends toward privatization, this is alarming. But it points, I think, to the need for a conceptual distinction between the *delivery of instruction,* and the *fostering of learning.* And it provides an opportunity for renewed clarity about what schools and teachers are best equipped to do. I would suggest that schools and teachers are best equipped to foster learning—to confront students with complexity, to support them in working through it (often in communities of practice), and in doing so to foster disciplinary habits of mind. Of course, this is not to say that schools actually *do* foster learning all the time, or even most of the time. Much of the time they are involved in the delivery of instruction, which is more about building coping skills in students than it is about learning. But that is exactly the point: Much of the current work of schools and colleges—work that amounts to little more than peddling credits and credentials—may well be absorbed by for-profit and distance education enterprises. This approach requires schools and colleges (and teacher education programs) to focus on strengthening their core mission of teaching and learning, using new technologies appropriately.

New technologies have many different roles to play in fostering learning. They can provide access to rich data sets and multimedia representations and disciplinary ways of querying them, they can support greater dialogue and exchange, they can enable students to express more accurately what they have learned. But to foster learning they cannot be simple pipelines for materials or lectures or streamlined discussions. The management of educational materials can be streamlined and made more

efficient, but the management of students' intellectual engagement with those materials cannot be: It is an interaction- and labor-intensive process, whether in person or on-line.

Conclusion

Commercialization, privatization, consumerism—all stand for the eclipse of public spheres in which any kind of common goods can be discerned, struggled over, and fought for. Technologies are deeply implicated in this historical process, but it is in no way a strictly technological process.

The history of literacy, or more properly of literacies, is one of continuous struggle between elites who have sought to limit access to the dominant tools of discourse to maintain their cultural, political, and economic status, and various publics who have by degrees wrested some measure of access and control for themselves and in doing so asserted their claims in an expanding public sphere. In modern democratic societies, schools are institutions consecrated to the expansion of that public sphere to include all citizens, a process that consists of giving all children equal opportunities to learn—to become literate users of the culture's tools. This mission places an affirmative obligation on educators to maintain professional autonomy in the face of commercialization pressures of all three kinds, and to use technology resources to foster in students active, critical, and democratic habits of mind.

Recommendations for Action

1. Identify relevant assessment frameworks for evaluating the quality of commercial products and services, including their cost-benefit ratios and their relevance to established standards.

2. Fund research and evaluation studies about the quality of educational commodities.

3. Create a clearinghouse for information about the availability, quality, and applicability of commercial and non-commercial products. Disseminate information through electronic and print media about products and services.

4. Encourage the formation of a consortia between public and private entities around a shared vision to leverage resources for mutual benefit.

5. Establish dialogue between public and private entities that allows stakeholders to develop a common language and identify common tasks.

6. Introduce and integrate the topic of information literacy into K-12 and teacher education curriculum and standards.

7. Encourage professional and constituent organizations to disseminate information about commercialization in schools.

8. Disseminate information about exemplary models through academic and popular media.

9. Investigate regulations and policies that apply to the use of commercialized products in education.

10. Encourage and support research that will examine the effects of commercialization on the structure and value of education.

11. Examine the allocation of resources in education.

12. Seek the consumer's perspective on the use of technology in education. Examine course delivery methods and the perceptions of students and faculty of these methods.

13. Establish guidelines for faculty rights and responsibilities with regard to engagement in commercial ventures.

14. Create dialogue inside the academic community about the implications of commercialism with respect to autonomy and academic freedom.

15. Explore ethical and legal parameters related to the transfer of intellectual property.

16. Document and analyze mobility patterns of educators involved in commercial ventures.

17. Develop policies and procedures to recruit and retain talented and able educational workforce.

18. Document and monitor changes that occur in the educational enterprise as a result of increased commercialization. Use this information to increase sensitivity to market demands, while retaining the quality of education.

Issue Area Four

Technology and the Roles and Responsibilities of Teacher Educators

Teacher educators will find that technology affords them more choices in how they deliver instruction, meet the needs of diverse learners, assess learning, conduct research, and pursue professional development. In addition, teacher educators can involve more individuals within the community in the preparation of teachers. Using technology as a communications tool, practicing teachers, administrators, nonprofit and for-profit entities in a community can have a voice in what teachers should know and be able to do. There will be more opportunities for joint planning, implementation, and evaluation of teacher training. The papers in this section explore how technology will change the roles and responsibilities of teachers and teacher educators.

The Technology Needs of Preservice and In-Service Teachers

■ Sara Armstrong

As educators in preservice and in-service programs have discovered, students and teachers need to be familiar with technology tools, find uses for them, have opportunities to learn basic skills, and practice with them before the tools become an accepted and natural part of teaching and learning. In recent years, it appears that preservice students are often familiar with computers and know how to use them, as many have grown up with computers in their homes or schools. The use of technology, however, might be limited to word processing skills and e-mail. Although these skills are important and can and should be incorporated into instruction, they do not constitute the full range of skills classroom teachers need to provide their students in the comprehensive and integrated uses of technology in teaching and learning.

Because a large number of teacher educators are still unacquainted with the range of technology use possible and therefore cannot include introduction of and practice with electronic technologies in their curricula, preservice students are often unprepared to use technology appropriately in their teaching assignments. Steps must be taken to immerse preservice teacher educators in appropriate technology use as part of preparing coursework and involving their students in learning how to be effective in classrooms. Challenges to fulfilling this charge are similar to those experienced by professional developers who work with in-service teachers. Preservice instructors may feel they do not have time to learn new skills, do not see the value for themselves and their work, and therefore fail to act as appropriate models for their students. They may also feel self-conscious, believing that their students are more proficient than they are, and thus unclear about their role as teacher. This concern often lies at the heart of the issue, for it is one that can cause instructors to feel devalued, unnecessary, and/or lost as to the role they are called on to play in their students' lives. Some speak about this shift in role as moving from the sage on the stage to a guide on the side.

A number of instruments have been developed to guide preservice and in-service teacher educators as they approach the question of mastery of

technology use for themselves and their students. The CEO Forum on Education and Technology's (1998) STAR chart and the work done by the International Society for Technology in Education's (ISTE's) National Educational Technology Standards (NETS) project provide important guidelines. Based on the Apple Classrooms of Tomorrow research, which defines five levels of professional development, the STAR chart provides descriptions of technology use, content of classes needed to facilitate growth in understanding and use of technology, and educational benefits of these practices. Both preservice and in-service instructors can use the STAR chart as a tool for diagnosing the needs of their students in terms of access to and use of technology tools.

ISTE's NETS project recently published a comprehensive document detailing technology standards for students, including performance indicators, examples of curricula, and scenarios. A major part of the hefty publication is made up of learning activities for K-12 students in all subject areas (International Society for Technology in Education, 2000).

To integrate technology as a tool in all curricula, it must be used appropriately in preservice and in-service programs. There are a number of good reasons for working toward the integration of technology that each student and instructor must address and realize. Perhaps the most compelling reason is to provide K-12 students with the tools they need to learn, think, and exchange ideas with peers and experts in our global society. As students collaborate, make decisions about big questions, do research, communicate their findings, and evaluate their thinking and their work, they will need to understand the scope and limitations of a variety of tools, including computers, CD-ROMs, Websites, calculators, cameras, and scanners. When preservice teachers work directly with classroom students throughout their programs, they delve deeply into how technology tools and other resources support curricular goals daily. For example, the Muir Alternative Teacher Education program combines early immersion of teacher interns in classrooms with on-site coursework. In a partnership between San Francisco State University and the San Francisco Unified School District, would-be teachers are placed in classrooms and mentored by master teachers at John Muir Elementary School. Part of each day is spent in university courses taught at the school site. Real questions about teaching and learning, including the appropriate use of technology tools, that come up during the day in the classroom can be addressed immedi-

ately. Coprincipals Virginia Watkins and Cecelia Wambach (1999) state that the "immersion approach to teacher education works best for interns who want the rigorous experience of participating in solutions for urban education" (pp. 10-11). Certainly interns in such a program will be better prepared to make decisions about the appropriate use of technology tools and other resources in their own classrooms, having had the experience of trying them out with students and getting feedback from colleagues, master teachers, and university professors.

The Curry School of Education in Charlottesville, Virginia, has incorporated technology throughout its 5-year teacher training program. A highlight of the program can be found in the case studies built into on-line exchanges among Curry students, in-service teachers at distant colleges, other school district personnel, and experts. On-line discussions take place, stimulated by video clips and comments by the experts on issues highlighted by the case studies. Students and other participants then engage in a careful analysis of each case incorporating a variety of perspectives and share them with each other on-line (Kilbane, 1999, pp. 1 & 10).

With quick access to the Internet more available than ever before, instructors in preservice programs are finding they must become proficient in the use of technologies in order to use them for instruction and to model their use so that their students feel comfortable and knowledgeable using the tools.

Professional development schools, such as the one at Michigan State University, collaborate with districts and schools. As part of the preservice program, MSU students enter the classroom earlier than their colleagues who wait for the fifth year of student teaching at other universities. MSU professors work with local schools to make their students' classroom experience meaningful and relevant both on the university campus and in the K-12 schools. Collaboration is a two-way street: Students benefit from early placement and close contact between university and school, and the university benefits from participating in real life teaching and learning experiences with their community schools. E-mail and Internet resources can play important roles in the process. By allowing all parties to be in close contact, vital communications can be exchanged. On-line resources can be found to support all levels of instruction. And communication with other colleges and universities in different parts of the country can

support discussions about change in curricula and integration of technology tools in teacher preparation programs.

Sometimes in-service education encounters seemingly insurmountable barriers. The North Slope Borough School District encompasses 88,000 square miles at the top of Alaska. Eight villages, not connected by any roads, make up the district. To ensure that high school students in the district could take advanced placement and other special classes, the district developed a satellite delivery system, allowing two-way interactive video between instructors in Barrow and classes in the bush villages. Recently, Mike Davis and Susan Mason discovered the importance of in-service training from a distance as they mentored teachers in the villages who developed and participated in the long distance classes. Through their long distance mentoring, Davis and Mason helped in the collaboration of bush teachers and specialists in Barrow so that students throughout the district were served; modeled mentoring for the bush teachers, enabling them to mentor others; and facilitated a successful experience for bush students who would not otherwise obtain the specialized instruction they received (e-mail and personal conversations, 1999).

On-line preservice and in-service classes have proved beneficial to many. Ted Nellen and Barry Sweeny, two educators who have developed on-line mentoring opportunities for in-service teachers, have found success using the Web to put teachers in touch with each other and break down the isolation many classroom teachers feel (*Edutopia*, 1999).

Questions about the appropriate and effective use of technology for preservice and in-service education can be answered in a variety of ways. Basic assumptions must be established, such as agreement that incorporating technological resources into teacher education is valuable for all involved. Defining the best use of technological tools for teaching and learning comes next. Allocation of resources for training and implementation are key. Aligning instruction with local, state, and federal standards—and identifying the ways in which technology can assist in the process—must be undertaken. As more and more stakeholders enter into conversations about transforming education, new ways will be found in which technology can support the process. The move toward better communication and the establishment of learning communities can enhance change. "Communications technology provides promising opportunities for collaborative learning environments for teachers in which they can

reflect on practice with colleagues, share expertise in a distributed knowledge framework, and build a common understanding of new instructional approaches, standards, and curriculum" (Fulton & Riel, 1999, p. 8). Communications technology and the development of learning communities offer hope for the time when all parties work together to develop the best possible teaching and learning experiences for preservice and in-service teachers.

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The Challenge of Distinction Versus Extinction

■ James V. Bruni

To many teacher educators, the incorporation of technology into teacher education programs may appear to be just another item on the ever expanding list of requirements for creating effective teacher education programs. It has become increasing apparent to me that technology is revolutionizing the teaching/learning process in schools. And, consequently, the impact of technology in schools is forcing us to reconsider our roles as teacher educators. In fact, I am convinced that our response as teacher educators to the challenge of technology may well determine the very future of teacher education in higher education institutions.

Will we play a leadership role in collaboratively exploring with teachers ways to use technology for more effective teaching and learning? Or will we fail to give technology sufficient importance in our teacher education programs and make it necessary for other institutions to provide the kinds of technology-rich teacher education being demanded by schools? Will we be proactive in exploring the potential of technology to help all students reach high levels of achievement, creating programs of *distinction* in our colleges? Or will we doom our teacher education programs to *extinction* by failing to respond to the opportunities, needs, and realities that schools are facing as more technology becomes available to them and graduate preservice teachers unprepared to teach in 21st century technology-rich classrooms?

A recent report of the National Council for Accreditation of Teacher Education (NCATE) emphasizes the revolutionary impact that technology has on every aspect of our society: work, leisure, entertainment, household tasks, our role as informed citizens, and how we learn in schools. Comparing the importance of this impact with that of the invention of the printing press, the document calls attention to the central role that technology must play in teacher education programs. The computer, video technology, and telecommunications of various kinds are transforming the way we approach knowledge and sources of expertise. Although students at all levels have been involved primarily in learning from the printed page, new technologies allow them to have direct access

to information in multimedia formats. A growing body of research confirms technology's potential to enhance students' achievement. And there is nearly universal agreement that students must have access to computer, video, and other technology in the classroom and an emerging realization that technology is likely to change the nature of schooling itself (National Council for Accreditation of Teacher Education, n.d.).

A document and video developed by the George Lucas Foundation entitled *Learn and Live* vividly describes the emerging central role of technology in schools with specific examples of how interactive media and simulation technologies offer powerful ways to change education by allowing students to explore information, pursue their interests, experiment, and demonstrate what they have learned (Burgess et al., 1999). The book highlights hundreds of programs across the country that are leading the way in showing "parents, educators, policy makers, and the general public how technology and other innovations are being used to help create dynamic, effective public schools, places where learning is meaningful and often fun" (p. v).

Colleges that prepare teachers cannot ignore this impact that technology is having on schools and on what the general public is demanding of schools. To do so would reinforce the ivory tower image that too often weakens the credibility and value of teacher education programs. The truth of the matter is that a serious and sustained effort to promote technology as central to teacher education offers an unprecedented opportunity for teacher education programs in higher education institutions to fulfill their stated mission, to become change agents in improving education in schools for all children, to make a contribution to meeting the extraordinary demand for more and better prepared teachers, and to build partnerships across the university and in the larger education community that enhance the stature of and support for teacher education.

The conceptual framework for most teacher education programs usually includes a description of a vision of the purposes of education, how effective teaching/learning takes place, and how teacher education programs are intended to model that vision and those beliefs about teaching and learning. Among the values most often cited are developing lifelong learners, creating a community of learners, promoting the role of the teacher as a facilitator of learning who helps students construct understanding for themselves, nurturing critical-thinking, problem-posing, and

problem-solving abilities, respecting different ways in which people learn, designing curricula that make connections to students' experiences and to the real world, and using alternative means of assessment and, more especially, authentic assessment that permits students to demonstrate what they know in meaningful contexts. Technology offers schools as well as teacher education programs a major vehicle for promoting those values.

Examples abound of the innovative uses of technology to promote interdisciplinary project-based learning involving students in exploring real world problems driven by questions about themselves, their communities, and their world. Through the Internet, students can connect to unlimited resources—museums, archives, experts in a field—and collaborate with students throughout the world to collect and investigate data for a particular project. Computer technology makes it possible for them to use simulations to learn key concepts and to develop multimedia portfolios to document and communicate the products of their collaborative projects. On the surface, these methods appear to be precisely the kinds of educational experiences that teacher educators value most.

But to take on a leadership role in exploring potential uses of technology in the teaching/learning process, teacher educators need to make technology become an integral component of all teacher education programs. Teacher educators must *model* uses of technology in all courses. It is not enough to simply make certain students are required to take a course in their programs to become acquainted with the potential of technology in schools. Teacher educators need to lead the way *by example.* As they involve students in their courses in using technology to carry out investigations that require using sources from the Internet or take advantage of e-mail to facilitate communication in their classes or use simulations as tools for learning, they send a clear message to their students about the value of technology.

In demonstrating their own willingness to investigate potential uses of technologies, teacher educators reveal themselves more clearly as lifelong learners and take on the role of action researchers with their students. That new role brings with it a special responsibility to help their students—preservice and in-service teachers—explore how these technologies most effectively promote learning and how to help students analyze the data and information they obtain from varied sources, compare and contrast sources, and test their reliability and validity. In fact, the roles of

teacher and student are transformed into roles of learner and learner as teacher educators facilitate a true partnership in the inquiry process with preservice and in-service teachers.

Such a transformation in the focus of teacher education programs and the role of teacher educators will require significant support for teacher educators. A long-term plan needs to be developed that incorporates such components as (a) what resources will be provided to make multimedia technologies available to all faculty and students; (b) how support staff will be made available as faculty implement the use of technology in their classes; (c) a plan for a multistage faculty development program that recognizes that faculty are at different stages in the change process and will require ongoing, sustained professional development that is relevant to their own needs and the courses they teach; (d) the creation of a support network of faculty and the extended professional community to provide ongoing, collaborative assistance and research opportunities; and (e) how the consideration of technology in teacher education will become a central component of program development.

Such a serious, ongoing commitment to technology requires an institutional commitment to providing very significant additional funding for teacher education programs. It also requires teacher educators to view themselves as lifelong learners and true partners with students, with faculty across the university, and with teachers in schools in a collaborative exploration of how technology can most effectively promote learning. This new role for teacher educators places them in the vanguard in promoting the uses of technology at the university, thereby bringing greater distinction to teacher education programs. Teacher educators help break down barriers between liberal arts and sciences faculty as they use the technology to involve their colleagues in working with schools and forge the way for college faculty to be seen as leaders in school reform.

In summary, the challenge of technology offers teacher educators a crucial opportunity to take a leadership role in the national effort to help all students reach high levels of achievement and to provide all students with teachers capable of helping them meet that goal. Not meeting the challenge that technology presents can result in the demise of teacher education programs in higher education institutions.

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Connecting Technology to Content in Learning

■ Allen D. Glenn

As educators look to the future, the challenge, according to Linda Roberts of the U. S. Department of Education, "is to connect technology more substantively to the content itself, to the very concepts in particular areas of the curriculum" (Jerald & Orlofsky, 1999, p. 62). To achieve this goal means that attention must be directed to instructional issues, because one cannot separate pedagogy from the content being taught. What are some of the issues teacher educators need to consider?

A Curricular Mind-Set

Teachers are producers and decision makers. They create instructional units by making decisions about content, learning outcomes, instructional activities, characteristics of students, curriculum, time, and technologies. Once teaching begins, the teacher makes hundreds of decisions each day that directly affect each student's learning opportunities. In doing so, they draw on their knowledge, expertise, and fundamental beliefs about teaching and learning—a curricular mind-set.

This mind-set helps determine what the teacher believes is important to learn, how units of instruction should be developed, appropriate roles for students and teacher, and which technologies are to be used. The more experience the teacher has, the more sophisticated and comfortable he or

she becomes with an individual curricular mind-set and the more difficult it is to change practices that are believed to be successful.

Acquiring Technology Skills

When teachers begin to implement technology in their teaching, they expect positive changes to happen. They believe that the additional work needed to learn the technical skills will make their jobs, if not easier, at least more efficient. They also expect that students will acquire new skills and learn more. Research over the last decade suggests that the changes in teachers' use of technology in the classroom occur gradually as they acquire more sophisticated technical skills and explore the possibilities of how technology can support instructional goals. Typically these stages range from entry level, where fundamental operational skills are learned, followed by increased integration into classroom practice. A final stage is the merger of technology and pedagogy into a transformed learning environment.

The more the teacher believes that technology can help develop higher order thinking skills, the higher the probability that he or she will use new technologies (Moersch, 1996-97). It is critical during this development process that teachers have access to technology, sufficient time to develop skills, strong support from their colleagues, and appropriate digital curricular materials.

Philosophy and Technology

At some point in this technological journey, the teacher confronts several questions: What does it mean if I continue to infuse new technologies into my classroom? And the answer to this question raises a multitude of others. What instructional methods should I use? What will my role be? What should I expect from students? What changes in expectations about learning will be needed? How will I manage the classroom? What type of materials will I need? What is the best way to assess students' learning?

Technology-rich classes tend to become more learner centered, participatory, and collaborative. Students spend more time constructing knowledge and focusing their attention on understanding and critical-thinking skills. Multimedia technologies are used for knowledge building, experimentation, and product development. In this type of environment, the teacher is responsible for providing a framework on which learning can occur. In doing so, the teacher makes decisions about how to cover cur-

ricular objectives, what information should be provided, what should be scaffolded, and what should be left to the student to discover. The richer the technological environment, the more information-processing instructional models from which to choose (Eggen & Kauchak, 1996).

Teachers most comfortable with direct instructional models and with using technology to present materials and assist students to learn materials are challenged when thinking about moving toward a more student-centered learning environment where students are producers of knowledge. The teacher may have the technical skills but not the philosophical disposition to move to the next level. In fact, using multimedia technologies as learning tools requires the teacher to have a high degree of comfort in using the technologies and requires reorganizing the classroom for more independent student work. Creating such a classroom means expanding or changing one's philosophy about teaching and learning.

Infusing technology does not mean that more traditional methods involving textbooks and lectures disappear; instead, they are expanded and used with a different purpose. A textbook, for example, may provide background to help students see patterns from the information presented or to assist them to draw conclusions. Or the text may be part of a wide range of data students access to develop hypotheses about a problem. The teacher's curricular mind-set, technical skills, and willingness to experiment shape the decision to move to the next level.

As teacher educators interested in providing a multimedia technology-enriched learning environment for students, we must prepare our beginning teachers and work with in-service teachers in four critical areas. Teachers must have the technical skills to use increasingly sophisticated technology. More and more this means going beyond the use of basic tools and into Web and multimedia technologies. In-service teachers also need opportunities to develop skills in using these emerging applications: (a) a working knowledge of information-processing instructional models and strategies about how they can be applied in the classroom, particularly inductive/deductive, inquiry, and cooperative models; (b) knowledge of digital curricular materials available in specific content areas that can be used in various instructional models; and (c) insights into how technology affects their beliefs about teaching and learning and strategies for continuing professional development.

Why? Simply because being able to operate a digital curriculum and maneuver around the World Wide Web is not enough. "Teachers are the

key to whether technology is used appropriately and effectively, and technology increases conversation, sharing, and learning among students and between students and teachers" (Jane David, cited in Trotter, 1999, p. 39). Pedagogy is the key.

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Economic, Political, and Social Trends: Insights for Today's Technology Revolution

■ Robert D. Koob

The rapid incorporation of advances in computing and communications in the social, political, and economic fabric of this country and much of the world has profound implications for teacher education. These advances, commonly known as *technology*, have created new tools for work and social interaction. In the same way, earlier introductions of technology changed the nature of work and social interaction in the so-called Agricultural Age and Industrial Age. Our challenge as educators is to recognize the new demands these changes place on individuals in this newly formed society and then prepare teachers to do effectively that which they have always done: aid developing individuals in adapting to that society.

A way to gain insight into ongoing change is to examine trends in economic, political, and social elements of American society. Economic change is perhaps the easiest to chronicle.

Census data for 1998 show median earnings of full-time, year-round workers by education range from $14,132 for workers with less than a 9th grade education to $55,460 for workers with a professional degree. These same data show a smooth progression of increasing income with increasing education (http://www.census.gov/hhes/income/income98/in98ern.html) (see also U. S. Census Bureau, 1998).

- Since 1967, the proportion of full-time, year-round women workers increased from 29% to 41%.
- The median income of men who were college graduates in 1997 was $47,126, a 22% increase since 1963. Less educated men showed declines in income.
- Women in all educational attainment groups experienced increases in income since 1963, with college-educated women showing, at 53%, one of the largest increases.

Perhaps even more striking, discretionary income as a percentage of family income decreased from 1970 to 1993 for all families except those with four years of college or more (Educational Testing Service, 1996). Based on these data, it appears that this trend has been exacerbated, not mitigated.

Because only 23.6% of Americans over 25 hold a bachelor's degree or higher (U. S. Census Bureau, 1996), an 80/20 rule of sorts applies; that is, the college educated (roughly 20% of the population) hold roughly 80% of the country's assets. Conversely, and obviously, those without this level of educational attainment, the large majority of the adult population, are left to share the remaining 20%.

Comparable trends exist in social and political involvement, although they are less easy to document. According to the National Center for Education Statistics (1998), common civic activities such as belonging to an organization, giving community service, voting in a state or national election, or attending public meetings all increase significantly with educational attainment.

The conclusion seems inescapable. The fullest participation in today's society comes from the best educated. Although this statement has perhaps always been true, what has changed over time is the level of educa-

tion required for full participation. Simple literacy appeared adequate in colonial times and high school graduation adequate in the middle of the 20th century. The change wrought by the introduction of technology in this so-called computer age (or information age, or knowledge age, or whatever) is to push the median representation to a 4-year college degree.

It is reasonable to conclude that the current state of dissatisfaction with P-12 schools and the high visibility of education on political agendas across the nation are the result of increased expectations for those schools. The expectation, stated or unstated, is that all school children should be prepared as though they were planning to go to college.

But this implicit expectation is strongly at odds with the elitist assumptions that grounded the preparation of most of today's teachers. It is no longer acceptable to think of the "best" students entering college and assume the rest will find a way to labor in the industrial workforce. The industrial workforce is rapidly being replaced by automation, and the percentage of these jobs as a fraction of the American economy is on a downward trend, comparable with the loss of farm jobs over the last century. Low-tech service or counter jobs remain steady but account for only 20% of available jobs. The increasing demand is for skilled office workers (Educational Testing Service, 1996).

These changing expectations provide an enormous challenge for those who would educate teachers. Teachers entering today's workforce must not only learn to deal with an exponentially increasing reservoir of information but also be committed to teach each child how to deal with that information and how to integrate it into his or her personal world view in a rapidly changing society.

Thus, today's teachers must be less focused on how they teach and more focused on how each child learns. Today's teachers need to understand multiple ways to reach educational goals. The time of debating over the best way to learn reading is past. It is now a matter of which approach to reading works for which student. And this example is replicated for all types of curricula.

Fortunately, the very technology that has required this change of teachers provides the tools necessary to meet its challenges. Detailed information about each student's needs, abilities, successes, and failures can be stored in forms readily available to all of that student's teachers. Information can be updated and shared as frequently as necessary. The

ready availability of information at a desktop obviates the need to remember large numbers of facts. Time can now be spent on learning how to access data or information necessary to solve any problem at hand. Critical thinking is a necessary element of this process, because judgments about the information's validity are constantly required. Varied media are available at the desktop, so teacher and student can select the media form most conducive to learning for the subject matter and the student.

The trends and remedies, once identified, appear obvious. The greatest barrier to implementation is the mind-set of those currently populating our teacher education programs. One can be optimistic that people dedicated to teaching teachers how to teach will be open to learning how to do that task best.

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Making Meaning, Creating Change, and Building New Structures

■ George L. Mehaffy

With the rapid proliferation and adoption of e-commerce, the Information Age, that much touted shift from the Industrial Age, has finally arrived. Technology has spawned a new era. Like the shift from the preprint society of 15th century Europe to the world of the Gutenberg press, another period of transformation also created by technology, this new age of information promises profound changes, severe dislocations, and dramatic new structures and processes. From the way we live and work to the way we communicate and spend leisure time, little will remain the same. The world as we know it will be transformed. No part of society will remain untouched, particularly education. Teacher education, teaching, and indeed schools themselves will likely be changed in ways that we are just now beginning to imagine.

Technology, as the driving agent of the Information Age, will change the roles and responsibilities of teacher educators in three broad areas. First, technology will force teacher educators to become meaning makers by working with others to forge new definitions of traditional structures and practices. Our new use of technology will force the educational enterprise to question every assumption, every definition, and every practice that has been established in both universities and K-12 schools. In the new Information Age, perhaps the most difficult challenge is making meaning in a world where many of the old rules no longer apply. Technology begins by challenging the most fundamental assumption: What is learning? In a previous era, learning was often, at least in operational terms, simply defined as the accumulation of information and the capacity to report that accumulation in some test environment. Increasingly, learning will have to be described more complexly, as the ability to acquire not only knowledge but also substantial thinking skills: knowledge acquisition, analysis, synthesis, and judgment. That change in definition also causes changes in the curriculum: What are identified as critical elements in a course? When facts and dates and other information are so readily available, what must be included and what can be omitted? Equally important, in an era when information is expanding exponentially, what can be included and what

must be omitted? Technology also challenges the definition of teacher, as the old hope of changing the sage on the stage to the guide on the side becomes ever more possible with technology. Students can be the actors in a world filled with technology, and teachers can be consultants. Technology changes the concept of what a course is, which for years in universities has been defined by seat time. In the virtual world of technology, seat time becomes increasingly irrelevant, the Carnegie unit increasingly meaningless. In fact, in the brave new world of technology, even the word *school* becomes increasingly harder to define. If no longer simply a place, what is a school? And for each of these questions, how are the answers different in universities and in the public schools? In other words, both for their own practice and for preparing future teachers for their own work, the first change of roles and responsibilities for teacher educators resulting from technology is making meaning in a world where every definition, every assumption, is suddenly questioned, suddenly turned upside down.

These challenges are incredible, for we have all experienced education in a very similar way. We all have similar concepts and ideas. Indeed, the current tradition of teacher-centered instruction has persisted without much change for a very long time. Challenging these traditions will not be easy. And technology does not guarantee certain outcomes. For example, look at the impact of technology on student centeredness. Some technologies, such as PowerPoint, may reinforce the notion of teacher as central player on the educational stage. Yet technology also offers multiple ways that students can be put in charge of their own education. The challenge is to counter old assumptions with new visions.

A second broad area of changing roles and responsibilities for teacher educators will be in making effective use of technology in teaching and learning. I recall the time when personal computers first arrived; some teachers taught students how computers worked, about ROMs and RAMs, but not about how to use computers as tools for learning. It made about as much sense as requiring a course in diesel mechanics before driving a Mercedes. Technology now allows students to interact with teachers as never before, to work together as learning groups, and to work individually with powerful search engines and new forms of learning tools, all across time and space in ways never before imagined. But imaging new uses, and then actually implementing new uses, call for creativity and a willingness to take risks. Those attributes are probably not found in the

curriculum of most teacher education programs. The critical issue is that teacher educators must first understand the most important elements in learning and then devise technological strategies that support those elements. In the same way, teacher educators must help their students think critically about the most important elements in teaching and learning as these prospective new teachers enter K-12 classrooms and design technology-based learning activities for students. The use of technology alone does not assure the appropriate outcomes. I recall seeing one early computer game about the opening of the American West that reduced the richness and pageantry, the complexity and ambiguity, of that experience to a mechanistic and simplistic computer game that robbed students of any deep understanding and wasted enormous amounts of their time. Yet I have also seen technology used to link students across national boundaries, to enliven and enrich subject matter, and to develop a profound understanding of subject matter, self, or another culture.

Finally, technology will change the role of teacher educators by forcing them to consider new structures for the initial preparation and ongoing support of K-12 teachers. For initial preparation, new structures are already appearing. The CalStateTeach (1999) project seeks to assist emergency-credentialed teachers to receive certification through a nontraditional program that involves substantial use of technology to reach candidates in their classrooms. But many more structures are possible, including substantial elimination of the current distance between schools and universities. What are the best examples of practice in the creation of professional development schools, when technology can be used to create a virtual mixed environment? How could in-class, live examples of current school practice enrich the curriculum of the teacher education program as well as engage university students in a dialogue with both university and public school teachers? What are the many ways that schools and universities could be linked by technology to improve education for students and the preparation of future teachers? The professional development of teachers, especially through the master's degree, is even more susceptible to change with the use of technology. Why do we still treat students in a master's degree program as solitary learners rather than as a community of learners, especially now that technology allows such linking? Why do we still often insist that they show up one night a week at the same time on a university campus, when technology does not require it? Technology

offers the promise of a sophisticated and multisensory curriculum and learning environment. Yet although calls are beginning to be made for a substantial revision of the master's degree in education, for far too many programs, the master's degree persists in its traditional form. Even the most comprehensive proposals for changes in the master's degree (see, e.g., Tom, 1999) suggest little recognition of the impact that technology could and will have to transform professional development for teachers.

The most difficult challenge of all, of course, is thinking in new ways. It is difficult to imagine a world that is different and then act on that imagination to create new and different assumptions, better programs, and new structures that will use innovative and emerging technologies in new ways for more effective teaching and learning. Yet the new Information Age we are entering requires us to fundamentally rethink our definitions and assumptions, our practices, and our structures if we are to create effective teachers for the new century. As Drucker recently argued (1999), this age we are entering truly is revolutionary, and for even the best teacher educators, their skills in redefining issues, changing the ways they teach, and inventing new models will be challenged as never before.

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The Impact of Technology on the Roles and Responsibilities of Teacher Educators

■ Howard D. Mehlinger

Teacher education in the United States is a complex enterprise enlisting the efforts of many people, including some who do not consider themselves to be teacher educators. For students, teacher education consists of courses and events that are loosely connected and driven largely by the interest of individual teacher educators. Whatever consistency may exist from one program to the next is largely a result of laws and regulations affecting state and national program accreditation and teacher licensing.

Teacher education has failed to attract the public respect accorded to many other professional training programs such as law, medicine, and engineering. Teacher education is judged by some inside and outside the profession to be less demanding of its students, less selective in the admission of candidates, and less specialized in its content than other professional education programs. This situation has led to acceptance—even endorsement and promotion—of alternative paths for teachers to obtain licenses.

It seems safe to predict that technology will affect teacher education as it has most other institutions in American society. Before speculating about what this impact may be, it is important to reflect on what the enterprise is today.

Who Are Teacher Educators?

At one level, we can define teacher educators as individuals who teach others to teach. The "others" may include those who are already licensed teachers with classroom positions, but it also includes those who are not yet employed as teachers or licensed to teach but wish to become teachers. This definition of teacher educator includes a large number and broad range of people, including some who do not think of themselves as teacher educators and would be surprised to be given that label. For example, according to this definition, one must count in colleges and universities not only professors of education but also professors in the colleges of arts and sciences who have teacher education students in their courses. The number includes elementary and secondary school teachers who host teacher education students for practicums and who supervise their "stu-

dent teaching," and it includes people employed by for-profit and not-for-profit enterprises who organize workshops and other training activities for teachers. By one definition, all of the above are teacher educators whether they identify themselves as such or not.

Another way to define teacher educator is to include only those who self-consciously think of themselves as teacher educators. Doing so reduces the number and range of teacher educators considerably; by this definition we should likely include only those employed in schools, colleges, and departments of education in colleges and universities. We should not include all professors of education because many do not teach teachers. For purposes of this paper, teacher educators are those academic professionals in schools, colleges, and departments of education who identify themselves as "teacher educators," recognizing that when we limit ourselves in this way we are ignoring a large number of people who contribute to teacher education.

What Are the Roles and Responsibilities of Teacher Educators?

The role of a teacher educator is to be a source of inspiration, advice, and knowledge to those already in the teaching profession and to those who wish to enter it. Traditionally, performance of any particular teacher educator's role is judged according to the individual's contributions to teaching, research, and service.

For the vast majority of teacher educators, teaching occurs principally in campus classrooms during a well defined period of the academic calendar. Whatever the particular content of the course or the manner in which the professor presents it to his students, the normal expectations are that the members of the class will meet as a group for a specified number of sessions and will conclude with some form of activity or examination that will determine by objective measure who has met the goals of the course and who has not. What is taught in a professor's course is largely his business to determine. Unless he makes a special effort to inform himself, he is unlikely to know much about what his students have already studied in previous teacher education courses or what they will learn in future courses. It is not unusual for a teacher educator to teach teachers who are already practicing in the profession—perhaps in formal study, usually graduate courses on campus or in special workshops or seminars organized by others, including the school system that employs

the teachers. In these cases, as in the initial preparation of teachers, the professor is seen as one who possesses specialized knowledge that is needed by the students enrolled in the graduate class or workshop. To be a professor is to "profess," i.e., to share what one knows with others who need that information and perspective.

A teacher educator's service can take many forms. It includes service to his students by counseling and guiding them as professionals; it includes service to the department, college, or university through work on committees, participation in faculty governance, and acceptance of administrative responsibilities; it includes service to the profession by participating in professional organizations, reviewing articles for publication, and advising business and government officials on matters affecting the profession; and its includes service to society by participating actively in community affairs. Each teacher educator finds his or her own way to provide service.

Responsibilities for research vary greatly among teacher educators, depending primarily on the expectations of the institutions that employ them and the teaching and service load they carry. What is counted as research also varies greatly. In some institutions, only monographs and articles published in refereed journals are counted as research; in other institutions, textbooks and articles dealing with practical problems confronting educators are accepted as scholarship. Whatever the quantity and whatever the form it takes, most teacher educators are expected to contribute to their profession through scholarship.

What Impact Will Technology Have on the Role and Responsibilities of Teacher Educators?

The role of teacher educator—a source of inspiration, advice, and knowledge—is unlikely to change, but the means of satisfying the role surely will change, and already has to some degree. The role of teacher educator today is largely performed face to face. Textbooks are an old technology that have allowed a few teacher educator authors to dispense their inspiration, advice, and knowledge through the printed word, but in most cases, the textbook has been buffered by a classroom-based teacher educator who decides which portions of the textbook to use, endorse, and contradict. The new electronic technologies have the capacity to extend the teacher educator's influence beyond his face-to-face encounters with

students and to bring other teacher educators into his classroom, using media that are more potent than the printed text.

Information and communication technology have already had a major impact on teaching, research, and service. Few teacher educators have to be convinced of the value of computers and other electronic tools to support their research. Professors conduct searches, analyze data, and publish results with the help of computers. Scholarship has become less tedious; results are more quickly disseminated. It has also become common for scholars who are widely separated by geography to employ modern communications technology to support collaborative research. In the near future, we may expect that electronic publications will be given the same status for promotion and tenure as publications through printed journals. Little effort is required to persuade teacher educators of the contributions technology can make to their research.

Service is another arena in which the value of technology is widely accepted. Teacher educators depend on e-mail, voice mail, audio and video teleconferences, and the fax machine to conduct their business. Draft reports are transmitted electronically; messages are left for people to answer at times convenient to them; meetings are held virtually and at a distance, eliminating the need for expensive and time-consuming travel. Teacher educators have been generally eager to embrace technology to meet service responsibilities, even to the extent of altering their practices to take advantage of the technology.

While teacher educators have been quick to recognize the advantages afforded by technology for research and service, they have been slow to adapt their teaching to take advantage of technology. Even professors who deem it important to use PowerPoint to support a conference presentation will avoid such techniques in their classrooms. How can we account for this discrepant behavior? The use of technology for research and service saves the faculty member time and money, reduces tedium, and increases efficiency. For most professors, adding a technology discussion to the classroom increases costs, adds to preparation time, and poses risks that the equipment will fail, thwarting the lesson and wasting the time and energy invested in its development. Professors who use technology find advantages in placing students' work on the Web, in communicating with students outside the classroom, and in sharing ideas with distant colleagues. Administrators see advantages in using interactive video to con-

nect classrooms across two or more campuses, thereby saving the salary cost of additional instructors. For a typical teacher educator who has no desire to share his class with others and who has the wish to be left alone to teach as he deems appropriate, however, most of the current technologies seem to be mainly a nuisance.

There are many exceptions to the foregoing conclusion. The number of teacher educators who employ technology in their classrooms grows steadily. A few professors teach all or most of their classes on-line, meeting their students face to face only once or twice during the semester. Some teacher educators connect their teacher education students to elementary and secondary school classrooms so that teachers in training can have direct experience with students like those they hope to teach. A few professors have developed simulations, depicting classroom situations that require resolution; others use interactive video to "visit" classrooms and provide professional training directly to schools. Still others share their undergraduate classrooms with practicing teachers so that teachers in training can query current teachers about problems they confront that may not be part of the college's teacher education curriculum. These examples are but a few of the current practices by a dedicated minority of teacher educators. As the technology becomes more ubiquitous and easier to use, the minority will surely become a majority. Nevertheless, there is much about the rewards and incentives for teacher educators that stands in the way of wide adoption of information technology for teaching.

What May Be the Impact of Technology on the Structure and Organization of Teacher Education?

In most industries, technology ultimately pays for itself by reducing personnel costs or by permitting the industry to provide and market services not previously available. The use of robots in automobile assembly plants is an example of the first, medical diagnostic equipment of the second. Teacher education, like other branches of formal education, has been slow to adopt technology for either of these two purposes. Thus, technology is treated as an additional cost without any noticeable change in the number of personnel or the services provided to clients.

Teacher education has a splendid opportunity to use technology to reduce costs and to provide new services if it elects to do so, but there is no obvious inclination to do so on the part of most teacher education

institutions. This failure to act will likely open the door to for-profit institutions that see the opportunity for making money from providing professional services to teachers.

The best opportunity for using technology to transform a portion of teacher education probably lies in professional development. Colleges and universities have already witnessed an erosion in that market. In some states, changes in licensing rules have eroded the advantage for teachers in pursuing a master's degree and have led to a proliferation of programs that provide graduate equivalent credits. What seems attractive about these alternatives is that they may be tailored to the teacher's interest and pursued in convenient ways with little cost. The growth of MBA and graduate engineering programs that can be taken by means of distance learning reflects a response by business and engineering programs to a professional need and a market in their fields. Enterprising teacher education programs, either singly or in a consortium with other teacher education institutions, will either enter this market in the near future or watch it taken over by organizations outside traditional teacher education.

While it is likely to be the case that many young people will continue to be drawn to undergraduate colleges and be prepared to teach in rather traditional ways, with or without much exposure to technology, an opportunity exists for a teacher education program using technology to bring people into the profession who are unable for various reasons to become full-time students attending classes on campus. Imagine a set of courses that have been designed by the best faculty in the profession and available to teacher candidates anywhere in the country. Imagine also a network of elementary and secondary schools where excellent teachers have agreed to supervise the candidate's student teaching, and imagine the provision of services to teachers wherever they live, providing counseling and helping them to find jobs in their immediate locale. Technology is now available to make such a teacher education program possible. The culture of teacher education is the source of the main constraints.

Conclusion

Teacher education has recognized the importance of ensuring that all those preparing to teach have at least a minimal understanding of instructional technology. This need is addressed primarily by adding special courses on the use of technology. Almost without exception, technology

has not been fully integrated across the teacher education program; instructional technology is judged to be the job of specialists. Until teacher education accepts technology as an integral part of its business and begins to take advantage of its power, teachers will be ill-prepared and teacher education will remain vulnerable to competition from those outside teacher education. On the other hand, instructional technology could serve as the catalyst for provoking needed changes in teacher education and for bringing new respect for the profession.

Preparing Tomorrow's Teachers to Work in Learning Communities

■ Margaret Riel

> The star teachers of the 21st century will be those who work together to infuse the best ideas into standard practice . . . who work every day to improve teaching—not only their own but that of the whole profession. (Stigler & Hiebert, 1999, p. 179)

The way we prepare teachers should model how we expect them to prepare students. Even though universities are strong advocates of the need for reform of the K-12 schools, most preservice teacher education programs are taught in very traditional, didactic ways. A recent study of a teacher education program in a medium size university indicates that few university professors or supervisors of student teaching modeled the use of any technology other than word processing in educational settings with new teachers (Carlson & Gooden, 1999). The matching of student teachers with a master teacher in a classroom prepares them to teach the whole class independently, but it may not prepare them to participate in grade-level planning of lessons or work in cross-discipline groups. When new teachers have minimal experience with technology and collaborative models of decision making, it makes the task of school renewal through pro-

fessional development extremely difficult. The university needs to model the teaching and learning context that they want teachers to create.

The students in our nation's schools come from diverse linguistic, cultural, and social backgrounds. Increasingly, the economy requires a high level of competence from more of these students. We do not have the social resources in classrooms to pair one teacher with one student. Therefore, we need to think of creative ways to use the social resources to design learning communities that will be effective for all students (Hill & Celio, 1998; Stringfield, Ross, & Smith, 1996; Mehan, Villanueva, & Hubbard, 1996). The current projected need for 2 million new teachers over the next decade challenges universities to think creatively about how to use social resources. It is the same problem teachers face in their classrooms, and solutions to the problem might be very similar in structure.

This paper proposes a collaborative approach to building knowledge that integrates theory and practice in diverse contexts. "Lesson study circles" (similar to learning circles and to ThinkQuest teams) are proposed as a strategy for professional knowledge building in education (see also Stigler & Hiebert, 1999). To provide the necessary time for teamwork in schools, the preparation of paraprofessional "learning guides" is recommended. The goal is to design a way of preparing professional teachers who have experiential knowledge to design learning communities that include people of diverse talents in the continual process of constructing new understandings and shaping new knowledge.

A Collaborative Model of Teacher Education

Professionals work as members of a community. They accept responsibility not only for their own actions but also for establishing and monitoring standards for professional behavior. The education of preservice teachers takes place in small professional communities, lesson study circles, which foster a commitment to learn from, and contribute to, a professional community. University professors, practicing teachers, technology consultants, and preservice teachers are members of a knowledge-building community facilitated by technology that models classroom teaching.

Lessons are the units of teaching. Writing lessons plans is typically part of preservice programs, and teachers frequently share written lesson plans. But these formalistic abstract outlines are not effective ways to record or share the important knowledge of lessons, including how a range of stu-

dents respond and how a good teacher uses these responses to structure learning. Text is not the best medium to capture the richness of needs and conditions that are involved in teaching a lesson. New technologies make it possible to represent our knowledge in ways that could lead to deeper understanding of the teaching process for new and practicing teachers and for researchers. Videos of teaching can be integrated with lesson plans, objectives, standards, displays of materials, and advice about how to incorporate the contributions of students. Multimedia digital formats make it possible to include different perspectives of the people engaged in the lessons and the information that led to the myriad of decisions that underlie every lesson. Excellent examples of how teachers' knowledge can be captured in multimedia formats already exist (see, e.g., www.irl.org/assess/home.htm).

In this plan, these multimedia digital descriptions of teaching and learning are referred to as "lesson stories." Stories used in this way do not imply fiction but refer to the collaborative process that precedes and follows the construction of a well designed lesson. A lesson story blends theoretical knowledge of learning, instructional strategies, and assessment with practical wisdom of classroom organization, the complex needs of a particular group of students, and the management and integration of technology to create the best educational context. They are planned patterns that will be shaped by teachers, the school, and the students. Because each year brings changes in the nature of students' skills, the structure of knowledge, and evolution in the tools available for teaching, lessons cannot exist as abstractions to be replayed in exactly the same way with any group of learners. Digital formats of lesson story telling can be powerful tools for promoting deep understanding about evolving practices in teaching and learning.

Lesson stories are knowledge products and, as such, could play a significant role in the evaluation of student teachers, professional teachers, and university professors. The production of lesson stories, like current book publishing, can help shape intellectual careers.

The first task of a lesson study circle is to participate in a national process of peer review of lesson stories. This review is organized by state departments of education to help identify examples of "standard" teaching practice in diverse contexts. New teachers use these examples as guides in developing their practice. In this way, new teachers could has access to

a continually evolving database of lesson stories to help shape their teaching philosophy and practice. These libraries can be used to illustrate standards of practice. This process will help prepare new teacher for a professional orientation to teaching that includes a responsibility to structure and participate in peer review.

Each year, universities and colleges select different schools to participate in lesson study circles. The goal would be to have all teachers in the school participate as members of the lesson study teams. The formation of these teams blends novice teachers with mentor teachers. Each team has two or three teachers, including one master teacher, four preservice teachers, two university professors (one in education and one in a discipline area selected by the teachers), and one technology expert from the university or the school district, for a total of eight to ten participants. The group's goal is to produce one digital lesson story with supporting materials. Because of the diverse locations of the group and the differences in time constraints, a good deal of the interaction among the members takes place on-line, using electronic community building tools. (For a list of good tools to use for supporting group work, see www.gse.uci.edu/ccre/knowledge_building/tools.html.)

The Phases of Lesson Study Circles

The team meetings are sometimes face to face and other times synchronous or asynchronous in on-line contexts. The participants follow a set of circle phases.

- *Phase 1: Peer review of previous lesson stories.* The circle members begin their work with a formal evaluation of four lesson narratives produced by previous lesson study circles using a rubric. This review helps the group understand the objectives and rubrics to be used to evaluate their own lesson story. Each preservice teacher monitors the review process of one lesson study, collects the comments and discussion, and writes the review. This process is the first stage of a multilevel review.
- *Phase 2: Identify the lesson topic.* While the preservice teachers write the reviews, practicing teachers take the lead in suggesting a particular lesson that will be taught some time in the future in their classrooms. The lesson is described in terms of the goals and objectives, the link to standards, and overall integration into the learning plan. They describe how students have reacted in the past and what they see to be the short-

comings or problems with the lesson. They evaluate the overall learning outcomes and the direction of the changes they would like to see.

- *Phase 3: Research and connections.* The student teachers conduct extensive searches for information, examples, and research that will inform the discussion about the content and format of the lesson. The professor will assess the thoroughness of their search and their skill in summarizing and presenting the information to the team. This search and presentation will become part of the background materials that will be included in the production of the lesson story. The university professors will encourage student teachers to link theories that help support one or another way of organizing the lesson. The student teachers will be involved in coursework that supports their participation in the lesson study circle. Video lectures and videoconferencing make it possible for the teachers to participate in relevant sessions from school or home. Years of participation in lesson study circles by faculty members will result in a professional library that can be incorporated or modified for use in new lesson stories. Teachers help ground the discussion of theories with experiences of working with a specific population of students in a particular school.
- *Phase 4: Technology consideration.* During this phase, the team reflects on the best form of technology to use to present the lesson, discussing the pros and cons of different procedures. The students will be responsible for providing summaries of new tools, and the group will evaluate them. If learning new tools is required, the technology expert organizes instruction sessions for the team members. Because many different teams may be using similar technology, these workshops are scheduled regularly. The preservice teachers can demonstrate their mastery of technical skills by teaching them to students or teachers. Students (or teachers) in the classes may need technology instruction to prepare for teaching the lesson they are studying.
- *Phase 5: Teaching the lesson.* The lesson can be taught by one or more members of the circle, with all the others taking notes as their lesson is taught. The lesson is followed by a session of taped reactions and reflections by other members of the circle. The discussion centers on what the students learned or did not learn and predictions of how a different group of students might respond. The university professors help the circle think about how students' misconceptions might be used to help

foster deeper understanding. They serve as content resources and a source of ideas about how the content of the lesson might be tied to larger conceptual units.

- *Phase 6: Producing the lesson story.* The circle participants decide which parts of their circle experience will be included in their final production. The final product might include video segments of one or more members teaching the lesson, commentary by members on outcomes or underlying rationale, images of materials used, documents that can be printed and used with students, and Websites for extending the lesson. The goals are to capture the learning process around the study of the lesson and to provide the links and resources that will help others to learn. Taped segments from experts in or beyond the group might be used to highlight aspects of the learning. The focus might be on what students accomplished as a result of the lesson. The final production might reflect a strong consensus, or it can present multiple perspectives. A teacher might want to design a lesson that does not deal with one aspect of learning that one team member feels strongly about. These feelings can be expressed as part of the final product. The lesson story might show different ways of presenting the materials with a discussion of when to use one or the other approach.
- *Phase 7: Self-evaluation of the process and the product.* The circle closes with each person's assessing his or her own development and a group discussion about these assessments. The group knows that other lesson study circles will formally evaluate its lesson story.

University and School District Partnership

The university and school district enter into a one-year partnership. The school agrees to help the university in its task of educating new teachers, and the university provides its resources to help renew the professional development of practicing teachers. This proposal relies on the extensive placement of teams of learning guides in the school. Learning guides are paraprofessionals trained as part of the university's undergraduate education program (see below). The use of these learning guides makes it possible for teachers to invest the time in service to the university as well as professional development.

The district and the university work to support access to technology needed during the year of work in lesson study circles. One of the bene-

fits that teachers receive for their participation in lesson study circles with the university is a technology allowance provided by the district and the university. From the district's perspective, having technology integrated with lesson planning helps provide a clear context that motivates the purchase of the technology. These purchases can be used to guide implementation of technology in the district.

The University Program

The four student teachers who are placed together in a lesson study circle use this setting for their methods and student teaching experiences and collaborative planning for lesson units. Working out their ideas as a team better prepares them for these roles in the educational community at the school where they evertually teach.

Team Planning of Lesson Units

The preservice teachers from a lesson study circle form a cluster that works together on course modules requiring writing, developing Web tools, producing video segments, and assessing materials. A major assignment involves the collaborative development of a unit or cluster of lessons. These lesson units follow guidelines that have been constructed by university faculty and reviewed by practicing teacher partners each year. This unit may include the lesson that is the focal point of the lesson study or a completely different topic. The four student teachers will teach different lessons from the unit in the classrooms of their lesson circle teacher partners or in other classrooms. They will design the lesson unit as a team and evaluate each part of the lesson by watching and discussing the unit as each student teacher teaches a part of it. While a lesson is taught, the other members of the team evaluate the lesson as well as the progress of the unit. In some cases, modification and adjustments to the unit may result in the need to try the unit again in a different classroom.

Students are evaluated in terms of their collective plans for implementing a grade level or thematic unit that involves the cooperation of a number of teachers. The university and school partners serve as resources and mentors in this process, participating in on-line discussions among students. These meetings model the grade level or team planning that increasingly takes place in schools.

In this model, student teachers work intensely in a single school setting. If the school represents an unusual teaching condition, the student may lack experience in multiple settings. But it is possible that understanding acquired in a single setting will provide a better preparation for teaching than a superficial exposure to multiple settings. This process would create visual evidence of the challenges that teachers face in urban settings, and it may curb the tendency to assume that incompetent teaching is the major problem in these schools. It will force the educational community to look inside classrooms and try to resolve the problems, not as individuals facing impossible challenges but as teams with a range of resources.

Paraprofessional Learning Guides

If teachers are to participate in this form of teacher preparation, they need to have more time away from the classroom. This requirement could be accomplished by the addition of "learning guides" to the classroom. Learning guides are paraprofessionals who work in classrooms with students. Their role is not to teach but to moderate students' and groups' learning. Their preparation focuses on learning group management skills and techniques of observational assessment.

Many of the prerequisite courses for learning to teach are taught during 4-year programs at colleges and universities. For some students, these classes in child development, learning theories, and instructional technology constitute a minor in education. For others, they are the first stage of their preparation to be a teacher. In this plan, after students take a set of foundational courses, they can earn certification as learning guides. Students in 2-year colleges could also be certified as learning guides.

Students who complete a set of courses and fulfill a minimum requirement of 20 hours of field service in classrooms receive provisional 2-year learning guide certification. With this certification, students can work in schools part time. The flexible nature of the time commitment fits the unusual work constraints of university students. It would provide students who are considering entering the teaching profession an opportunity to work in many different classrooms.

Learning guides frequently work in teams. Teachers can use one or more learning guides to supervise students' work following a lesson. Learning guides with provisional certification cannot be left alone in a classroom with students, but it is possible for a teacher to leave a class in the care of a

team of learning guides. With provisional certification, a learning guide can supervise students in a ratio of one learning guide for every ten children with the stipulation that at least two learning guides need to be present in a room for a teacher to leave. (Certified learning guides can supervise whole classes.) Learning guides are not substitute teachers and would require restriction to make sure they are not used in this way. Learning guides could be restricted to periods of work with a specific class of no more than 1 hour at a time and no more than two hours in a single day. (Full certification as a learning guide requires an additional 500 hours of classroom experience and three teacher evaluations.)

The plan to certify learning guides has a number of benefits:

- *A career path for paraprofessionals.* Learning guides provide for the participation in schools of people who enjoy working with students but who are not sure they want to invest the time and effort to become professional teachers. Full certification as a learning guide provides a flexible, low commitment job ideal for parents of young children. It provides an avenue for learning more about working with children as a preparation for parenting or other careers involving work with children.
- *Preparation for teaching.* Work as a learning guide can provide a prospective teacher the opportunity to develop classroom management techniques independent of instructional practices. Observing how lessons are taught and monitoring students' learning processes can help prospective teachers formulate theories about the relationship between teaching and learning.
- *A solution to the shortage of teachers.* Freeing the teacher from management of individual and group work can provide the needed time to prepare and reflect on lessons. Powerful communication tools in the classroom make it possible for teachers to make maximum use of this time for interaction with a professional community.

Advantages of The Model

This proposal provides preservice teachers with a rich experience in using technology for teaching and learning in a collaborative context. It is designed to address a range of problems created by the separation of theory from practice. It blends university outreach with the instruction of new teachers. Different educational stakeholders would derive different benefits from the program:

- *Learning guides* would have an opportunity to work in schools without having to take on the role of a professional teacher. Some individuals have the ability to relate to students but not the time, energy, or intellectual orientation to be professional teachers. This opportunity to contribute to education values their skills as well as those of professional teachers.
- *Preservice teachers* have the experience of group planning and working in a team to create a knowledge product. This experience will help them understand the way this model could be used in the classroom. They share their resource of learning time with the circle and begin their teaching careers with their first coauthored production.
- *University professors in education* are part of a structure in which they publish their ideas as they teach. Often in education programs, teaching requirements make it difficult to share their ideas beyond the classroom. The lesson story can serve as a form of publication. They will be constantly forced to relate theory to practice and to deal with the complexity of teaching with specific contexts.
- The *university* benefits by making teachers from other disciplines available to teach in lesson study circles. The university-wide investment in education signals to the community the importance of education. The interaction between the education department and other departments helps create a mechanism for reflection on university teaching and a way of new technologies for teaching and learning to be shared with the university community.
- *Practicing teachers* participate in reflection on their teaching. They are exposed to new ideas and new forms of technology proposed by preservice teachers. They also benefit from the addition of paraprofessionals to the school staff who make it possible for them to leave the classroom and become involved in rich learning communities.
- *Schools* are helped to create personal libraries of their best practices and have a process that encourages teachers to review, evaluate, discuss, and revise the lessons in their libraries. These lesson stories are a visual report card to the public and, like written products, have value that could bring recognition to the school. Lesson study circles also provide a structure for the introduction of new technologies to the school.
- *Education technical experts* learn to provide technical support in the service of educational projects. Technology experts will be guided in

their own choices of technology by educators who need to know how to accomplish educational goals with technology.

- The *education community* creates professional visual practice "standards" to link with conceptual standards. A digital library helps provide images of what takes place in classrooms when a lesson plan is followed in a particular setting.
- *Students* are engaged in public displays of learning, which the community values. Although issues of privacy need to be determined and dealt with, students will see that the community values what they do in classrooms.

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Technology and the Changing Roles and Responsibilities of Teacher Educators

■ Richard L. Schwab

The newest crisis that threatens schools, colleges, and departments of education (SCDEs) is the technological revolution. As teacher educators, we have been called to arms in the minimal competency, high stakes testing, back to basics, diversity, alternative certification, and others I can't remember revolutions. Having no Congressional medal of honor to show for our deeds but many purple hearts, how do we know this revolution is any different? Will we be able to tweak a few courses, add a few competencies to our outcome measures, talk tech, and win this war? I think not.

What Makes This Revolution Different From the Others?

- *Technology is not something isolated in the world of education.* In the last decade, technology has transformed almost everything we do, from the way we shop, cook, bank, and plan trips to the way we communicate with each other. People in general may not know the impact of standardized tests on classrooms, but they do know the effects technology has had on our society. We can't talk our way around the issue. The public expects us to use technology to enhance students' achievements, improve productivity, and prepare students for the workplace.
- *Teacher educators are not in the lead.* The generation of students entering our teacher education programs knows more about using technology than many of our teacher educators. In addition, investments by school districts, federal and state governments, and foundations in K-12 technology have resulted in many schools' being better equipped than some schools of education and many teachers' knowing more about using technology effectively than many teacher educators. Although some programs or departments in our SCDEs lead the way in using technology, the majority of teacher educators lag behind our nation's teachers in using technology. Likewise, many K-12 facilities are better equipped than our SCDEs to model effective and seamless use of technology in all aspects of our daily lives as teacher educators.
- *Learning with technology works.* I recently completed a study with two colleagues that reviewed more than 200 technology projects in schools

over a 4-year period (Foa, Johnson, & Schwab, 1997; Foa, Schwab, & Johnson, 1998; Johnson, Schwab, & Foa, 1999). Over and over again, we witnessed how talented teachers have used technology to transform their classrooms into vibrant learning communities. We have observed people of all ages, backgrounds, and locations use technology to enhance achievement, break stereotypical perceptions, and kindle or rekindle the joy of learning. For example, we observed 2nd and 4th grade students in Seattle conducting field studies to identify streams where they could release salmon fry they had raised in four different schools. They gathered data, recorded it on laptops, analyzed the data, shared information on results over the Internet, videoconferenced with other schools about their projects, and created their own Webpages. They released their fry into the stream that they predicted would be best for their survival. While research, problem-solving, data analysis, and writing skills were all important learning outcomes from the project, the most important result we observed was the joy and motivation the students displayed as they worked. The joy of learning these children experienced is something that is not being discussed on the agendas for national reform or state competency tests, but it is safe to say as many future scientists were hatched and nurtured as were salmon fry.

Considerations for Integrating Technology in Teacher Education

- *Technology is a tool.* Although technology is a powerful tool for a teacher, it will never replace an effective teacher. In the hands of a poor teacher it is a useless tool; in the hands of a good teacher it is a powerful tool. Knowing how to build an electronic portfolio for assessing student learning is useless if you do not know how to assess students' knowledge effectively. If a teacher does not have sufficient knowledge about a subject area to distinguish good information from misinformation, using the Internet to locate information is a waste of time. If a teacher spends most of the day on mindless worksheets, then transforming those worksheets to computer programs is equally mindless. The first thing we must do therefore is to focus on our core business and be selective about whom we admit and graduate from our teacher education programs. Our students must have a solid foundation in their content area as well as in how people learn. Pedagogical coursework and clinical experiences should be taught in the context of how

to use technology to enhance teaching and learning, resulting in higher achievement for students in all subject areas.

- *We must walk the talk.* If SCDEs are to establish themselves as leaders in using technology, then we must model effective use of technology in all institutional aspects. That means we must do such things as use effective data-based decision making in managing our SCDEs, take advantage of distance learning to provide convenient access to quality education, ensure all classroom instruction models effective use of technology, and create on-line learning communities where faculty and students share knowledge and experience across cyberspace. Simply put, effective use of technology must be embraced beyond courses in educational technology. It must be integrated seamlessly.
- *SCDEs must invest in the infrastructure.* If technology is to become a ubiquitous tool for learning, then it must be fully accessible on demand, not down the hall in a locked room that is open from 8 a.m. to 5 p.m. Would businesspeople use technology if they had to jump those hoops? Basic infrastructure begins with hardware and software. Every office and classroom needs plug and play capability with appropriate software—which means SCDEs must restructure their budgeting process to allow for wise purchase (or lease) and maintenance of regularly updated hardware (with a 3-year life span), a core package of supported productivity software, and network connections (servers and wiring).

  Support personnel are the most important part of infrastructure support. Networks need to have competent on-site managers to keep things moving. If faculty need to develop course materials, they need access to programmers to build what they design. Universities have created centralized support systems that have minimal effect on change at the school level. Depending on highly centralized support staff does not work in managing technology or in professional development activities.
- *Professional development needs to model best practices.* Perhaps more than ever, the need for faculty to be lifelong learners is highlighted by the need to retool faculty skills for the integration of technology into education courses. Centralized workshops on generic topics (such as how to use PowerPoint) will not transform faculty and staff and are not an effective use of valuable resources. Professional development should be job-embedded and just-in-time and should take full advantage of available technology to facilitate learning. If faculty are to embrace technol-

ogy, it must work and make their jobs easier, not complicate or make them more difficult. Consequently, it is not unrealistic to think that at least 25% of an SCDE technology budget should be targeted initially for professional development.

- *We must document that our investment pays dividends.* Although we believe that technology can enhance learning, make us more cost-effective, and increase accessibility, we must prove it. Ongoing evaluation of technological innovation is essential for improving practice and benchmarking growth.

  Savings from data-based decision making and sharing faculty resources via distance learning are easier to document than improvements in achievement. With the large investments continuing to be made to equip K-12 classrooms, the effect of technology on students' achievement is a question on the minds of parents, legislators, business leaders, and educators. While the wide variety of technology and its uses limits an answer to the question at that level, researchers must address more precise questions about specific uses of specific technology and their impact on thinking and learning. For example, supporting electronic portfolio development, storage, and on-line review of portfolios by faculty can enable and enhance techniques for assessing future teachers on how they learn as well as what they learn. And it can serve as a model for how K-12 teachers can begin to assess their students on process as well as products when they get their own classrooms.
- *We must use technology to develop mutually beneficial partnerships.* We can use technology to become much more efficient and effective in our delivery of programs. For example, distance learning techniques can bring closer connections with professional development schools without the time, expense, and scheduling problems associated with on-site meetings. Chatrooms and discussion lists such as WebBoard can be used to create learning communities for student teachers, while advanced ATM and digital video connections cameras can allow for classroom observations that do not interfere with the normal interactions in a classroom.

  Technology can also be useful in sharing resources with fellow institutions by enabling access to national experts and specialty interests that not all SCDEs can afford to have on staff. It may be that, in the future, joint appointments will begin to appear among SCDEs in dif-

ferent universities, K-12 schools, state departments of education, and private organizations. It is possible that individuals with such joint appointments would never set foot on campus but would communicate virtually.

- *Supporting and mentoring new teachers and enhancing educators' professional development are vital.* With technology as simple as e-mail (but also WebBoards and Netmeeting software and the like), faculty can stay in touch with students, supporting them through the critical first years of teaching and beyond (as well as fulfilling the moral obligation to help graduates succeed). When graduates feel supported, they are more likely to give back to the institution as their earning potential increases.

  In the same vein, distance learning can facilitate the access to professional development of teachers just-in-time at their school desks. Creatively designing and delivering such programs can have a tremendous effect on improving student learning in all our nation's schools.

Summary

Although the challenges are many, the potential for accomplishing the dreams of those who established our common school system in the United States has never been brighter. Technology is not the answer to all our educational problems, but it does give us a tool that can have a bigger impact than the invention of the printing press. We must use this tool wisely and enable our teachers and professors to continue to adapt to a very dynamic and challenging time.

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Technology and Expectations for New Teachers

■ Lajeane G. Thomas

Evolving expectations for new teachers reflect sweeping changes in American society. The economy of the 21st century will be dynamic, ever changing, and interactive worldwide. Graduates of our educational system will prepare for careers that did not exist a few years ago. Technology is changing the work we do, how and where we do it, and with whom we interact. The proliferation of new technology-related jobs and electronic communications and information resources is changing what is expected of our educational system and the new teachers joining it.

Societal change historically produces widespread change in education. Unleashing the power of technology for learning, information exchange, and communications has the potential to effect dramatic changes in how faculty facilitate learning, how students contribute to the learning process, how knowledge is demonstrated, and even the venues where learning takes place. These possibilities challenge teacher educators to design experiences for teacher candidates that apply the power of technology to address new expectations of today's students in the areas of learning and communications (Thomas & Knezek, 1999).

Compounding the effect of rapid economic change on education is a predicted shortage of experienced teachers. In less than a decade, America's schools will need to hire more than 2 million teachers to handle increased enrollment, replace an aging workforce, achieve smaller classes, and respond to the chronic attrition of novice teachers. Although some of those hired will be former teachers returning to the field, most—one-half to two-thirds—will be first-time teachers (Riley, 1998).

The challenges and opportunities these new teachers will face are different from those of the past. The children they will teach are more diverse than ever before. They come from differing cultures and speak different languages. Many of them come from disadvantaged backgrounds, and many of them have special needs (DeWert, 1999).

Moreover, standards for student learning are higher than ever before, and teachers are being held accountable for ensuring that students achieve those standards. Basic skills such as reading, writing, and mathematics are still

important, but they are no longer sufficient to prepare students for a life of successful learning and work in the 21st century. To succeed, students must have communication and information-processing skills that go well beyond the ability to read and write, and they must master workplace skills such as managing resources, working on teams, negotiating, evaluating data, solving problems, and selecting and using appropriate technology to do their work (International Society for Technology in Education, 1998).

At the same time, new teachers will have many opportunities. Over the past two decades, our understanding of learners, learning, and practices that enable learning has expanded greatly (Bransford, Brown, & Cocking, 1999). New teachers will also have access to more information technology tools and resources than ever before (Anderson & Ronnkvist, 1999). And a growing body of evidence suggests that when information technologies are made available to teachers who understand how, when, and why to use these tools and resources to enhance teaching and learning, our nation's children realize important educational and workplace-readiness benefits (Rockman, 1999; Schacter, 1999; Wenglinsky, 1998).

Teacher preparation has emerged as a critical factor in ensuring that new teachers' practice embraces the best that technology can bring to learning for all children. This raises an important question: How must the roles and responsibilities of teacher educators change to address the impact of technology?

Technology resources, increasingly available in K-12 classrooms, add important tools to a teacher's repertoire of resources for addressing the tasks incumbent on teachers working in a modern educational system. These tools are effective for improving student learning only if the new teacher has had opportunities to apply technology for learning in his or her teacher preparation experiences. Colleges of education must establish modern teaching/learning environments that reflect the increase of technology resources available in schools. University faculty and supervising teachers in the field must then provide experiences throughout the teacher preparation program that model and apply the use of technology for improving student learning and provide opportunities with technology enhancement for teacher candidates to plan, observe, and practice facilitating learning and communications.

All teachers should arrive at their teaching assignment with skills and dispositions that prepare them to apply classroom technology resources at least at

the level described in the International Society for Technology in Education (ISTE)-recommended Technology Foundations Standards for All Teachers.

ISTE Technology Foundations Standards for All Teachers

The ISTE Technology Foundations Standards for All Teachers reflect professional studies in education providing fundamental concepts and skills for applying information technology in educational settings. All candidates seeking initial certification or endorsements in teacher preparation programs should have opportunities to meet these educational technology foundations standards.

A. Basic Computer/Technology Operations and Concepts. Candidates will use computer systems to run software; to access, generate and manipulate data; and to publish results. They will also evaluate performance of hardware and software components of computer systems and apply basic troubleshooting strategies as needed.

1. operate a multimedia computer system with related peripheral devices to successfully install and use a variety of software packages.
2. use terminology related to computers and technology appropriately in written and oral communications.
3. describe and implement basic troubleshooting techniques for multimedia computer systems with related peripheral devices.
4. use imaging devices such as scanners, digital cameras, and/or video cameras with computer systems and software.
5. demonstrate knowledge of uses of computers and technology in business, industry, and society.

B. Personal and Professional Use of Technology. Candidates will apply tools for enhancing their own professional growth and productivity. They will use technology in communicating, collaborating, conducting research, and solving problems. In addition, they will plan and participate in activities that encourage lifelong learning and will promote equitable, ethical, and legal use of computer/technology resources.

1. use productivity tools for word processing, database management, and spreadsheet applications.
2. apply productivity tools for creating multimedia presentations and Web-based products.

3. use computer-based technologies including telecommunications to access information and enhance personal and professional productivity.
4. use computers to support problem solving, data collection, information management, communications, presentations, and decision making.
5. demonstrate awareness of resources for adaptive assistive devices for student with special needs.
6. demonstrate knowledge of equity, ethics, legal, and human issues concerning use of computers and technology.
7. identify computer and related technology resources for facilitating lifelong learning and emerging roles of the learner and the educator.
8. observe demonstrations or uses of broadcast instruction, audio/video conferencing, and other distant learning applications.

C. Application of Technology in Instruction. Candidates will apply computers and related technologies to support instruction in their grade level and subject areas. They must plan and deliver instructional units that integrate a variety of software, applications, and learning tools. Lessons developed must reflect effective grouping and assessment strategies for diverse populations.

1. explore, evaluate, and use computer/technology resources including applications, tools, educational software and associated documentation.
2. apply current instructional principles, research, and assessment practices as related to the use of computers and technology resources in the curriculum.
3. design, deliver, and assess student learning activities that integrate computers/technology for a variety of student group strategies and for diverse student populations.
4. design student learning activities that foster equitable, ethical, and legal use of technology by students.
5. practice responsible, ethical and legal use of technology, information, and software resources (International Society for Technology in Education, 1996).

If we accept these expectations for teacher preparation programs and teacher candidates, the responsibility for preparing teachers to provide these experiences is placed squarely on the college of education faculty and their

collaborative teacher preparation counterparts in the university arts and sciences departments and K-12 cooperating classrooms. Teacher preparation programs that prepare candidates to effectively use technology depend on more than just access to technology. Leadership, resources, and other support must be in place to fulfill that responsibility. Physical, human, financial, and policy conditions greatly affect the success of technology use in colleges of education and schools. To equip teacher candidates with foundational knowledge, skills, pedagogy, and dispositions expected of the new generation of teachers, colleges of education must institute a combination of conditions that provide essential support for learning environments conducive to effective preparation of teacher candidates for powerful uses of technology.

Essential conditions for teacher preparation programs addressing new technology expectations for teachers include:

- Proactive leaders providing vision and setting high expectations for effective technology preparation of candidates,
- Faculty (arts and sciences, teacher education, and cooperating K-12) skilled in the use of technology for learning, communications, and scholarly activity,
- Research- and standards-based curricula developed collaboratively by faculty (arts and sciences, teacher education, and cooperating K-12) with effective use of technology interwoven throughout,
- Student-centered approaches to learning facilitated by technology,
- Tools for assessment of students' performance supported by technology,
- Access to contemporary technologies, software, and telecommunications networks,
- Technical assistance for maintaining and using technology resources,
- Professional development opportunities readily available, of high quality, and relevant to needs of faculty and candidates,
- Planned and ongoing financial support for sustained technology use,
- Policies and standards supporting new learning environments in which technology facilitates interactions with teacher candidates and cooperating classrooms on campus and in remote locations.

When these conditions are addressed, the foundation for supporting integration of technology in teacher preparation is a firm one. The teacher preparation faculty can build a program on that foundation for readying the new generation of teachers to be prepared for 21st century teaching.

Colleges of education, through high quality preparation of our future teachers, must lead the way in reshaping our educational system to take advantage of the available technologies that are rapidly becoming integral to success in our information-based society.

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The Challenge of Faculty Professional Development: New Approaches and Structures for Teacher Educators

■ Ann D. Thompson

The need for colleges of education to effectively infuse technology into teacher education has been clearly established. After completing a comprehensive review of the literature on information technology and teacher education, Willis and Mehlinger (1996) concluded:

> Most preservice teachers know very little about effective use of technology in education and leaders believe there is a pressing need to increase substantially the amount and quality of instruction teachers receive about technology. The idea may be expressed aggressively, assertively, or in more subtle forms, but the virtually universal conclusion is that teacher education, particularly preservice, is not preparing educators to work in a technology-enriched classroom. (p. 978)

In fact, many observers currently suggest that infusion is not a strong enough word for the type of use teacher education needs to make of technology. Advocates of this point of view suggest that technology needs to be more than infused into current teacher education programs. They suggest that technology should be used to assist in the transformation of teacher education and that technology provides tools and the opportunity to create experiences never before possible in teacher education programs. Both the infusion and the transformation models share the need for education for teacher education faculty, however.

It seems clear that traditional professional development models are not working for teacher education faculty (Milken Exchange on Education Technology, 1999; National Council for Accreditation of Teacher Education, 1997; Office of Technology Assessment, 1995). Although many colleges and universities around the country have worked to make technology workshops and experiences available for teacher educators, few have provided evidence that these workshops are either well attended or effective. Evidence from several national studies indicates that teacher

education faculty need more effective methods of learning both the how and the *why* of using technology.

The special needs of using technology in classrooms require faculty members to learn to use the technology and to learn to adopt new pedagogical approaches. Although technology workshops may help address the first need, these workshops will not help the faculty define and implement meaningful uses of the technology that will expand and enhance teacher education programs. A multifaceted approach to professional development for teacher educators that would address the challenges of this complex area includes instituting one-on-one mentoring for teacher education faculty, developing networks and models for sharing approaches among teacher education institutions, and establishing professional rewards for teacher educators who invest their time and professional expertise in technology in teacher education projects.

One-on-One Mentoring

Results from teacher education institutions that have instituted one-on-one mentoring programs for faculty members are almost universally positive. In general, these programs are characterized by the use of graduate or undergraduate student technology mentors who work one on one with teacher education faculty. Such mentoring programs allow individualized instruction that meets faculty members' specific needs. In most of these programs, the faculty members chose topics they wanted to explore with their mentors.

The College of Education at Iowa State University began a student-faculty mentoring program in 1991 (Thompson, Schmidt, & Hadjiyianni, 1995). Data collected from the program provide significant insights into the structure and results of one-on-one mentoring. Over the years, data from the mentoring program indicate that several characteristics help facilitate the success of mentoring programs:

- establishing regular meeting times for mentor and mentee,
- setting goals collaboratively,
- making technology available for the faculty member involved,
- being flexible to meet the emerging needs of the faculty member as the mentoring progresses,
- clarifying the assumption that the mentor assists the faculty member in learning about technology but does not do the technological work for the faculty member,

- providing the opportunity for the mentor to get to know the faculty member and to learn about his/her approaches to teaching and learning,
- providing the opportunity to continue the mentoring after the initial semester.

Faculty members have been extremely positive in their reactions to the mentoring program; they indicate that the mentoring has increased their confidence in their ability to learn about and use technology and their willingness to try technology applications with their students. Further, the one-on-one nature of the programs provides the opportunity for meeting their individual needs and allows them to learn about technology "in private." Many faculty members have indicated that they dislike workshops because they fear exposing their lack of knowledge in the area of technology. Faculty members also indicate that the typical 1-hour per week mentoring sessions provide a structure and time for learning about technology. Many faculty members have reported that they are surprised at the amount they are able to learn in these weekly sessions and that structuring times to learn about technology has been very useful for them.

Although this approach provides an effective way for the faculty to learn about technology, the mentoring alone is generally not enough to successfully enable use of technology in teacher education classes. Mentoring programs can help faculty members develop the technological skills necessary, but they also need help with the pedagogy associated with use of technology. Faculty members need additional programs and approaches to help them create visions of how technology can improve teacher education and provide access to tools and approaches developed by others. In addition, work with technology must be incorporated into the higher education reward system.

Networks Among Teacher Education Programs

The task of effectively infusing technology into teacher education programs and using technology to help transform these programs is far too large to be handled individually by teacher education institutions. Teacher education institutions must work together to communicate about effective approaches and to share effective materials. Developing effective approaches to using technology and developing materials for teacher education are enormously time-consuming activities. Currently, many simi-

lar approaches and materials are being developed simultaneously by teacher education faculty members throughout the country. Structures to facilitate sharing work in technology in teacher education must be developed and maintained. These structures might include national and/or regional centers dedicated to the dissemination of knowledge and materials on the use of technology in teacher education.

In addition to sharing knowledge and materials, teacher educators must also begin to share models of effective use of technology in teacher education. Most teacher educators have never observed effective use of technology in teacher education, and most need active models that they can use for their own teaching. Given the new video-streaming capabilities, making these classroom models available for teacher educators should be a relatively simple task. With these video models, for example, a math educator would be able to see what effective integration might look like in a mathematics education classroom and a foundations educator might see examples from a foundations classroom.

Faculty Reward Structure

Realistically, it is unlikely that teacher education faculty members will be able to respond to the need to strive toward meaningful use of technology in teacher education unless the current reward structure for faculty members is adjusted. Administrators need to revise evaluation structures to include faculty work with technology. The faculty must receive credit for work developing approaches to using technology in teacher education, and products produced by the faculty must be valued as contributions to knowledge. We are accustomed to providing faculty members with scholarly credit for written products, and we must now develop mechanisms for recognizing the creation of technology products.

Summary and Conclusions

There is little argument to the assertion that technology can provide powerful tools for renewal of teacher education, but the issue of developing the faculty's knowledge of the how and the why of technology use is a major challenge. One-on-one mentoring, collaborations among colleges of education in sharing technology materials and models, and including the development of technology tools in the academic reward structure can help make innovative and appropriate uses of technology in teacher education a reality.

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Harnessing Technology as a Tool for Teachers and Students

■ Pete Tuana

My comments about the impact of technology on teacher training are from my perspective as principal of a comprehensive high school located in the middle of Silicon Valley. Fremont High School's teacher training program attempts to address the questions of how technology alters the definition of work for preservice teachers and teacher educators, what challenges technology offers for the organizational structure of teacher education, how teacher educators might use technology in conceiving of and delivering teacher education program, and how technology alters the definition of work for in-service programs.

Fremont High School is located just one mile from Apple Computer's headquarters. Its rich 75-year history has seen changes from a community of farms and orchards to today's high-tech industries. The student body in many ways mirrors the emerging diversity of California: 58 different languages, 10% recent immigrants, many complex social and economic conditions. The staff turns over rapidly, and both experienced veterans and new staff need continuous training. Yet despite the change, Fremont has found the way to generate a learning environment that is inclusive for staff and students alike. At the core of much of Fremont's work is an attempt to answer the question of how to harness technology so that it becomes an effective tool for teachers and students.

The Bay Area National Digital Library

Most Americans know that the Internet and technology in general are thought to hold tremendous promise for improving teaching and learning and transforming how schools do their work. But everyone working in a school also knows that we have far to go to realize the promise of a technology-supported curriculum. We at Fremont High believe that part of the power of technology is linking it to an inquiry-based curriculum, using it to engage students in exploring important questions, and using real world resources to do so.

In spring 1998, Fremont High School, a middle school, and an elementary school joined the first phase of the Bay Area National Digital Library (BANDL) research and development project to explore the development of technology-supported, inquiry-based learning lessons by testing them in teachers' classrooms. Based on early observations, we are confident that this project will develop and document new approaches to preparing teachers to use technology effectively and, more important, to improve students' academic success.

BANDL is an exciting opportunity for teachers, librarians, and information specialists to explore new forms of collaboration, improve teaching (especially the humanities), and learn more effective uses of technologies. The use of digital libraries, which contain vast quantities of primary resource documents, can alter teaching and learning for students and teachers. No longer is the teacher the only expert: Students and teachers can together reconstruct learning supported by technology.

Fremont's foundational work for the BANDL project has been completed. Some of our early findings are that:

- Teachers need to have relevant curricular content to focus student learning; therefore, primary source documents and inquiry-based lessons are essential.
- To sustain learning, understanding the end product of essential learnings is much more critical than the creation of interesting activities focused around technology. Therefore, the teacher must understand authentic assessment strategies that allow students to demonstrate knowledge while providing a framework for the teacher to know when students understand the knowledge.
- Development and delivery—teaching teachers how to develop lessons and delivering the product—are equally important. Most current staff training consists of a variety of workshops and conferences, but rarely do we learn to use technology in the classroom by ongoing, coached training. Fremont teaches the framework for the use of technology and then provides ongoing coaching by experts in the classroom as well as monthly meetings for collaboration and reflection.

The Professional Development School

Fremont High School and Stanford University have together established a professional development school to explore and coordinate the resources of the Stanford Teacher Education Program (STEP) and a high school staff training program. The construction of a learning community of teachers from preservice to seasoned professionals presents an interesting challenge. It is clearly a misconception that all new teachers are skilled in the use of technology. We have discovered that many have only basic skills and that familiarity does not necessarily translate to the ability to apply technology in the classroom. Training this broad spectrum of teachers with varying skills in technology presents additional challenges. Some strategies we are currently using include:

- Including new teachers in all the staff's training and work to encourage more opportunities for all staff to learn collaboratively. It also establishes relationships among adults and supports the concept of a total learning community sharing ideas and growing together.
- Using videoconferencing to expose preservice teachers to a variety of teaching styles and strategies. Practicing teachers can discuss skills, strategies, and results with preservice college students through electronic media.
- Using videoconferencing to provide feedback from university staff to new teachers in a timely manner. Classrooms are being created that allow

for multiple video takes. Live video will create an opportunity for remote coaching by university staff during a lesson. Taped lessons can be digitized and archived for new teachers to include in portfolios and resumes.

Just-in-Time Learning

Fremont also considers just-in-time learning—the concept that students learn much of what they know about technology on a need-to-know basis—an important part of teaching students. It is important for staff to understand this aspect of student learning and, if possible, adapt the strategy in teaching teachers how to use technology. Many teachers who are used to teaching in a linear manner, one step at a time, also learn in this manner. We need to help teachers understand that complete subject knowledge is not so critical in educating students of the future. Our schools need teachers who are well trained in content, curriculum development, and learning, yet they also need to understand that they are part of a learning community that includes students. Understanding this challenge may alter the way we think about training teachers.

On-Line Learning

Over the last few years, Silicon Valley industries have begun to develop on-line learning programs, which may include learning about new product information as well as new business skills and applications. How does this concept apply to the training of teachers and schools of the future? The University of Nebraska, among others, already offers on-line learning to high school students. Fremont High plans to provide on-line instruction to some students in the near future. Current teacher training programs have not explored the development of vital skills for teachers working in this arena. How do we maintain relationships and help students' social development while providing on-line instruction? When is on-line instruction acceptable? How do we effectively assess students' progress? This area may deeply affect schools, but teacher training institutions have not begun to consider how to deal with this issue.

Summary

Teacher training needs reform as much as our schools. Teacher training is relatively unchanged; even though we know much more about learning,

we still have not altered our methods of training teachers. Developing educational communities that respect the ability of all to contribute to learning will allow us to create opportunities that become inclusive in the development of teachers for the future. We can use the experiences of seasoned practitioners, the theories and intellect of university faculty, and the exuberance of young teachers to collaborate, reflect, and create new learning environments. Technology and teacher training will be critical components of school reform. We have no choice but to find new answers.

Five Critical Skills for Tomorrow's Teachers

■ Allan H. Weis

This paper was written from the viewpoint of a businessman who has been involved in computer and communications networks for the past 40 years. It briefly describes the forces behind the rapid transitions occurring in today's world and the five critical skills tomorrow's teachers and their students must master. If tomorrow's teachers can master these five skills so that their use of technology becomes easy and fluid, the very nature of their work will change.

A World in Transition

Today there are no borders, information moves almost at the speed of light, and the resources of the world are available in one's home—the result of the use of the computer and network technology that many now take for granted.

During the first five years after the introduction of the computer, most people felt that computers had almost no impact on their lives. But for the past 40 years, computers and their underlying technology have been improving at the rate of tenfold every 5 years. That's 100 million times in the past 40 years. Dramatic improvements in price and performance have moved computers and networking into our everyday lives.

Younger people are learning how to use computer and network tech-

nology to do the things we used to do in totally different ways, making our old fundamental business models obsolete. Who would have thought just 10 years ago that almost everything you need can be ordered from the comfort of your home via the Internet or that computers would be given away free so that donors could control what you see? The Internet is changing the ways we look for information, buy our toys, and interact with others. But we have seen only the tip of the iceberg.

As a direct result of these advances, almost every area of the economy has been able to dramatically change the way it does business. Companies have used computers and networks to cut their costs. Such investments have led to the productivity and the economy we now enjoy. But in education, in so many instances, the investments in technology require "new money" with no displacement. This model is broken!

Our world is in transition, and we need to change the way we view technology in education and the way we educate our teachers (and their students). Those who allocate the funds for technology must believe in and demand the same improvements industry has reaped for decades. They must enable tomorrow's teachers to enter the classroom ready to make their students competitive in the rapidly changing world economy.

The Internet gives us an opportunity for a whole new style of learning. It provides an enormous reservoir of timely information and encourages our exploration and collaboration. It allows powerful multidimensional, relational, educational learning tools to evolve. It stimulates the creative juices in many people, and it is having an increasingly profound impact on our everyday lives.

This impact has rippled through the business community and some of the more technical schools in universities. Basic methods of learning and ways to find needed information quickly are shifting in those environments, and the schools and colleges of education should help tomorrow's teachers prepare for that changing future.

To help make students competitive in this world, teachers must, in their own disciplines, master five critical skills. It is the teachers who will have to teach the students these skills; thus, they themselves must be computer and information literate.

The Five Critical Skills

Students (including tomorrow's teachers) must master the following five critical skills to be successful in this changing world:

- Have the ability to use technology as an extension of themselves,
- Be information literate,
- Be an efficient collaborator,
- Be able to learn how to learn, and
- Have the ability to help others.

First, if students are to succeed in this new millennium, *they must learn to use technology as an extension of themselves,* much the same way they use their legs to walk down the street. Its use must be transparent and be only a tool to gain insight and knowledge. Students not only have to be familiar with technology but also master it and become technology athletes.

Using computers and the Internet to gain access to resources should be as natural for students and teachers as asking their friends a question. Comfortable and competent use of computers and the Internet will be as critical in the future as reading and listening are today. It's just another—but much more powerful—form of gaining information. But students must be advised to be intelligently selective, because there is so much information on the Net.

Students need to be information literate, able to easily find, filter, and use information effectively. They must understand that there are many forms of information, and they must learn how to discern the reliable and sensible information from the spurious or questionable. They need to learn how to make good judgments about the quality and validity of the mass of information. Students also must learn that different information has different forms of ownership and protection, and they must understand proper use of information.

The power of technology also brings a more human element. *Students must learn how to collaborate with each other,* how to take advantage of each other's skills to form cross-disciplinary groups. In the past, when problems were smaller, learning was an individual activity. Learning is changing from listening to a teacher and studying in a room to a more interactive exercise with others, who may be neighbors or persons on the other side of the world with quite different languages and experiences.

Being able to form and maintain good working relationships with other, sometimes distant fellow students will become a critical skill. Successful collaboration occurs when the collaborators trust each other and can depend on the other collaborators to fulfill their roles. But how

can you trust someone you have never met when all you have is his or her handle and an e-mail that says "OK, I'll do it"? Students must learn to expect what they inspect. By doing so, they can build, in small steps, the trust and interdependence that leads to successful collaboration. It is a lesson that goes beyond the Net.

In this new millennium, when the problems to be addressed may be increasingly complex, collaboration will be a key way for people to learn and work. Schools, like businesses today, could evolve to be collaborators where students work together on projects and teachers are coaches rather than lecturers.

Students must learn how to learn, because learning is a lifetime endeavor. When students learn how to learn—not merely memorize facts to pass a test—they will be equipped to make rapid transitions, a vitally important skill in this rapidly changing world.

But learning is not just absorbing and understanding content. To succeed and achieve their potential, both teachers and students must learn how to manage their time, for it is a perishable resource. The world where teachers and students live will be shaped by them and their values, bringing us to the final point.

Students must learn how to help others. Those who have mastered the use of technology have a social responsibility to help others who are less technologically advanced. They need to give back intellectual assistance, not just old clothes and money, and if they do not, the digital divide will only widen. The instabilities created by this chasm can make society more hostile, diminishing comfort and safety for all people.

Conclusion

Tomorrow's teachers, and the institutions that educate them, live in a world that is in transition. This is a fact. If the institutions do not use technology well and graduate educators who are information and technology illiterate, all of society will suffer.

Recommendations for Action

1. Technology should be used to promote the establishment of more powerful learning communities. Specifically, SCDEs must address:

- the need for self-directed learning and collaboration
- the need for ongoing modeling and facilitation of effective collaboration
- the provision and support for seamless connectivity
- the access to learning/resources across time and distance
- the development of technology-based knowledge products

2. Technology should be used to change the traditional ways that teacher educators teach and evaluate instruction. SCDEs must address:

- the delivery of instruction to provide for different learner needs
- performance outcomes to evaluate effectiveness and completion
- the full range of learning abilities and styles
- engagement of students and teachers in legitimate and authentic knowledge production
- evaluation of and effective and proper use of modern information resources
- choices available to the teacher and the teacher educator, including concepts of information, knowledge, and tools for research

3. Technology should be used to allow for more individuals to participate in the preparation of teachers to teach. SCDEs must use technology to incorporate a variety of human resources in providing rich learning experiences for teacher candidates.

4. Technology should be used to facilitate joint planning, implementation, and evaluation of teacher education as a partnership of colleges and school districts.

5. Support for technology integration must be provided on various levels, including technical support, educational support for the redesign of curriculum, and information support for community knowledge-building.

6. Technology should be used to facilitate the creation of new partners in the conception and delivery of teacher education programs. SCDEs must address:

- establishment of for-profit partnerships
- development of policies regarding intellectual property, ethics, and values addressing new technology-based entrepreneurial ventures

7. Distance learning technology should be used to facilitate the collaborative co-construction of teacher professional development programs across boundaries. SCDEs must address:

- development of inter- and intra-institutional relationships to support teacher preparation
- access to content experts
- opportunities to observe and interact with a variety of classroom settings.

Issue Area Five

Redefining Teaching and Implications for Schools, Colleges, and Departments of Education

At the heart of the future vision of the teaching profession is the concept of education being learning-centered. Armed with new tools for teaching, teachers will become facilitators of learning rather than masters of knowledge. Schools, colleges, and departments of education (SCDEs) are responsible for training new teachers to successfully use new technology and teach their students to process the information available to them through new media. The papers in this section look at how teaching will be redefined and how SCDEs must be prepared to train 21st century teachers.

A Call for a National Effort to Develop Technology-Proficient Educators

■ Thomas G. Carroll

Teacher preparation has emerged as a critical factor limiting the contributions of new technologies to improved education. We are making significant progress in equipping our schools with modern learning tools. Now we must accelerate our efforts to develop educators who know how to use these resources to teach 21st century students. It is time to join forces to ensure that all future teachers are technology-proficient educators.

Through federal, state, and local agency programs, we are investing billions of dollars annually to provide our schools with computers and Internet access. These initiatives, combined with national volunteer efforts and philanthropic commitments, are making significant inroads into the equipment and networking our schools need. But despite these investments, only 20% of the 2 million teachers currently working in our schools are comfortable using these technologies in their classrooms.

This finding is particularly alarming in light of recent research showing that classroom technology makes its greatest contribution to improved student achievement when it is used by well prepared teachers who know how to use these modern learning media to engage students in complex reasoning and problem solving. In fact, the research indicates that when computers are used primarily for drill and practice, they can actually impair students' achievement.

Despite our efforts to furnish their classrooms with state-of-the-art equipment, the majority of our students are being denied full access to the power of these new learning tools because their teachers are not technology proficient. Students in low income schools and rural areas are at a particular disadvantage. These students rely heavily on their schools for access to computers and the Internet, and they will fall farther behind students in more affluent communities if they do not have teachers who know how to use these tools to engage them in challenging learning activities that help them meet high standards.

Well prepared teachers are the most valuable resource a community can provide its students. To meet the needs of the digital generation, school boards, school administrators, parents, and students will expect all future

teachers to be technology proficient. No future teacher who is not technology proficient will be qualified to teach in 21st century schools.

Reeducating the existing teaching force to take full advantage of the powerful new learning technologies in their schools is an enormous challenge. Lessons learned through the Apple Classrooms of Tomorrow project indicate that an in-service teacher needs several years of professional development to become technology proficient. With more than 2 million teachers in the schools today, states and schools across the country are faced with marshaling substantial resources to meet this challenge. But 2 million additional teachers will join the teaching force in less than a decade, and the task of ensuring that every teacher is technology proficient will become overwhelming if these new recruits do not arrive at their schools ready to use the modern technologies they will find in their classrooms. No school system or state in the country can meet the demand for teachers prepared to educate 21st century students without a significant national commitment to improved teacher preparation programs.

Every teacher preparation program in the country has a responsibility for meeting this expectation, whether it graduates 15 teachers a year or 1,500. To develop millions of technology-proficient educators, we must have the active support of leaders in all sectors of higher education, the K-12 schools, and business and community organizations who will commit entire programs, institutions, and schools to substantially improved teacher preparation. Leaders are joining forces to transform our factory era schools into information age learning centers.

Installing computer labs, creating methods courses on technology in education, or developing a cadre of education technology specialists is not sufficient. Ensuring that all future educators are technology proficient will require comprehensive improvements that infuse technology throughout the teaching and learning experiences of all prospective teachers. Future educators should learn with these modern learning tools integrated into their studies by teachers and faculty who are modeling technology-proficient instruction, particularly in those courses where they acquire the subject area expertise they will use in the classroom. Tomorrow's teachers must begin their careers with several years of experience learning and teaching with modern technologies. They must enter the classroom with learning technology skills that enable them to pick up from where the current cohort of technology-proficient in-service teachers leave off.

Teacher preparation programs are ready in various degrees to meet the challenge. In scattered regions of the country, strong programs are making active use of new technologies in the education of future teachers. Several national associations are developing new standards for proficiency in instructional technology, and some states are beginning to include technology skills in their certification requirements.

But independent reports find that many teacher preparation programs lack the hardware, software, and network connections that are a prerequisite for integrating technology in the curriculum; they have been last in line for these resources at their institutions. In many instances, faculties in education and in the arts and sciences have not acquired the professional knowledge and skill they need to use these new technologies for improved teaching and learning in their own courses. Moreover, the introduction of new technologies has been so rapid in K-12 schools that some postsecondary education faculties are growing out of touch with the profound changes occurring in education, and they are not modifying their teaching methodologies to stay current with those developments.

To mount an effective response to these conditions, we must develop a coordinated effort across multiple initiatives that are emerging in recognition of the urgent need for technology-proficient educators. In FY 1999, Congress appropriated $75 million to begin a new grants program known as "preparing tomorrow's teachers to use technology." Administered through the U. S. Department of Education's Office of Postsecondary Education, the program awarded 138 capacity building grants, 64 implementation grants, and 23 catalyst grants to support preparation and improvement of teachers at all levels of development. Those who received catalyst grants, in particular, have the expertise and resources to sustain significant statewide, regional, and national initiatives to develop technology-proficient educators. They will join with grantees supported by the teacher quality enhancement program and the technology literacy challenge, which are also supported by the U. S. Department of Education.

These federal initiatives provide a strong base for mounting a response to the need for millions of well prepared technology-proficient educators. But they cannot do the job alone. Their efforts must be reinforced by the efforts of national organizations such as ISTE, SITE, AACTE, NCATE, and content-area professional associations that are working to infuse

modern technologies into teaching and learning. And the work of all these partners must be buttressed by the business leaders, state policy leaders, and community organizations that are joining forces with them to build a 21st century educational system.

These undertakings are significant. The catalyst grantees will convene a series of workshops and conferences to support the coordination of efforts among these partners. We invite all interested parties to join us.

If Colleges and Schools of Education Are the Answer, What Is the Question?

■ Carmen I. Coballes-Vega

Debates about reform in teacher education and issues of standards, assessment, and accountability have been around for several decades. The rhetoric is sometimes more substantive than the solutions proposed. In addition, the efforts, following a top-down model, are generally put forward by those who are not directly involved in the reform itself (Tyack & Cuban, 1997). The view that colleges or schools of education are the last stop in the preparation of preservice teachers denies what we know about the nature of adult learning and the career-long education of teachers (Tomlin, 1997).

First, our mission as teacher educators is set within the context of numerous political forces that shape educational policy, including school board administrators, legislators, governors, state education officials, and others who believe they know what is in the best interests of teachers and students. Although these forces are real and cannot be ignored, they need to be balanced with the reasoned voices of those who have the expertise in their respective fields.

Second, each college or school of education must be anchored in a conceptual model that reflects its program's philosophy, mission, and goals. The conceptual model of the College of Education and Human Services

at University of Wisconsin-Oshkosh (1997, pp. 37-42) prepares the future teacher as a "caring intellectual" (Giroux, 1988; Noddings, 1984); "the educator as intellectual is well prepared to impart knowledge, to assist students in constructing knowledge, and to participate in transformative, democratic, and reflective practice" (College of Education and Human Services, 1997, p. 39). The critical knowledge base for educators includes knowledge of content, culture, and learning, which in turn produces an understanding of diversity, pedagogy, and curriculum.

Third, each college or school of education should be accredited by the state and/or accreditation agency. A number of schools across the United States contain similar components in their conceptual models and are accredited by the National Council for Accreditation of Teacher Education. Regardless of the teacher education program and state agency or the accreditation group with which a college affiliates, however, the conceptual framework is the foundation that supports the standards and curricula developed. For the colleges or schools, these conceptual models provide the definition for the programs and the collaborative relationships with school district personnel and their programs.

Fourth, colleges and schools of education must reinvent their programs, not because of the specific calls for reform but because of the commitment to a redefinition that should normally occur as part of periodic review. Thus, they should not be driven primarily by the calls for standards without the requisite documented evidence that supports their implementation (Raths, 1999). They should not be driven by additional mandated testing to measure achievement without considering the already existing qualitative forms of assessing students' learning. They should not be led by calls for restrictive instructional strategies that have already been demonstrated to be ineffective or inconclusive. The process of reexamination necessitates an open and clearly articulated dialogue with principal stakeholders that include teachers, administrators, school board members, parents, and policy makers. In addition, our vital partnerships with the liberal arts colleges in preparing teachers who have the general education coursework and content area specialties to meet the disciplines they teach must be strengthened.

Fifth, as teacher educators, we work toward an inclusive curriculum that reflects our commitment to preparing teachers who can meet the needs of students with diverse needs, including those with disabilities and the gift-

ed and those who come from social, economic, racial/ethnic, and multilingual backgrounds (Gollnick & Chinn, 1998; Genesee & Cloud, 1998; Coballes-Vega, 1992). In addition, this call also includes preparing them for an increasingly technological global society that may not be equitable in its distribution of resources (National Governors Association & Milken Exchange, 1998). Our participation in the design of programs that effectively integrate technology in the teacher education curriculum must be accelerated. As educators, we must also understand that our comfort level in using technology may be lower than that of our students, but it should not dissuade us from becoming actively engaged (Johnson, Schwab, & Foa, 1999; Coballes-Vega, Lundeberg, Standiford, Larson, & Dibble, 1997). Educators must also move to student-centered approaches and project-based learning (Sandholtz, Ringstaff, & Dwyer, 1997). The evaluation of this type of instruction using qualitative means also requires careful study (Persichitte, Caffarella, & Tharp, 1999). Cultural and traditional assumptions about the teacher education classroom will also require rethinking to include distance education, Web-based education, and digital formats that can transport us to new settings and reshape our interactions with students and teachers (Jonassen, Peck, & Wilson, 1999). But it is vital that institutional leadership, commitment to the development of infrastructure and resources, and faculty development keep pace with new developments (International Society for Technology Education, 1993).

The following questions are intended to stimulate discussion about the future of the teaching profession and implications for schools, colleges, and departments of education:

1. What value do we as college and university leaders, policy makers, foundation representatives, and legislators place on the academic success of children and youth in our schools, and how do we demonstrate our commitment to those who have the primary responsibility of educating them?
2. Are the calls for accountability in education overshadowing, limiting, and/or expanding our reform efforts in teacher education and our efforts to promote the academic achievement of our pupils?
3. If we think technology is the answer for colleges or schools of education, what do we speculate are the questions?
4. If colleges or schools of education are the answer for serving the future cultural, educational, economic, political, technological, and

social needs of our nation, then what are the concrete questions we must ask ourselves now to meet the educational and workforce challenges of this new millennium?

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Partnerships, Technology, and Assessment

■ Dennis Hinkle, David Wizer, and Paul Jones

In 1993, the College of Education (COE) at Towson University implemented an ongoing planning process that identified three substantial issues—partnerships, technology, and assessment. This paper addresses these three issues while focusing on technology.

Partnerships

The College of Education at Towson University began the implementation of a network of professional development schools (PDSs) early in 1993-94. The nationally recognized Towson University PDS network focuses on continuous professional development of undergraduate student interns, experienced teachers, and college faculty in the area of instructional technology.

Technology

Towson's College of Education, like all colleges across the United States, has watched the rapid growth and development of information and instructional technology and its impact on teaching and learning. The issues extend beyond just having access to technology, knowing the technology, and understanding its impact. The issues have become using technology to access information and integrating technology in the teaching/learning process.

In preparing for the future of the teaching profession and its impact on schools, colleges, and departments of education, attention must be given to the technological resources needed and the curriculum for both teacher candidates and experienced teachers. The first step is to develop and implement a planning process as well as a specific plan. Some states have undertaken efforts to implement aggressive technology plans that provide statewide technology infrastructures for distance learning and universal access, state revenues to supplement local revenues for acquiring technological resources for P-12 schools and higher education institutions, and a systematic plan for professional development of teachers and instructors. In Maryland, a joint committee of the Maryland State Department of Education and the Maryland Business Roundtable developed a statewide plan for education. The 1995 plan, which was updated in 1999, has served as an impetus for technology program development and funding at the state level. At the local level, the plan provided a catalyst for improved planning and use of technology as well as more targeted funding using state and federal matching funds. State, local, and federal funding for technology has increased over the years since implementing the plan. The Maryland plan does not address the needs of higher education and, specifically, the needs of teacher education. The acquisition of needed resources has remained the responsibility of the individual universities and, to some extent, the University System of Maryland.

At Towson University, significant funds have been allocated for implementing a campus-wide technology plan. In the College of Education, a technology plan developed in 1994 and updated in 1996 and 1998 provides the benchmarks for resource acquisition and curriculum planning. Across the campus, numerous technology classrooms and laboratories have been upgraded and more have been added. The College of Education has acquired significant technological resources over the past several years. Since 1994, four computer-enhanced "smart" classrooms/laboratories have been developed, two Macintosh based and two DOS-Windows based. The student workstations are networked to a server, which contains major software packages and has full access to the Internet. The instructor workstations are also networked to the server and the Internet and have projection capabilities for enhanced video, audio, and computer-generated presentations.

The College also has an educational technology center (ETC) and a multimedia and assistive technology center (MATC). The ETC serves as

a virtual library and work area for all students in the COE. The ETC has work space for small groups of students, a circulation desk, 20 to 25 workstations with Ethernet access to campus resources as well as remote databases. All workstations have current software corresponding to that in the three classrooms/laboratories so that students have the resources needed to complete classroom assignments. The MATC provides advanced multimedia production capabilities and serves as a preview center for assistive technologies. The MATC provides the latest hardware and software for producing computer-based and computer-enhanced instruction. It also serves as a preview site for a leading producer of computer-based assistive technologies. In addition to the classrooms/laboratories and the centers, the COE plans to upgrade every classroom in the COE building with enhancements to the video and audio displays and with active connections to the campus network and to the on-line resources available in the ETC.

The commitment to providing access to contemporary technological and information resources and to using these resources effectively extends beyond physical resources. It also includes required courses for students and professional development activities for faculty. Towson University teacher candidates are required to complete two courses (6 semester hours) in instructional technology: ISTC 201, Using Information Effectively, and ISTC 301, Utilization of Instructional Media. ISTC 201 is a required general education course whose general goal is to prepare graduates who can use information technology to communicate effectively, work successfully in teams, solve problems, and think creatively. The course was planned collaboratively by COE faculty and university librarians with backgrounds in education. Topics for the course include organization of information, retrieval strategies, the Web and PowerPoint as instructional tools, on-line library and database catalogs, Website development, and assessment and evaluation of generic and specific resources.

ISTC 301 was designed specifically to focus on integration of technology in the curriculum and its application in the classroom. The objectives of this course are to help students obtain knowledge in using a range of practical technology applications as tools for improving their personal productivity and instructional capabilities, allow students to gain experiences in the evaluation of current educational technologies as well as in the integration of these technologies into classroom instruction through the creation of a range of technology lesson plans, and produce an edu-

cational technology portfolio that demonstrates proficiency in integrating media and information technologies in the curriculum.

As the College of Education has acquired and updated its technological and information resources and has developed the required two-course sequences required for teacher candidates, a commitment has also been made to providing professional development for COE faculty. For the past several years, one faculty member has been given assigned time to develop and implement a faculty development program for COE faculty. This faculty member has offered a series of seminars and has worked extensively with individual faculty members. More recently, the College of Education received a grant from the U. S. Department of Education to implement a faculty development program for faculty engaged in teacher preparation from across the campus and P-12 faculty in the Towson PDS network. The program focuses on multimedia integration and Web-based curriculum development. Thirty-one faculty have been identified for involvement in the program.

Assessment

At Towson University, the use and integration of instructional and information technology are major components of programming for teacher candidates, experienced teachers, and COE faculty. Courses have been developed for teacher candidates and experienced teachers, and a development program has been implemented for College faculty. The framework for both is based on standards created by the International Society for Technology in Education in collaboration with NCATE and technology objectives developed by the state of North Carolina; the Towson University framework (Dabbagh & Wizer, 1988) is appended to this paper. The framework proposes to move teacher candidates, experienced teachers, and college faculty from using practical technology tools to having them become producers of their own multimedia products. Two of the goals are applying technology as a "mindtool" that serves as cognitive reflection and expanding the use of media that allow learners to construct their own representation of existing and new content domains (Jonassen, 1996). The Towson framework has four major steps, each of which addresses two of the eight standards in the Towson framework.

- *Technology literacy and information access (Standards 1 and 2).* The first step involves students in gaining a knowledge foundation in technolo-

gy literacy and information access. This knowledge provides an understanding of how to use a range of software tools and hardware devices.

- *Tool proficiency (Standards 6 and 7).* The second step is to expose teacher candidates and experienced teachers to software tools that will improve their effectiveness as students and teachers. Students gain specific knowledge that can be directly applied to their teacher education coursework and to future teaching. The step includes exposure to a range of software and hardware in the area of adaptive technology as well as assessment devices.
- *Integrating technology into teaching (Standards 3 and 5).* The third step is the evaluation and modification of software and lesson plans to improve instruction. The evaluation component involves teacher candidates and experienced teachers in the process of analyzing educational software and Internet sites to determine their appropriate use based on content and student development and instructional goals. In addition, these groups consider ways to modify lesson plans for successful integration of educational software in the teaching/learning process.
- *Producing media (Standards 4 and 8).* The fourth step is to have teacher candidates and experienced teachers produce some form of multimedia technology for use in classrooms. These multimedia presentations also serve as artifacts for their professional portfolios, for example, creating a multimedia demonstration using a presentation package and placing a portion of their portfolio on the Internet. Such artifacts demonstrate links among conceptual frameworks, data, graphic organizers, lesson plans, and research.

Summary

The rapid growth and development of technology will continue to impact teaching and learning in P-12 education and higher education, especially teacher education. For colleges of education, these emerging technologies will require planning for resource acquisition, faculty development, curriculum development, program/course delivery, and performance expectations to meet certain standards. It is important now to focus on assessment strategies for standards and performance expectations for teacher candidates and experienced teachers. This effort will provide necessary information to review, rethink, revise, and update needed resources, planned curriculum and faculty development, and revised programs and courses.

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Essential Dimensions of Technology Standards
Instructional Technology
Towson University

1. INFORMATION ACCESS
- Access resources for planning instruction available via telecommunications (e.g., expert guidance, lesson plans, authentic data, curriculum materials).
- Locate, evaluate, and select appropriate learning/teaching resources and curriculum materials for the content area and target audience.

2. INFORMATION ETHICS
- Establish classroom policies and procedures that ensure compliance with copyright law, fair use guidelines, security, and child protection.
- Discuss social, legal, and ethical issues related to technology use.

3. INTEGRATING TECHNOLOGY INTO THE CURRICULUM
- Demonstrate knowledge through practical application.
- Support active student involvement, inquiry, and collaboration through the use of appropriate organizational and management strategies.
- Select and create learning experiences that are appropriate for curriculum goals and relevant to learners, based upon principles of effective teaching and learning.

4. INSTRUCTIONAL TECHNOLOGY
- Use media technology to present the subject so that it is comprehensible to others.
- Use technology to facilitate teaching strategies specific to the discipline.

5. TECHNOLOGY AND COMMUNICATION

- Use technology in the discipline/subject as a tool for learning and as a medium for instructional delivery.
- Use computers and other technologies effectively and appropriately to communicate information in a variety of formats.

6. TECHNOLOGY AND ASSESSMENT

- Develop performance tasks that require students to locate and analyze information and use a variety of media to communicate results.
- Use computers and other technologies effectively and appropriately to collect information on student learning using a variety of methods.

7. ADAPTIVE/ASSISTIVE TECHNOLOGY

- Use media and technology to address differences in children's learning and performance.
- Use media and technology to support learning for children with special needs.

8. EMERGING USE OF TECHNOLOGY

- Ensure students acquire analytical skills to determine the utility of emerging technologies in learning/teaching settings.

Understanding 21st Century Teaching Tools

■ Barbara B. Levin

Tomorrow's teachers must have a complex set of knowledge, skills, and dispositions to adapt to their changing roles as teachers. At a minimum, they must have knowledge about their learners, the content they are teaching, the curriculum, the context in which they teach, and appropriate pedagogy (Shulman, 1986; Shulman, Wilson, & Richert, 1987). The context for educating students is changing rapidly, however, and tomorrow's teachers must learn to adapt to changing contexts, including the Internet, and to new curricula in multimedia formats.

Of course, teachers will continue to use traditional 20th century teaching tools such as textbooks and chalk well into the new millennium because they are readily available, relatively inexpensive, portable, and comfortable. But computer-based technologies are rapidly becoming ubiquitous in educational settings. Arguably, as the processing speed, storage capacity, and versatility of chip-based technologies continue to increase and costs go down, computer-based technologies will eventually replace textbooks and chalk. No other technology in our history has continued to provide more power, speed, and capability while continuing to decrease in size and price than chip-based technology. No other technology is so omnipresent in so many jobs and professions. Further, new computer-based products that can be used effectively for teaching and learning will continue to be developed.

In this rapidly changing context for teaching and learning, one aspect of the knowledge base for teachers that is rarely addressed is visual literacy, which includes understanding how students learn from pictures, graphics, video, and multimedia. Tomorrow's teachers need to understand how their students process and learn from visual images on the Internet and other media that are readily available to students from many sources. This knowledge will become central to teachers if we want to understand and exploit the power of multimedia and new contexts for teaching and learning such as the Internet. Although some researchers have studied the impact of visual imagery (e.g., Debes & Williams, 1978) and multimedia (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Jacobson & Spiro, 1995; Spiro & Jehng, 1990) on learning, little of this informa-

tion has filtered down to the classroom teacher, and few teacher education programs include visual literacy in their curricula.

Since the advent of motion pictures, television, video games, Sesame Street, MTV, and now DVD, visual images have been used to convey information and to entertain. "Edutainment" is big business and often stands in direct competition to teachers, who are already challenged to make their lessons as educational and entertaining as those available on the Discovery and History channels, on many excellent Websites, on laser discs, and now on DVD. Most teachers currently choose to ignore this competition for their students' minds but wonder why today's students learn differently and seem bored and restless in their classrooms.

With the exception of work by the Cognition and Technology Group at Vanderbilt (1990), there is little research or development focused on helping prospective (or veteran) teachers understand issues related to teaching and learning with still and moving images or with multimedia. Visual literacy is not something that most teacher educators know anything about. Even though prospective teachers spend time in several courses that focus on literacy, the definition of literacy is usually limited to print literacy. In every curriculum area, however, visual images can be used to present material in more depth and with more reality than can be conveyed with print or by a single, human teacher.

Unfortunately, using multimedia seems too complicated and too high tech for most teachers today. Visual images available on laser discs, on the Internet, and in multimedia software are rarely used as teaching tools in most classrooms. Information conveyed through images—still, moving, multimedia—can be more stimulating and engaging than information conveyed by a teacher standing in front of a group of students using textbooks and the chalkboard, or even an overhead projector. But visually enhanced presentations are not the norm.

The fact is that most teachers, and most teacher educators, have no concept of what their students are learning from television, at the movies, on the Internet, or in the video game parlor at the local mall. We also do not understand how learning from visual images occurs, although there are some theories about learning from multimedia sources (Jacobson & Spiro, 1995; Spiro & Jehng, 1990). Nevertheless, teachers need to understand the power of visual images and of multimedia for educating 21st century students. If we do not understand them and do not add visual

images and multimedia to our pedagogical toolkit, then we will lose many of our students to other learning venues, including the Internet. In fact, many would say we have already lost them.

Of course, the human connection is often missing from lessons learned only from multimedia or on the Internet, and teachers are certainly more adept at and comfortable with high touch than high tech. But the issue of interactivity and making connections with others, which was a problem with a passive medium like television, is no longer an issue with the Internet. Although interaction on the Internet is not always synchronous or face to face, it is becoming more and more common. In fact, we currently have access to many human experts through the Internet, and schools will have face-to-face interactions via two-way video and audio in increasingly economical ways in the next few years. Whether tomorrow's teachers will take advantage of these nearly unlimited resources for their students or continue to see them as competition—or irrelevant—remains to be seen.

Besides learning to understand and use the power of multimedia and the Internet, tomorrow's teachers will need to shift out of their traditional didactic roles as deliverers of content to become learning mentors for their students. To be successful and to continue to be viable, tomorrow's teachers will need to guide their learners in finding the best tools for learning and tutor their students to help them interpret and understand all the information available to them. Further, tomorrow's teachers will need to be learners themselves. With the exponential growth of knowledge in recent decades, however, there is no way individual instructors can know everything they need to know to be the sole teacher for a student. Instead, teachers will need to know how to guide students to the resources available, help them make sense of this information, teach them to be critical thinkers, and continue to learn along with their students.

How can we prepare teachers for this kind of future? For one thing, schools, colleges, and departments of education must require prospective teachers to learn to use the same kinds of tools that their students are using at home every night when they play video games, surf the Net, and watch MTV. Teacher educators need to use multimedia simulations to help prospective teachers learn about classroom management and how to teach various subjects. Multimedia tools should be a part of every teacher's repertoire. Teacher education programs must also require research and evaluation of information from a multitude of Internet sources so that

tomorrow's teachers can understand the scope of the resources available on the Internet and the issues involved in interpreting their validity and credibility. We also need to take advantage of Web cameras to view real classrooms and interact with teachers and other experts on student learning in real time. When virtual reality becomes inexpensive and readily available, we must also be ready to use this technology for educating students and teachers. These examples are but a few of the technologies teacher educators must adopt—at least until the concept of a holodeck of the Starship *Enterprise* becomes available.

While I am serious about the necessity of tomorrow's teachers becoming visually literate, immersed in multimedia, and adept at exploiting the Internet, I do not believe that all of teacher education should shift completely away from traditional classroom settings where a professor and a group of students engage in face-to-face discussions that promote critical thinking and focus on problem solving (Levin, 1999). The value of gaining multiple perspectives through sharing information, asking questions, and clarifying responses to learn from each other is too important. And although these kinds of activities can and do occur on the Internet, I believe that learning to read people's body language and voice inflections is also essential for teachers. A substantial portion of methods courses for teachers and much of the content of foundations courses like educational psychology and child development, however, should be learned using 21st century tools, including multimedia and the Internet.

I also think that we should not give up hands-on experiences in real classrooms in favor of training in virtual classrooms, even when it becomes a possibility. What we do need is a transition plan and a curriculum that bridges how teachers have learned to teach in the past that extensively uses multimedia and Internet-based resources for instruction. We need such a curriculum so that teachers can learn in the same ways that we expect them to teach their students. Teachers need to learn to be learners as well as guides, tutors, and information managers with their students. And they can do so only by using the same tools to learn that many of their students are already using.

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Teach Connected

■ Wade D. Sayer

In the not too distant future:

1. Teaching will be *student centered,* engaging students in their own learning, helping and coaching them learn through a variety of strategies rather than doing it to them.
2. Schools will be less grade and class oriented and more oriented toward *individual learning.*
3. Teachers will *work in teams,* sharing teaching responsibilities with colleagues and team members, jointly planning activities, sharing assessment information about individual students, and communicating continuously with peers, students, parents, and community members about students' work and activities.
4. Teachers will work with individual students and create small *interdependent project and task groups* rather than classes or grades. Students will participate in flexible groups engaged in learning projects, and individual students will have participatory roles that complement their fellow students' roles.
5. Flexible and expandable academic *course modules* will contain information and activities by content, with clearly defined academic course objectives that will be aligned with state and national standards and will not be defined by weeks, quarters, semesters, or other time periods.
6. *Student assessment* will be based on multiple instruments: students' performance, portfolios, oral exams, and paper tests. Students will demonstrate their knowledge and competency in order to progress.
7. Instruction will be more *interdisciplinary,* while expectations, requirements, and standards for subject content will be more clearly articulated. Course modules will be more sequential, less duplicative.
8. Teachers' assignments to students will *incorporate technology* in their schoolwork and will require the use of technology for presentations and documents. Students and teachers will communicate electronically as well as in person.
9. Schools and teachers will be *more outcome oriented,* accountable for meeting learning standards of state and national standardized tests and expectations from their own communities.

Best Teaching Practices and Technology

Computer technology is the single most powerful tool that we can apply to learning and teaching since the invention of the printing press. In the 21st century, two powerful movements will come together in schools, as they already have in many businesses: the ability and need to customize services for individual customers (students), and the ability for people (teachers, students, administrators, and parents) to communicate asynchronously, from different places at different times.

Learning the tools of technology is a necessary prerequisite for improving schools, but it is not sufficient by itself to improve students' academic achievement. When technology and modern telecommunications tools are used in conjunction with the best research on improving education, however, look out!

In many schools, teachers work in isolation. Schools hire professional teachers, assign them students and a room, and introduce them around the building. Little actual management of teachers takes place in their classrooms. Teachers often do not know what the teacher in the next room is teaching or how it might relate to what they are teaching. And seldom does a teacher from one grade relate his or her lessons to what a teacher in another grade might do. In other words, each teacher works as an independent self-contained unit interacting little with colleagues. The daily schedule has no time for joint planning meetings or for comparing professional practice and seldom any time for teachers to discuss individual students and their problems.

Technology in the form of computers, the Internet, and e-mail can easily remove these barriers and make communication with teachers in the next room or the next state common. Through local area networks, e-mail, and the Internet, teachers can share information, form professional collegial communities to work together to ensure high quality learning, work jointly to plan activities, and establish common assessment rubrics, portfolios, and continuous improvement techniques.

Teams of teachers can meet on-line and off-line, plan activities and learning projects together, share information about students, discuss individual students and coordinate the best strategies for motivating and managing them, and ensure that all academic course expectations are met. Teams of teachers can also ensure that all students have multiple resources and multiple assessments of their progress.

Technology will allow teachers to discuss common concerns in an asynchronous environment, so they need not have the same planning period or the same training times, or physically meet in the same place. Principals and leaders can provide assistance and solicit ideas from their staff via e-mail, and teachers can reply. Teachers can communicate with students, parents, and community members through e-mail, bulletin boards, threaded discussions, and instant messages.

Teachers will use technology in their classrooms as a presentation medium. They will also use it to allow teams and groups of students to work independently, searching for information, researching background materials, linking to original sources and individuals who can assist them, and systemically structuring their findings in databases, spreadsheets, and presentation pieces. Access to computers and Internet resources will allow teachers to divide students into small groups for some activities while maintaining larger groups for common instruction or practice. They can then focus portions of quality time on small groups of students, ensuring that all students are working through appropriate assignments, are on schedule for their work, are engaged and participating in learning activities, and know that the teacher cares personally about them and the quality of their work.

Implications for Schools

Schools will need to focus on:

- *Educational management.* Management of teacher groups; ensuring that curricula materials are covered for student teams; and ensuring that appropriate teaching strategies are adopted for students, assignments meet the schools' expectations, and the community and parents are involved. School administrators will need to learn management skills used in other businesses—delegating tasks, holding people accountable for successful completion of tasks, solving problems for staff, and negotiating solutions with parents, the community, and businesses.
- *Training and professional staff development.* Schools will need to ensure that all teachers are trained in a variety of teaching strategies, that they can diagnose students' learning strengths and weaknesses, and that they can develop appropriate projects and learning activities in the effective use of numerous technologies and multiple assessment instruments. Training and professional development will be carried out through many

strategies, including on-the-job training in teams (junior teachers working with more experienced teachers), formal training courses, on-line training, and teacher-to-teacher coaching and mentoring.

- *Support for schoolwide teaching initiatives.* Schools will need to ensure that all staff and teachers work as a team.
- *Accountability.* States, districts, and communities will hold schools and school administrators more accountable. In turn, school administrators will have to hold their teachers accountable for meeting and surpassing standards and achieving clearly stated educational objectives, ensuring that all teachers support and participate in school improvement procedures.
- *Technology as a tool.* Technology will be a ubiquitous tool, used by all students, all teachers, and all administrators. But like telephones, technology is only a tool. Teachers still must ensure that students are learning and must still help all their students learn to their fullest capacity.
- *The celebration of successes.* Schools will need to celebrate success, recognize and reward students who accomplish goals, and build on successful experiences. Success begets success.

Implications for Colleges of Teacher Education

Colleges of teacher education will need to ensure that preservice teachers are skilled and trained in:

- Multiple strategies and teaching practices, how to coach and assist students to learn.
- Development of individualized educational learning plans for each student.
- The creation of learning contracts with students and parents in collaboration with colleagues.
- The use of technology and telecommunications as effective teaching tools to ensure students are learning.
- Multiple forms of student assessment: portfolios, performance, journals, oral examinations, essays, and multiple choice tests. Preservice teachers also must know how to ensure that testing and assessment are not used to categorize students by high expectations and low expectations but to determine what additional learning strategies need to be applied to ensure that all students achieve educational objectives.
- Pedagogy and content areas for all levels of school. Highly skilled teachers with experience will need improved credit and credentials and may

actually specialize in some area of expertise in their schools, such as master of assessment, technology, teaching strategies, or curriculum planning. Advanced degrees and/or certificates may need to recognize areas of specialization.

Implications for Departments of Education

State departments of education have been the moving forces for curriculum standards, standardized testing, and school reform and improvement. They have also been the most reluctant to manage change in local schools. Departments of education will need to learn to insist that all schools meet state standards, and provide resources and assistance to ensure that they do.

In the next decade, local school funding through local school taxes will be seen as clearly unconstitutional, and courts will mandate fair and equitable treatment for all students, including expenditures per pupil, teaching resources, technology and equipment, books and materials, and buildings and grounds. Local schools will be less autonomous, and the responsibility for success will be focused on state departments of education.

Departments of education will need to:

- Be able to manage teaching and fiscal resources across the state;
- Be able to test students and to ensure that students meet academic expectations for promotion and progress;
- Ensure the fairness and confidentiality of testing;
- Hold school districts and schools accountable for students' success or failure to meet standards;
- Provide resources, assistance, training, and professional development for all schools, and ensure high levels of quality in teaching and learning;
- Maintain academic expectations and standards;
- Provide recognition and rewards to schools that succeed in meeting and exceeding state standards;
- Provide sanctions and assistance to schools that fail to meet state standards;
- Maintain and oversee the availability of resources to schools;
- Act as an arbiter of educational content materials;
- Provide a technology network.

Communities of Practice as Catalysts for a Revitalized Teaching Profession

■ Mark Schlager

The K-12 teaching profession is currently at a crossroads paved on the one side by a need for more qualified teachers and on the other by a system struggling to meet the need. The premise of this position paper is that parallel advances in Internet technology and teachers' facility with on-line collaboration will enable education practitioners to form large-scale, distributed communities of practice that will help meet the need and transform the teaching profession over the next 10 years. The focus here is not on eventual outcomes of the transformation process but on current trends and how they will catalyze fundamental changes in teacher education and professional development programs and, in turn, K-12 classroom practice.

Challenges Facing the Teaching Profession

Most states are currently experiencing a critical shortage of certified teachers. Many of those who are certified lack key content knowledge and teaching skills, especially in math and science (Corcoran, Shields, & Zucker, 1998; McDiarmid, David, Kannapel, Corcoran, & Coe, 1997). In California, the situation is reaching crisis proportions. Student achievement lags behind, and teachers are underprepared to meet this challenge (a full one third are uncertified). In high schools, one third of math teachers, one fourth of English teachers, and one fifth of science teachers are teaching without a college major or minor in their field, and teacher shortages are real and continuing statewide. Smaller classes and the exodus of certified teachers from low income areas have exacerbated the teacher shortage.

School districts, university schools of education, and state departments of education are doing their best to offer professional development and bring more qualified educators into the workforce. Unfortunately, formal teacher education and professional development systems have not been able to keep up with the current need, much less scale up to address an expected need for 2.2 million new teachers nationwide over the next 10 years. Both preservice training and in-service professional development programs employ largely outdated approaches that do not reflect research-informed characteristics of effective professional development

(e.g., Loucks-Horsley, Hewson, Love, & Stiles, 1998; Darling-Hammond & Ball, 1997). Few are able to *sustain* support for teachers as they engage in the long (3- to 5-year) process of developing competency with new practices (Bush, 1997; McLaughlin, Mitra, & Stokes, 1999), and fewer still are able to scale to reach all teachers who need training (Corcoran, Shields, & Zucker, 1998).

Certainly, innovative teacher preparation programs can give teachers a better chance to progress from student teacher to skilled practitioner, and more innovative summer institutes and workshops can help introduce teachers to new ideas and practices. Local systemic reform programs can put in place organizational structures, processes, and policies for school change. But none of these approaches in isolation can provide all the resources, expertise, and services needed to situate teacher education and professional development in the context of daily practice, as advocated by professional development research (Lieberman & McLaughlin, 1999). We believe that the way to provide more and better trained teachers is not just to offer more of the same formal programs. Teachers need to work in collaboration with each other, media specialists, and other adults in ways that our current education system rarely supports. Uncertified and new teachers need access to high quality content and the expertise of master practitioners. These needs cannot be addressed by individual programs or projects alone. They must be addressed for the profession as a whole if we are to help K-12 education professionals work toward higher achievement for all children.

Opportunities Afforded by Technology

Recent studies (Hawkins, 1996; President's Committee of Advisors on Science and Technology, 1997; Corcoran et al., 1998) suggest that Internet technology may make it possible to give teachers easier access to high quality professional development in the context of work through on-line seminars, follow-up consultation and mentoring, and collaboration among teachers, without the expenses and effort associated with repeated face-to-face meetings. The teaching profession, however, has lagged far behind most other professions in access to and facility with the communication channels, information resources, tools, and workplace conditions needed to remain up to date and manage its own professional development. Teachers are commonly isolated from their peers during the workday and have little

access to, or support for, the kinds of informal learning opportunities that most professionals take for granted (Renyi, 1996). They also have been isolated from innovative tools and authoritative information, relying on stagnant information (primarily from textbooks) and outdated tools.

The situation has not escaped the notice of for-profit education publishers and software vendors such as Classroom Connect, Teacher Universe, College Board, and Lightspan Partnership, which are gearing up to fill the gap in teacher training through on-line offerings. They see dollars in the statistics: Computers with Internet connections are now in more than 90% of schools and more than 40% of 4th through 12th grade classrooms, enabling unprecedented access to tools, information, and expertise (Becker, 1999). The U. S. Department of Education predicts that by 2000 all *classrooms* will be connected to the Internet. Now, according to *Education Week,* 61% of K-12 teachers report using the Internet for instruction, and 49% of connected schools have a T-1 line (September 23, 1999). A rapidly growing percentage of teachers (more than 60%) have Internet access from home, enabling access to professional development opportunities, colleagues, and teaching materials like never before.

Universities have also felt the winds of change blowing. With more and more educational content being provided through the World Wide Web, Internet-based courses are becoming attractive to those who are seeking an alternative to a traditional university campus or neighborhood school. Many technical and business courses (e.g., UNext) and a growing number of education degree programs are already offered on-line. For example, Pepperdine University School of Education and Psychology offers two master of arts degree programs for practicing teachers that are conducted primarily on-line. The California State University system has recently implemented CalState TEACH in response to the critical need for more teachers. The program offers a Multiple Subject CLAD teaching credential to emergency permit and long-term substitutes who teach in a public elementary school in California. The coursework is completely integrated into the K-12 classroom. There are no separate courses and no university classes to attend. Intern teachers are guided and supported by a faculty mentor and an on-site school supervisor. Both programs offer the benefit of situating learning in the student's local educational setting, as opposed to a college classroom.

What will this mean for the teaching profession? The implications are far-reaching. For example, it is only a matter of time until this trend in on-

line courses extends downward. High school courses are already being taught over the World Wide Web. For example, the Virtual High School Project, administered by the Hudson Public School district and the Concord Consortium, involves more than 50 schools in 18 states nationwide offering approximately 30 courses on-line (http://vhs.concord.org/). The University of California-Santa Cruz has a similar plan in the works (http://vhs.ucsc.edu /vhs/), and several established companies (e.g., Sylvan, Kaplan, Princeton Review, College Board) and start-ups are trying to recruit top teachers in high school disciplines to offer Web-based advanced placement courses, tutoring, and test preparation on-line. It is quite likely that over the next two decades public schools will have to compete for resources, teachers, and students—not only with private schools and home schooling options but also with Internet-based alternatives.

This trend also suggests the emergence of new ways in which education professionals and other adults contribute to students' learning. If it is true that teachers teach the way they were taught, significant changes in how teachers learn the craft of teaching will propagate into K-12 classroom pedagogy over time. Tutors, or learning guides, will provide support, coaching, and monitoring for student activities but will not do assessment for accreditation purposes, much as tutors work in the British system of higher education. Teachers will provide a broad structure for the activities of groups of students and take responsibility for assessing students' work and documenting the competencies they have attained. Adults and other students in the community will interact with students, providing resources useful to their learning. Brick and mortar schools will not disappear, but they will become one among many sites for formally organized, distributed learning. The school incorporating the technology of the future can offer the best combination of the role models, socialization, and morale building of face-to-face instruction, along with increased participation in systems of distributed learning that engage broader communities, learning—enhancing representations of concepts and data, a restructuring of teaching and learning roles, and more advanced assessment practices.

The Loose Ties That Bind

What is still missing in this equation is an invigorated, vibrant professional community of educators and an understanding of the role that technology can play in supporting systemic education professional communities of

practice (Hawkins, 1996). Teacher professional development researchers argue that communities of practice can be powerful catalysts for enabling teachers to improve their practice, and research is converging on a common set of effective professional development characteristics and strategies that stem largely from concepts about communities of practice (e.g., Little, 1994; Lieberman, 1996; Darling-Hammond & Ball, 1997; Loucks-Horsley et al., 1998; Corcoran et al., 1998). The National Science Foundation Educational Technology Workshop draft report, *Setting a Computer Science Research Agenda for Educational Technology* (February 1996) predicted that computer networks will cause fundamental changes in how the roles of teachers are defined and suggests that virtual communities for teachers' professional development and socialization can help teachers make the transition. Those changes are happening now, but they are evolutionary, not revolutionary, and therefore difficult to see taking shape.

As researchers, policy makers, and practitioners struggle to change teacher preparation programs, school policies, curricula, testing, and professional development strategies, teachers are beginning to find opportunities to overcome their isolation and make more effective use of the time they spend on their own professional growth through on-line communities of practice. A community of practice is people held together by a common sense of purpose and a real need to know what each other knows (Brown & Gray, 1995), "not merely peers exchanging ideas around the water cooler, sharing and benefiting from each other's expertise, but colleagues committed to jointly develop better practices" (http://www.co-i-l.com/coil/knowledge-garden/cop/definitions.shtml). Learning is a social activity that occurs as newcomers and journeymen move through an established community's professional hierarchy toward expertise (Brown & Duguid, 1996; Lave & Wenger, 1991; Wenger, 1998). Newcomers gain access to the community's professional knowledge in authentic contexts through encounters with people, tools, tasks, and social norms. The public education system today does not do well in cultivating and supporting such communities on a systemic level, and that must change.

The future of the teaching profession is one in which educators, like their counterparts in technical and business professions, will work on-line with colleagues and organizations to meet their just-in-time professional development needs. On-line educator communities of practice will provide the context in which education professionals gain access to, and facility with, ideas, methods, content, and colleagues (not just Webpages); where novice

educators will learn about the profession through peripheral participation in the activities of the community; and where journeymen will become valued resources and community leaders. Such communities will foster cooperation among education organizations and university schools of education to help avoid redundancy, identify and fill gaps in local services, and improve the quality of professional development products and services, thereby blurring the current distinction between on-line and classroom based learning. We are already seeing pioneering K-12 practitioners and teacher educators incorporate community based learning techniques into their own professional development (Schlager, Fusco, & Schank, 1998-99). Many are incorporating their on-line community into their teaching practices, as well (e.g., Nystrom, 1998). We must cultivate these seeds and help them flower or risk perpetuating the game of catch-up in which the teacher education and professional development systems are now engaged.

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Preparing Teachers for Emerging Educational Environments

■ Ted Stilwill

A story several years ago told of a school district that wanted to prepare its teachers for the arrival of the computer age. Since the district had yet to acquire its first instructional computer, the teachers received their initial training on paper "keyboards" that resembled placemats. While this type of staff development activity seems ludicrous today, I often think of this example in discussions of how to best meet the challenge of training new teachers for schools that have yet to be redesigned.

For example, we know that technology holds great promise to support significant and needed change in the ways that children and adults acquire necessary knowledge and skills. In our nation's schools today, however, the promise of technology is mostly unfulfilled. Today's schools use technology in ways that are still fairly limited and typically fragmented. For the most part, the computers used in schools are primarily designed for other workplaces, with software applications that are not comprehensive in terms of meeting broad, multilevel curricular goals. Today's instructional software does not respond differentially to varying student needs and typically does not easily document complex instructional performances. It will require a substantial national investment to provide teachers with the technological tools to substantially improve learning.

For the billions of dollars being spent on instructional technology today, teachers are still too often required to search for technology that provides partial solutions that, once found, may not integrate with each other or with the ideal instructional design the teacher had in mind. It is to be hoped that the future will not require this type of instructional scavenger hunt to support instructional improvement.

As cynical as this view might appear, I am optimistic that the next decade will bring changes that are more substantial and more positive. The market forces that have been attempting to shape education in the United States are now crystallizing a message that is increasingly unmistakable. Although the dissatisfaction with education in America for most of the last two decades has created a vocal opportunity for those who sim-

ply mistrust or oppose public education or government in general, these voices are *not* the fundamental source of the unrest. As is so often the case, the source of energy for educational change is economic and social, even if its voice appears to be only political. That source is the global demand for intellectual capital as the natural resource for new economies. The products that we increasingly demand require higher incomes to acquire and are created, assembled, distributed, and maintained by workforces of much greater sophistication than are readily available.

Some of us who have grown up professionally in the public sector have been frustrated by these market demands because the initial messages that we received were confusing and conflicting. For example, employers still want "more basic skills," but after some dialogue with these employers, it becomes apparent that the real demand is for advanced skills in mathematics, science, and communications. All the while this conversation about skills in core subjects has masked a growing need for new employees to understand other cultures (not just to accept diversity) and to work with others in generating new learning around processes, products, and performances (not just "working in teams"). Had educators been trained in the basics of marketing, they would know that customers—the employers, in this case—often can articulate their current needs only in terms of their past experience. It is not up to the customers to conceptualize new products; it is up to developers to understand the emerging needs and to create a response.

Perhaps to the surprise of some educators and members of local boards of education, the market forces affecting elementary and secondary education today might be best met if the majority of students who graduated from high school had a broad liberal arts background, skewed perhaps toward mathematics and science. This background serves nearly any student who intends to acquire any type of postsecondary credential, whether technical or arts and science. For the vast majority of young Americans, that initial credential and the willingness to reengage with continued education will be the prerequisite to even a modestly comfortable standard of living.

Unfortunately, our current system of early childhood, elementary, and secondary education was not intended to deliver the vast majority of its graduates with this background. The schools of the 20th century were organized around a belief that such a broad background with advanced

knowledge and skills would be needed only by those graduates destined to attend college. It is this tension between consumers' expectations and the system's capacity that is at the heart of today's dissatisfaction with education. The national response is to champion these increased expectations and assess progress toward meeting them. While that may be a necessary first step, it will not, in isolation, change the capacity of the educational system to respond.

We are beginning to take genuine ownership for the reality that many more students must leave the doors of our educational systems—secondary and postsecondary—with the ability to integrate and to apply knowledge and skills in ways that only a fraction of our students were able to attain in the past. We are on the verge of understanding that fundamental changes in the teaching and learning environments are more essential than any degree of exhortation or coercion.

If education is to succeed in meeting these challenges, the magnitude of change required is cultural and social, not just organizational. Parents, even working and very busy parents, must be seen as critical assets and not as obstacles. The strategic alliance with parents and the educational system must begin at birth, not 5 years later. We must understand the need to provide support for these parents in their work developing and nurturing these young lives.

Interestingly enough, the best of today's preschools may have given us a preview of tomorrow's educational settings for secondary and postsecondary students. A preschool teacher understands the domains in which each child must potentially develop and attempts to offer timely experiences to support that development. There is an understanding throughout that these domains are interdependent, even though progress in each will always be uneven. There is an implicit understanding that the variety with which this development presents itself, mixed with differences in cultural and social backgrounds in most groups of students, provides a set of assets that enrich the learning of the group or the community. This more flexible and more holistic view of learning demands that teachers have a deeper understanding about the development of concepts related to multiple subject areas and vastly increased sophistication and much broader repertoires in the methodology of teaching.

We must organize learning environments and prepare teachers and other instructional staff by working backward from the needs of tomor-

row's students. It is unlikely that we will succeed unless we consider learning environments that personalize students' learning by involving more adults and by increased use of powerful instructional technology. This will also demand that adults assume a variety of specialized roles with different levels of training and compensation. Just as in complex health care staffing, the authorizations of each of these adult roles must be clear.

Finally, we must create a national research and *development* agenda to create these new delivery systems. We cannot dedicate our research efforts to hoping that such complex change will simply emerge, full blown, at the local level and believe that our task is simply to evaluate and disseminate. We owe our teachers, our schools, and most of all our students more than that.

Visions of a New Age in Teaching and Learning

■ William R. Wiencke

Technology's Growing Influence on Education

Although electronic technologies have had some impact on society for the last 100 years, the end of the 20th century witnessed a dramatic and unprecedented increase in their effects on our daily lives. In some ways, this impact has changed forever the way we define such fundamental concepts as work and leisure. In the 1970s, technology also began what would become a growing influence on education. At first, as in business and industry, technology was used to automate teaching and make record keeping more efficient. Today, technology is beginning to shape educational delivery processes, reference resourses, and approaches to collaborative learning.

In the near future, technology will gradually change from the current model of desktop or even portable laptop computers to a plethora of small, interconnected devices providing assistance through an unobtrusive interface. This change will open a number of avenues of learning alternatives that hold potential to alter the current model of education.

To describe the impact of new technologies on teaching and learning practices, this paper first reviews a series of emerging technologies whose characteristics have potential for profound effects on how we work and learn in the future and then analyzes those technologies in terms of possible implementations in educational systems and the changes that could be produced.

Recent Technology Releases: Hints of Things to Come

New technologies are introduced almost daily. The consumer electronics and computer industries constantly produce new products to replace our outdated 2-year-old technologies. Individually, this flood of technologies seem unrelated. By combining technologies, however, we can begin to clear away the confusion and focus on potential directions technology can take and its implications for education.

Voice Recognition: The Interface of the Future

Dating back to the industrial revolution, keyboards have been a means of recording text on paper. The first production typewriter was introduced in 1876, exactly 100 years before the Apple II microcomputer. Word processing refined the process with efficient methods of editing and reusing words, phrases, and documents. Nevertheless, keyboards remain the primary device for entering text. If technology is to advance beyond its current level, another more efficient, natural, and transparent device must replace the keyboard. The first and most necessary interface change of the new millennium is being made possible by advancements in voice recognition.

- *Voice recognition software.* Alwang (1998) reviewed programs that represent breakthroughs in continuous speech recognition technology, including NaturallySpeaking (Dragon Systems), ViaVoice (IBM), FreeSpeech (Philips), and Voice Xpress (Lernout and Hauspie). "The three most important features made possible by these packages are: accuracy, accuracy, and accuracy" (p. 193). He also cites increased ease of use and program command and control capabilities as desirable improvements in these packages.
- *Voice-controlled Internet use.* In a later article, Nobel (1999) describes another advance in this area that is reflected in voice recognition software packages: voice-controlled Internet browsers. Dragon's NaturallySpeaking, the first such package to offer this feature, will support Internet Explorer, but it seems likely other browsers also will be supported later.

- *E-mail via telephone.* The Orchestrate Website (http://www.orchestrate.com) describes another development in voice interfaces: sending and receiving e-mail over the telephone. Companies have made great advances in recent years toward creating a voice interface that is both easy to use and accurate. Users can now control programs as well as enter text in a variety of applications. Keyboarding skills will take second place to dictation skills as voice becomes the prime interface in conjunction with the keyboard and pointing device.

Portability: Increasing Utility Through Ubiquity

The voice interface will also provide an opportunity for the creation of small portable devices that will free users from a desktop-delimited work space. Currently these devices are primarily palm-top computers (personal digital assistants or PDAs), which provide business organization utilities such as contact lists and schedules. Systems now are becoming available that provide wireless communications, access to mainframe data structures, and the Internet. In addition, other common hand-held devices, cellular phones and pagers, are beginning to offer the same capabilities as today's PDAs.

- *The PC identity crisis.* Briody (1999) reports that the 17th annual PC Expo demonstrated handheld computers that indicate a shift in the role of portable computers. "The handheld revolution is at hand. The proliferation of myriad devices that offer simple, easy access to the Internet is fundamentally changing the purpose of the PC" (p. 38).
- *Other handheld devices.* Lee (1999) reports on a variety of devices in addition to multipurpose handheld computers, including Nokia's 9000 Communicator telephones that can open up to provide a keyboard and screen and can allow a user to surf the Web. Lee says the near future hold the promise of access to one's home server to allow fast retrieval of up to the minute information updates. Backman (1999) describes the Blackberry, a pager by Research in Motion through which one can send and receive e-mail.

  "Traditional" PDAs use a pen or micro keyboard, which require a stylus to press the keys. These methods are cumbersome and slow, but users seem to be striving to adapt to their requirements because the devices are so portable and handy that they are worth the trouble. The adaptation of voice recognition to these devices is a natural direction to

pursue. Combined with the traditional pointing devices, voice will provide the ease and efficiency required for portable devices to become commonplace.

Wireless Networks: The New Computer Community

Wireless networked communities provide the necessary connectivity to create a new paradigm in information technology. Although voice recognition and portable computing provide a potential for changes, wireless networked communities will pull everything together into a coherent integrated system.

- *The "silicon cockroach" standard.* Spangler (1998) describes "tiny, intelligent personal communication devices and information appliances that you'll carry around with you wherever you go" named "silicon cockroaches" by John Sidgmore, CEO of MCI WorldCom's UUnet Technologies. The key to seamless integration of these devices is a wireless communication standard. One such standard is being developed by Bluetooth Special Interest Group (www.bluetooth.com).
- *Little devices that think.* Levin (1999) describes the emerging capability for small (thus portable) devices to communicate. Jeni is a technology "that deposits Java code on digital devices so they can self-organize into communities" (p. 123), adding a necessary dimension of intelligence to this communication system.
- *The network of networks.* "The next generation of services will be delivered, seamlessly, by a network of networks that will combine the best of voice and data, wireless and wireline" (Lucent CEO Richard McGinn, quoted in Seminerio, 1998). Wireless technologies will make possible a unified networking system that will enable all devices to be interconnected. To the user, it will be like accessing one system.

A wireless networked community will provide the same freedom and ease of movement that has made the cellular phone system so popular. Like cellular phones, these developments allow users to move between established zones, transferring users' identity and connection as they enter the next community. Although wireless networks have been available for some time, it is the community aspect that makes the difference. Traditionally, wireless networks allow users to move within the geographic umbrella established by the system's range, a capability similar to the cordless phones we use in our homes. Wireless community

networks, however, will allow people to move between and among network groups, more like the range provided by cellular phones.

Changes for Education

Combining these three emerging and growing technology areas could create electronic devices that would be extremely portable, easy to use, and have the capability to be connected to all network resources throughout the day. Although the devices and systems described here are just becoming available or are in the development stage, they soon will become commonplace in the business community. In light of increasing demands for a technology ready workforce, their use in education may not be far behind. These technologies could provide the means to change drastically how educators deliver content and foster learning inside and outside the classroom.

Impact on Student Work Options

The developments described here make possible a learning scenario in which students will have technology resources available continually during the day. Centralized computer labs and limited stations at the back of the room will not be necessary. Indeed, they already are being phased out in some higher education institutions. Lessons, assignments, information resources, and evaluations can be delivered directly to the students at their desks or any location at any time. This flexibility will affect every task and operation in the education system.

Students will not need to be in the classroom to receive information or assistance, which does not mean that school facilities will not be used. Daytime supervision of elementary children and early teen students will still be necessary, together with the need for organized socialization and extracurricular activities. The flexibility of voice-activated, ubiquitous access to information and people, however, will provide additional options for home schooling and alternative education settings.

Impact on Teachers' Work

With ready access to networked resources, educators will be able to provide information rich content for all students and greater freedom and flexibility in lesson design. The availability of alternative interfaces (e.g., voice activation) will make it easier to teach students with diverse needs. Ubiquitous access to resources will allow movement outside the classroom to broaden

field experiences that foster authentic, constructivist learning. Expertise in subject matter will not be limited to the individual teacher but can be distributed among a number of on-line experts. High achieving students could easily access college level courses while completing their secondary education (Carr & Young, 1999). The lines between education levels and institutions that already are beginning to blur may virtually disappear.

Necessary Changes

Although all of these capabilities are positive, they will not be achievable without major changes to current guidelines and practice.

- *New learning skills.* Students will need to acquire new skills in using voice recognition and handheld technologies. Some students, released from limitations prescribed by print material, will relish the new interfaces. Others who have worked well with traditional resources may encounter difficulties with them. Thus, flexibility in matching students' needs with the appropriate system resources seems likely to result in increased achievement for all types of learners. In addition, having the ability to locate information continually on-line will decrease the necessity for students to retain numerous facts and, it is hoped, decrease the emphasis on rote learning. At the same time, there will be a gradual and long-term increase in the need for skills in information retrieval, information processing, and decision making—although this transition may take decades.
- *New roles for teachers.* Educators' roles already are changing from knowledge storehouses to knowledge managers. Although expertise in a subject always will be desirable, the ability to locate resources, either through reference materials or on-line experts, will be equally important. And because technology will offer many more alternatives to traditional learning, educators will need an increased knowledge of learning theory, styles, and methods appropriate for the new instructional environments, as well as teaching/learning strategies that take advantage of this new potential.
- *New policies.* Institutions of higher education also will see great impact from these advances in technologies. These same capabilities will be incorporated in the delivery of all their programs. Teacher preparation programs must incorporate knowledge of content with increased focus on the use of technology for the advancement of learning. Researchers

and theorists will find it necessary to continually redefine their models of learning as the basic definition of the learner morphs dramatically.

The Certainty of Change

Predicting the future is always a risky and sometimes futile endeavor, even when forecasting what will happen tomorrow. Drastic changes to our educational system will be tempered by the needs of society and the demands of the economy. It seems certain, however, that the technologies described here will change the fabric of our daily lives, changes that are certain to be reflected in our educational systems.

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The Future of the Teaching Profession

■ Arthur E. Wise

A Vision of Tomorrow's Teachers

The America of the future will require more children to reach higher levels of cognitive functioning than in the past. To reach this goal, we must ensure that our teachers are knowledgeable in their subjects and are able to teach it effectively so that students learn.

How can we speed the arrival of this vision? Following are expectations for beginning teachers from NCATE-accredited institutions. The expectations are explicit and are framed as NCATE accreditation standards (http://www.ncate.org and click on draft unit standards). The standards create a vision of the new professional teacher that will emerge from NCATE institutions.

- *Teachers will know their subject matter.* Standard I of NCATE's new performance-based accreditation standards calls for candidates to "know the content of their fields." How will NCATE hold accredited schools of education accountable? Evidence will include "performance assessment data collected internally by the unit and external data such as results on state licensing tests and other assessments." Teachers' knowledge of subject matter is a prerequisite for entry to the classroom.

  To help ensure that new teachers have appropriate knowledge of subject matter, NCATE has initiated a collaborative venture between its member professional associations and the Educational Testing Service (ETS). The effort will align standards and assessments in teacher preparation accreditation and licensing. The standards will provide broad guidelines for curriculum development and candidates' knowledge. Candidates will be better prepared for state licensing examinations. Colleges will design curricula according to the standards. Alignment will translate into an opportunity for better prepared candidates and a higher percentage of well qualified candidates.
- *Teachers will learn how to teach their subject matter in a variety of ways to help all students learn.* They will be able to apply research knowledge and best practices. Teacher graduates will be able to explain why they use a particular strategy. The NCATE 2000 performance-based standards require teachers to "demonstrate professional and peda-

gogical knowledge, skills, and dispositions and apply them so that students learn."

- *Teacher candidates will be able to reflect on practice and be able to change what does not work.* Graduates of NCATE institutions will be able to apply effective methods of teaching to students of different backgrounds. They will be able to manage classrooms using a variety of techniques. They will be able to nurture the growth and development of each student in their classes. Teacher candidates will be well prepared from their variety of clinical experiences in P-12 schools and will have studied under a variety of master teachers during a structured program of clinical education.
- *Teacher candidates will be able to use technology effectively as an instructional tool.* They will have basic computer literacy skills. In addition, they will be prepared to integrate technology into their instruction and understand methods of incorporating it effectively into student learning. Expectations for the competent use of technology are integral to the NCATE 2000 standards.

All of these statements represent NCATE's vision of the new professional teacher—competent, caring, and well qualified. Teachers who graduate from NCATE-accredited institutions will meet these expectations.

Preparation Versus Emergency License

Several trends push toward the idea of a common standard for teacher preparation; other trends push toward the elimination of teacher preparation as a knowledge-based activity. Which of the two trends will predominate? The policy directions we choose will dictate the answer.

Awareness is growing that emergency certification has not raised students' achievement. The current administration is calling for fully licensed teachers in the classroom. The significance of this proposal cannot be overestimated. For the first time, a presidential administration has called for fully licensed teachers to teach our nation's children. On the other hand, some conservative scholars are calling for the opposite—for complete deregulation of teaching. These scholars would allow those with only a bachelor's degree in hand to teach. This policy direction is uninformed by research and therefore misguided, however. Research has demonstrated that teachers who are fully prepared are more effective than

teachers who are not. More than 100 research studies underscore this fact. The ETS study referred to earlier reinforces that preparation makes a difference in teachers' qualifications and readiness to teach.

Teaching in an Environment Suffused With Technology

NCATE Standards and Technology

Technology is part of the NCATE 2000 standards. Of NCATE's six new standards, five incorporate technology. NCATE's standards require colleges of education to articulate their conceptual framework, or shared vision. In this framework, the college must show how it plans to integrate technology in its instruction.

Standard I expects candidates to know their subject matter and how to teach it. In their response to this standard, colleges are expected to reflect expectations set by the profession—including expectations for the use of technology as a tool in learning. Each NCATE member subject matter association (e.g., National Science Teachers Association) has or is developing performance-based standards that are used in NCATE's accreditation system. And each of those associations must incorporate the use of technology in instruction. Institutions must base their programs on the standards of the profession. The college of education is required to explain how it integrates technology "throughout all aspects of programs" to improve students' learning.

Standard II, the program assessment standard, says that colleges will monitor their students and the effectiveness of their programs. The degree to which candidates are being prepared to use technology will be revealed by this standard. Institutions must monitor their candidates carefully and determine that they are measuring up to specific performance expectations, including the ability to integrate technology in instruction.

Standard III, on clinical experience, requires candidates to have experiences that enable them to further develop the knowledge and skills they are acquiring in higher education. These experiences must include the use of technology as a teaching tool.

In terms of university faculty, NCATE's previous standards focused on faculty *qualifications*. The new NCATE standards focus on faculty *performance*. NCATE's new Standard V expects college faculty to model effective teaching practices, including, of course, the appropriate use of technology in their own instruction.

Both NCATE's current standards and the new NCATE 2000 standards (Standard VI) require colleges of education "to have the resources, including information technology resources, for the preparation of candidates to meet professional, state, and institutional standards."

Change and Accountability

Schools of education must prepare teacher candidates who are able to adjust to change. Change will be a constant in the 21st century. Technology has changed and will continue to change the delivery of instruction. Changes in delivery present new challenges for measuring the quality of instructional programs. Colleges already use distance education as an important part of instructional delivery. They use technology to communicate with students during class (videos) and between classes (e-mail). Many professors have Websites with class assignments, syllabi, discussion rooms, and so on.

In the future, some high school instruction may be accomplished through distance education. School populations are growing and school facilities are growing old. Budgets for repair and building replacements are increasing. The supply of teachers in certain subjects is problematic. Change is occurring so rapidly that events that were not on the horizon 10 years ago—such as the Internet—are changing our lives. Simply because distance education has not been a method of delivery for K-12 instruction does not mean that it will not in the future. Auditoriums may be used as distance education classrooms, or students may opt to dial in from home for certain subjects.

In K-12 classes, students are already communicating with students in other countries via the Internet and e-mail. When students use the Internet as a learning tool, class structure and students' and teachers' behavior change. Students can accept more of the responsibility for their own learning. Learning becomes an infinite process rather than a finite one. The teacher's role becomes facilitator of learning, resource, and guide when students are conducting research on the Internet for a project, when they are gathering data, or when they are working on a tutorial. Colleges of education must prepare teacher candidates who are comfortable using technology as an integral part of instruction.

Partially because of changes in technology and the quicker availability of data, there is a new emphasis on accountability and outcomes. This

emphasis on performance and data presents new challenges to institutions as they prepare professionals. The new technologies and the new emphasis on accountability will likely result in the release of data on the performance of graduates in professional programs not heretofore released to the public. These data will be used in making accreditation decisions. The public will have firsthand data about the performance of each institution's teacher preparation graduates. Those programs that produce graduates who cannot pass state licensing exams will not likely stay in business.

In addition, the public will gain information about how P-12 schools fare in terms of students' achievement. Schools are publishing "report cards" with basic performance data—how students in various grades at that school scored in specific subjects on state tests. Thus, the public will know that only 40% of 4th grade students at a given school passed the social studies exam. The public will demand change once the tests and curriculum are in alignment.

Students' achievement scores will produce increased accountability in P-12 schools as principals strive to increase students' scores and take proactive steps in areas where students are lagging. More focus on teaching and teachers' performance will result. Thus, technology will play a role in increased attention to the quality of teachers.

Recommendations for Action

1. The preparation of teachers must be recognized as an institution-wide responsibility at colleges and universities

2. All academic assets of an institution should be linked to support the preparation of teachers.

3. Faculty members at colleges and universities — in teacher preparation programs and other disciplines — should be linked to community educators in a way that demonstrates interdependence built on mutual understanding and respect.

4. The leadership of an institution of higher education and teacher preparation programs, as well as all faculty members, should be dedicated to their own continuous learning as part of a community of learners.

5. The leadership of teacher education programs must be willing to form strategic alliances or partnerships with others within the community with a stake in teacher education

6. The leadership of teacher education programs must take responsibility for meeting standards that define quality programs and take responsibility for transforming teacher candidates into effective practitioners.

Issue Area Six

Measuring the Success of Teachers and Teacher Education Programs

Success for teachers and teacher education programs can be defined by several variables: high student test scores, a teacher's use of performance-based assessment, the high marketability of teacher education graduates, and retention rates for teachers. As technology changes how learning occurs and teachers teach, the emphasis on assessment should be measuring what students are learning. The papers in this section look at how success of teachers and teacher education programs should be measured in the age of technology.

Opening the World to Learners Through Technology

■ Karen I. Adams

Applications of emerging technology clearly impact measures of teacher quality and effectiveness as evidenced through student learning. Technology, therefore, is changing the way in which schools, colleges, and departments of education prepare teachers and measure their success, both in the means of the measurement used and in the actual performance expectations. Many teacher preparation programs currently require that preservice teachers, in their upper level methodology and content courses, prepare well integrated PowerPoint lessons, conduct on-line research projects, participate in Internet supported projects linked with students in elementary or secondary classrooms, and demonstrate the ability to integrate technology appropriately into lesson plans designed to maximize students' learning. Subsequently, these programs often expect students to prepare and maintain electronic portfolios and then encourage graduates to register on-line for possible teaching positions. At the core of these changes in expectations regarding teachers' preparation and performance are several questions: How have actual classroom instruction and student learning changed as a result of technology? How should learning now be different? How can we measure this difference?

The early uses of technology in P-12 and university classrooms were often no more than glittery, fast-paced worksheets on a screen. No new learning actually occurred. Only the medium of instructional delivery had changed and become, for some, more enticingly packaged. The opportunities for productive applications of technology are today quite different. Interactive computer based writing labs allow students to read, question, and critique one another's essays in a way that traditional classroom writing processes could never have allowed. Science lab simulations permit students to conduct experiments and to measure results individually or in small groups without expensive or potentially unavailable labs.

Internet bookstores and news sources provide students and teachers with current author interviews, book reviews, and the opportunity to discuss bestsellers with readers throughout the world. Oprah Winfrey has done more to produce an enthusiasm for book chats among American adults

than four years of high school literature response groups ever accomplished. The medium of Web based technology has drastically changed opportunities to learn. The days of clipping a current events article from the newspaper for a world history class have now been replaced by CNN's World News instant updates with video clips and on-the-spot interviews.

Technology can indeed open the world to learners of all ages. Daily English language newspapers from Albania to Brazil to Tanzania are readily available to Web users. News media Websites provide 5-day weather forecasts for cities from Timbuktu to Mandalay. No longer tied to quickly outdated classroom maps, teachers can use search engines to display current country and city maps, allowing students to view entire continents as well as to chart their route on the Paris Metro from the Louvre to the Champs-Élysées. Interactive Websites allow students to plan a possible, though perhaps imaginary, weekend of theater and art gallery exhibits in London and to plan month-long train trips through western Europe. *National Geographic* offers contemporary and historical articles on world cultures supported by interactive maps, and programs such as Maya Quest allow students to experience adventure travel through ongoing journal entries and video clips from real-time travel throughout the world.

My personal enthusiasm for the enhanced learning that technology can encourage is not for the possibility of fast-paced, entertaining reading and math skill programs but for technology's ability to open the world to learners. At the time of Princess Diana's funeral, CNN provided Internet users the ability to view Westminster Abbey from a complete 360 degree perspective, looking up and all around at every angle. Students wanting to learn about another country can not only view updated maps but also read U. S. State Department advisories, check current exchange rates, find typical menus and recipes, and even identify the number and location of automatic teller machines.

While to some this may seem like peripheral fluff and nonessential to increased ACT and SAT scores, I contend that an increased knowledge of the world and its resources is essential for the production of an informed citizenry, one of the traditional purposes for the American education system. This is the learning I believe technology can and should encourage. It should *not* be merely an update of the old worksheets and learning strategies, but technology can and should take the student to levels and methods of learning not possible before, providing the opportunity to

explore, to interact, and to discuss. Teachers continue to be accountable for students' learning in an increasingly technology enhanced world, but the breadth of this learning possible has changed drastically, as should the measures of teachers' accountability. Teachers can now be evaluated not only by the knowledge they impart but also by the appropriateness of the technological tools they have provided to learners in their classrooms in the quest for this knowledge and by how they as teachers have personally demonstrated the effective use of these tools. The teacher who simply tells a classroom of students to surf the Web for information on a general topic without additional guidance and purpose is no better than a teacher who in the past distributed "word search" sheets for students to complete or asked students to fill a morning of instructional time trying to create the most words possible from "Thanksgiving."

Teachers still need to establish learning purpose and to determine the best means for attaining that desired learning. Technology, however, has increased the number and variety of these best means. Alan Kay, a Walt Disney Fellow in Imagineering, has defined this change by broadening the commonly applied definition for computer literacy. "Genuine computer literacy is not about learning to use tools like a word processor or spreadsheet, but about learning a new language of events, processes, and dynamic relationships that will help make the world and its ideas more understandable, more communicable, and more civilized" (Schmucker, 1999, p. 40). This new definition helps to identify part of the change that technology has brought to teaching: The language and learning processes are now different. While debate continues about appropriate applications of technology, particularly in the area of learning simulations and games intended to re-create reality, the teacher's role in selecting the best instructional tools is a serious one. Technology is not necessary for all learning, and it may even be detrimental for some. It is therefore the role of the teacher to know when it is and is not best to integrate technology significantly in the learning process and, subsequently, what technology to use and how to use it.

The models used for the evaluation of instruction in teacher preparation programs have perhaps become more intricate than in the past. Although evaluators have traditionally looked for accurate material presented in the most effective manner, they now expect to see effective applications of available technology. Teachers must be highly proficient in

their understanding of technological applications and available resources lest they be inappropriately impressed with cute but unnecessary technology and unaware of the possibilities of emerging applications. The question for the teacher involves what technology, if any, might best have supported this lesson, accompanied by an understanding of the relative simplicity or difficulty of such technological application and any additional student preparation necessary to ensure that students learn. In *Technology and the New Professional Teacher* (National Council for Accreditation of Teacher Education, 1997), the Task Force on Technology and Teacher Education succinctly identifies this new role: "Teachers should help students pursue their own inquiries, making use of technologies to find, organize, and interpret information, and to become reflective and critical about information quality and sources" (p. 4).

With the increasing amount of information accessible to students, teachers must now help students not only identify information and technology for instructional use but also guide students in evaluating the technology itself and the quality of information presented. The NCATE task force describes the "new attitude" necessary for the teacher who is "fearless in the use of technology, encourages them [students] to take risks, and inspires them to become lifelong learners" (p. 4). Administrators and faculty in teacher preparation programs must respond to this new role for teachers as they rethink their programs and the anticipated knowledge and ability they expect from their students. At the heart of this process is the question, well phrased by the task force, "What knowledge, skills, and attitudes will they [teacher education students] acquire from the teacher education program that are essential for them to perform successfully in technology enriched P-12 classrooms?" (p.10).

Accountability for learning, therefore, is tied to the appropriate selection and use of available resources. This is not a new idea in evaluation, but the available resources have significantly increased. Basic computer skills such as keyboarding, use of search engines, and design of spreadsheets are no longer enough in the area of technology. Teachers must be accountable for their knowledge of technology directly attached to their areas of instruction—how to use it, how to demonstrate its use, and how to evaluate its impact on students' learning. Teaching about technology will not suffice; instead, teachers must teach with technology imbedded in their instructional planning processes. This in itself is a challenge for

teacher preparation programs. These programs face an equally serious challenge, however, in determining how best to measure this new teaching knowledge and skills. What scoring rubric will suffice to evaluate such a prospective teacher?

Some would argue that students need only learn the basics of computer use in P-12 settings, basically a computer literacy course, as preparation for the job market. These critics of the integration of technology into the curriculum would artificially separate technology rich instruction from traditional classroom content and instructional approaches, but they are ill informed about the possibilities for the contemporary classroom and in fact would do students a great disservice. Their understanding is no different from those who have recently argued for the teaching of synthetic phonics, teaching letter sounds isolated from actual words rather than in the context of literature and storytelling, to build language use and understanding. Technology separated from meaningful content is as empty and limiting for students as are those isolated letter sounds. Employers in all areas of business and industry are seeking employees with good problem solving skills and technology application abilities. The requisite learning for these abilities cannot occur in an isolated setting of technology for its own sake. They depend on the thoughtful and planned use of technology to enhance learning and to assist in meaningful problem solving. This will be the measure of students' success in grades P-12 and in teacher preparation programs, and it will be the basis on which to measure teachers' success.

As a final note of change, many schools, colleges, and departments of education are now looking at an additional application of technology in the preparation of teachers: Web-based courses and instruction. The use of Web-based and Web-supported courses can indeed provide instruction to students whose geographical locations or work schedules may not allow them to take advantage of traditional on-campus class scheduling. This need for a new adaptation of distance learning is especially important as we face an increasing shortage of teachers. These newly developed Web courses should not, however, be the same old worksheets placed on a computer screen as was true of early classroom applications of technology. Instead, meaningful interaction needs to occur through exploration, problem solving, and discussion—the same traditional methods but in a new format. Public and private not-for-profit institutions must consider

their responses to such instructional needs quickly, as the for-profits are well aware of the potential for financial gain. The future will continue to present exciting and challenging applications of technology in the instructional arena, particularly in the area of teacher preparation. Higher education should take a lead not only in the design of instruction but also in the area of evaluation of instruction and subsequent learning that is technology dependent.

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Educational Success in the Age of Technology: Aligning Learners, Teachers, and Teacher Education

■ National Evaluation Systems, Inc.

Technology and Education

Technology is changing everything, including education. The ways in which students learn, teachers teach, and prospective teachers prepare to teach are changing. In many ways, these changes have been learner driven in that students have brought their enjoyment of technology to the classroom, leaving educators to react to this new reality.

Most children today are more comfortable with computer technology than their elders. With great ease, children navigate 3D landscapes, use

multimedia, set up instant networks with their friends on the Internet, and surf the Web. But technology is not just child's play; it promises to be of great use in education. If technology is to play an important educational role—and there is little doubt that it should—teachers will have to become involved. They will have to do what good teachers always do: turn students' strengths and interests to instructional advantage.

Students need teachers to make technology educationally useful, to understand the learning possibilities latent in technology. They need teachers who can help them use their 3D know-how to explore science, geography, and art; teachers who can help them use multimedia resources to enliven history, literature, music, theater, and a wealth of other topics. It is teachers who must show students how to use their instant networks to collaborate meaningfully on homework and research projects and teachers who can help students use the unbelievable riches of the World Wide Web to explore questions in both a focused, linear way and a more unfocused, hyperlinked way.

Teachers who are comfortable with the use of technology in the classroom can then make technology personally and professionally useful to themselves in planning and preparing lessons, managing their classroom activities and environment, assessing and monitoring students' progress, facilitating their own professional development, and collaborating with distant colleagues.

So how do we make sure that teachers play the central role in bringing technology to education? In the United States, individual states play an important role in encouraging the productive convergence of learners, teachers, and teacher educators around technology.

The State Role in Educational Change

To be successful in the new world of technology, teachers will have to be comfortable with technology. All the key players in the educational world appear to realize this truth and are committed to making it happen. The following paragraphs illustrate how individual states are changing public education at all levels—from student learning to educator preparation—to accommodate and foster technology.

The Licensing Function

States measure success for teachers and teacher education programs in large part in terms of the state's responsibility to protect the health, safe-

ty, and welfare of children in public school classrooms. This responsibility is exercised through licensing or certifying teachers. Each state exercises this responsibility in its own way.

The responsibility to protect the welfare of schoolchildren includes the responsibility to ensure that students learn what they will need to know to become successful members of society. In the age of technology, this includes an understanding of technology's tools. Again, each state defines for its own citizens the nature and level of understanding that students are required to achieve.

Academic Standards for Students

Often, states endeavor to ensure that children will learn what they need to know by specifying the academic content that students in that state are expected to learn and the standards that they are expected to achieve in relation to that content. Technological content and standards—defined differently by each state—are becoming important aspects of each state's specification of learning. These content standards typically have regulatory or legislative force.

New York State, for example, has developed learning standards applicable to students at all levels from elementary through secondary that include a technology standard addressing seven issues: engineering design; tools, resources, and technological processes; computer technology; technological systems; history and evolution of technology; impacts of technology; and management of technology.

Taking a different approach, the Illinois learning standards contain a standard for using technology that is infused across the academic subject areas covered by the standards and through all grade levels from early elementary to late high school. The way this standard is applied differs depending on whether the subject area is language arts, social science, or physical development and health.

Standards for Teachers' Content Knowledge

What students are required by the state to learn, teachers are required to teach, and the requirement is often specified in state laws and regulations. These laws and regulations are often promulgated as teaching standards that relate to the knowledge of subject matter content that prospective teachers must acquire before they will be allowed to serve as teachers in the state.

Similarly, states often require teachers to understand other educational functions that technology can facilitate, including classroom management, curriculum development, instructional planning, student and teacher evaluation, and professional development. These functions are often the subject of professional knowledge standards that teachers must attain before they are certified by the state. Like content knowledge standards, professional knowledge standards vary from state to state.

An example of one approach to including technological content in its professional teaching standards is seen in draft Illinois professional teaching standards, which are congruent with the technology requirements in the state's learning standards for students. For instance, according to Illinois professional teaching standard number 4, Planning for Instruction, a teacher is expected to understand (among other requirements) how to integrate technology into classroom instruction, how to review and evaluate educational technologies to determine their instructional value, how to use various technological tools to access and manage information, and how to use technology to address students' needs (see Document A).

Teacher Preparation

States generally enlist teacher preparation institutions in their efforts to ensure that students have access to classroom teachers who can confidently facilitate students' use of technology. Well prepared teachers can help their students appreciate technology as a learning tool. By so doing, the teachers can help their students acquire technological skills and understanding that will serve them well in work and in the larger society. Teacher preparation institutions hold the key to the success of both teachers and students in the state's classrooms.

If students are to receive knowledgeable assistance in turning their technological instincts and pleasures into solid learning, teacher preparation programs must enable prospective teachers to understand the power and potential of technology as well as its basic vocabulary, structures, and applications.

The emerging importance of technological preparation is corroborated by the fact that the National Council for Accreditation of Teacher Education (NCATE) incorporated into its own list of standards for teacher education programs the International Society for Technology in

Education's Recommended Foundations in Technology for All Teachers. This document offers basic technology standards that "all candidates seeking initial certification or endorsements in teacher preparation programs should have opportunities to meet." The foundations standard (see Document B) cover three areas: basic computer/technology operations and concepts, personal and professional use of technology, and applications of technology in instruction.

Individual states respond to these and other national standards with their own variations reflecting their own situations. New York State, for instance, now includes in its standards for teacher preparation programs leading to an initial certificate a "pedagogical core" requiring that teachers use technology, including instructional and assistive technology, in teaching and learning, and that they be skilled in using technology and teaching students to use technology to acquire information, communicate, and enhance learning.

Certification Testing

States have access to a singularly powerful means to ensure that students, teachers, and teacher educators are all working toward sensible goals for the use of and instruction in technology. If teacher certification tests are closely aligned with the state's requirements and standards for students, teachers, and teacher preparation institutions, those tests will add a forceful voice to the call for properly focused learning about technology.

Well aligned tests based on state standards for students, teachers, and teacher preparation programs reinforce every element of the educational structure. The tests ensure that only those candidates who have demonstrated the requisite knowledge receive certificates to teach, in turn ensuring that schoolchildren have access to teachers who can help them learn what the state has determined they should learn. College students preparing for jobs in education have a well articulated framework for planning their coursework and focusing their studies. Educator preparation programs have access to the same framework for guiding students toward appropriate studies, interpreting students' test results, and evaluating their own curricula.

To be effective, the tests must be based on standards that are parallel or identical to those that drive the other elements of the educational enterprise. When they are, the learning accomplished by students, the teach-

ing performed by teachers, the preparation provided by teacher educators, and the knowledge assessed by teacher certification tests become productively aligned elements of a cooperative network.

The center of the network is the state and its powers of certification and licensure. The state decides what sort of technological knowledge is appropriate for its own context, publishes technology related standards for students and teachers, and requires mastery of similar standards by candidates for teaching certificates. The network, properly aligned, ensures that all levels of education pursue the same state-specified goals with respect to technology.

Approaches to Testing Prospective Teachers' Technological Knowledge

Several approaches are available for incorporating technological content into teacher certification tests. Four are outlined below.

- The state could develop a *stand alone* assessment of instructional technology for teachers containing assessment items that address general technological content and overall instructional and professional applications. The content would be applicable across teaching in all content areas. This approach would support a state policy in which technology is recognized as a central topic of teacher preparation coursework and certification requirements. Knowledge of technological issues would have a considerable emphasis statewide.
- A *subarea or content domain* could be included in a test of professional knowledge. This approach would attribute to technology a level of importance similar to that accorded to other pedagogical domains, such as instructional planning or delivery. This approach would support a state policy that emphasizes technology as a discrete element of a teacher's professional knowledge. Teacher preparation institutions and candidates would be expected to recognize the importance of technology as a defined topic of preparation.
- Technological content could be *infused into some or all pedagogical objectives* in a test of professional knowledge. This approach would emphasize that technology is an essential and integral component of the teacher's professional portfolio, with wide applicability across instructional situations. This approach would support a state policy in which technology is recognized as a universal tool for teachers, inseparable from other elements of professional knowledge and referenced by

teacher preparation programs and candidates whenever instructional planning, delivery, evaluation, and reflection are discussed.

- Technological content could be *infused into content knowledge* tests for teachers. The content could be spread across objectives or contained in one technological objective or subarea of content. Under this approach, technology is conceptualized not as a separate body of knowledge or a discrete tool but as an integral part of all instruction. The message to teacher preparation institutions and candidates is that technology is a means to an end, not an end in itself. This approach would support a state policy that emphasizes the instructional usefulness of technology to accomplish curricular aims. It would require decentralized attention to technological issues throughout the academic and educational curricula of teacher preparation institutions.

An example of a subarea of technological content that would be included in a hypothetical test of professional knowledge is included in Document C.

Assessment Formats and Item Types

Several types of assessments could be developed to assess prospective teachers' knowledge of technology, including:

- Technology integrated assessment in which candidates actually use technology to demonstrate their technological knowledge (e.g., using the Internet to solve a problem in real time or using a computer spreadsheet to generate a series of grades);
- Technology delivered assessment in which items are presented on computers and responses are entered and recorded on computers or on another medium (e.g., computer assisted assessment, or video or audio stimuli);
- Analytical and simulation exercises in which candidates explain or simulate through written exercises how they would approach and solve contextualized problems involving the use of technology (e.g., candidates develop a plan for using technology to support instruction on a topic in their content areas or candidates analyze a student's work and develop technologically assisted instructional interventions for the student).

Document A

Excerpt From Draft Illinois Professional Teaching Standards

4. Planning for Instruction: The teacher understands instructional planning and designs instruction based upon knowledge of the discipline, students, the community, and curriculum goals.

The teacher...

Knowledge

A. understands the Illinois Academic Standards, curriculum development, content, learning theory, and student development and knows how to incorporate this knowledge in planning instruction.
B. understands how to develop short- and long-range plans consistent with curriculum goals, learner diversity, and learning theory.
C. understands how to take the contextual considerations of instructional materials, individual student interests, and career needs into account in planning instruction that creates an effective bridge between student experiences and career and educational goals.
D. understands when and how to adjust plans based on student responses and other contingencies.
E. understands how to integrate technology into classroom instruction.
F. understands how to review and evaluate educational technologies to determine instructional value.
G. understands how to use various technological tools to access and manage information.
H. understands the uses of technology to address student needs.

Performance

1. establishes expectations for student learning.
2. applies principles of scope and sequence when planning curriculum and instruction.
3. creates short-range and long-term plans to achieve the expectations for student learning.
4. creates and selects learning materials and learning experiences appropriate for the discipline and curriculum goals, relevant to the students, and based on students' prior knowledge and principles of effective instruction.

5. creates multiple learning activities that allow for variation in student learning styles and performance modes.
6. incorporates experiences into instructional practices that relate to the students' current life experiences and to future career and work experiences.
7. creates approaches to learning that are interdisciplinary and that integrate multiple content areas.
8. develops plans based on student responses and provides for different pathways based on student needs.
9. uses teaching resources and materials which have been evaluated for accuracy and usefulness.
10. accesses and uses a wide range of information and instructional technologies to enhance student learning.

Document B

International Society for Technology in Education Recommended Foundations in Technology for All Teachers

I. Foundations. The ISTE Foundation Standards reflect professional studies in education that provide fundamental concepts and skills for applying information technology in educational settings. All candidates seeking initial certification or endorsements in teacher preparation programs should have opportunities to meet the educational technology foundations standards.

A. Basic Computer/Technology Operations and Concepts. Candidates will use computer systems to run software; to access, generate and manipulate data; and to publish results. They will also evaluate performance of hardware and software components of computer systems and apply basic troubleshooting strategies as needed.

1. operate a multimedia computer system with related peripheral devices to successfully install and use a variety of software packages.
2. use terminology related to computers and technology appropriately in written and oral communications.
3. describe and implement basic troubleshooting techniques for

multimedia computer systems with related peripheral devices.
4. use imaging devices such as scanners, digital cameras, and/or video cameras with computer systems and software.
5. demonstrate knowledge of uses of computers and technology in business, industry, and society.

B. Personal and Professional Use of Technology. Candidates will apply tools for enhancing their own professional growth and productivity. They will use technology in communicating, collaborating, conducting research, and solving problems. In addition, they will plan and participate in activities that encourage lifelong learning and will promote equitable, ethical, and legal use of computer/technology resources.

1. use productivity tools for word processing, database management, and spreadsheet applications.
2. apply productivity tools for creating multimedia presentations.
3. use computer-based technologies including telecommunications to access information and enhance personal and professional productivity.
4. use computers to support problem solving, data collection, information management, communications, presentations, and decision making.
5. demonstrate awareness of resources for adaptive assistive devices for students with special needs.
6. demonstrate knowledge of equity, ethics, legal, and human issues concerning use of computers and technology.
7. identify computer and related technology resources for facilitating lifelong learning and emerging roles of the learner and the educator.
8. observe demonstrations or uses of broadcast instruction, audio/video conferencing, and other distant learning applications.

C. Application of Technology in Instruction. Candidates will apply computers and related technologies to support instruction in their grade level and subject areas. They must plan and deliver instructional units that integrate a variety of software, applications, and learning tools. Lessons developed must reflect effective grouping and assessment strategies for diverse populations.

1. explore, evaluate, and use computer/technology resources including applications, tools, educational software and associated documentation.
2. describe current instructional principles, research, and appropriate assessment practices as related to the use of computers and technology resources in the curriculum.
3. design, deliver, and assess student learning activities that integrate computers/technology for a variety of student group strategies and for diverse student populations.
4. design student learning activities that foster equitable, ethical, and legal use of technology by students.
5. practice responsible, ethical and legal use of technology, information, and software resources.

Document C

Assessment Framework Sample: Instructional Technology Subarea for a Professional Knowledge Assessment

Note: This assessment framework sample has been formatted as an example of a subarea within a broader professional knowledge test. The subarea and objective numbering of the sample presuppose a complete test framework of five subareas and 19 test objectives.

SUBAREA V. TECHNOLOGY IN THE EDUCATIONAL ENVIRONMENT

0017. Understand fundamental concepts and skills related to the use of information technology in today's world.

For example:

- demonstrating knowledge of basic hardware and software components of computer systems, the function of computer subsystems and peripheral devices, and terminology related to computers and technology (e.g., CD-ROM, DVD, application, hard disk, RAM, hierarchical file system, multimedia, browser, baud rate, modem, DSL, FTP)
- applying procedures and strategies for using information technology in various contexts (e.g., installing and using hardware devices and software packages; accessing, generating, and manip-

ulating data; using telecommunications devices and software; managing, backing up, and storing computer files; evaluating and troubleshooting computer components; using imaging devices with computer systems and software; protecting hardware and software from damage, intrusion, and viruses)

• analyzing uses, advantages, limitations, and effects of computers and advanced technology in business, education, and society, including ethical, social, and equity issues raised by the use and abuse of information technology

0018. Understand how to use information technology to enhance professional growth and productivity and to support instruction that is responsive to student needs and goals.

For example:

• recognizing characteristics, uses, advantages, and limitations of technology that can enhance planning, classroom management, instructional preparation, evaluation, and professional development (e.g., word processing software, databases, spreadsheets, graphics tools, presentation programs, desktop publishing)

• recognizing characteristics, uses, advantages, and limitations of telecommunications and other resources that can support professional development, facilitate collaboration with colleagues, and promote lifelong learning (e.g., World Wide Web discussion groups and list servers; e-mail; on-line research services, databases, and catalogs; CD-ROM information and reference sources)

• applying knowledge of computer-based technologies to solve problems and make decisions that enhance teaching and learning (including the use of adaptive assistive devices for students with special needs)

• analyzing equity, ethics, legal, and human issues related to the use of computers and technology in educational situations

0019. **Understand how to use computers and related technologies to support learning and sustain the development of critical thinking, problem solving, communication, research, and collaborative skills in all students.**

For example:

- recognizing the uses, advantages, and limitations of various types of computer/technology resources (e.g., word processing, databases, games, telecommunications, multimedia) for supporting and enriching learning
- applying strategies for using various technological tools to foster active inquiry, independent learning, communication, the construction of knowledge, higher-order thinking, metacognition, and collaboration
- structuring technology-based learning opportunities to support individual work and productive collaboration among students; address the needs of students with diverse strengths, needs, goals, and experiences; protect students from exposure to threats and abuse; and facilitate teacher monitoring, assessment, and feedback to promote progress
- evaluating technology-based instructional strategies in relation to specified goals (e.g., fostering the equitable, responsible, ethical, and legal use of technology by students; stimulating curiosity; promoting risk taking and problem solving) and principles of effective instruction (e.g., promoting active engagement in learning; encouraging students to assume responsibility for shaping their own learning; helping students use individual strengths as a basis for growth)

Meaningful Evaluation of Teachers and Teacher Education Programs

■ Alan Bain

The current backlash in education surrounding the accountability and standards movements (e.g., Houston, 1999) creates an interesting context within which to take a position on the identification of educational evaluation measures. The reasons for the backlash are consistent with the long history in education of fixing the parts while ignoring the whole. We have known for some time that educational systems and individual organizations are remarkably complex, frustratingly informal in their professional culture, and highly resistant to change (Evans, 1996; Sarason, 1990). As such, they are ever ready to rebuff one-dimensional efforts at innovation. Whether it be the international trend toward devolving responsibility without providing the necessary expertise to make devolution work, providing access to technology without curriculum integration training, or setting new standards for teachers without engaging in the fundamental reform of models of preparation, we know the outcome all too well. In each case we see the same predictable and repeated pattern of failure.

So much of our accreditation and evaluation effort is disproportionately focused on the correlates of school success (e.g., adequate infrastructure and the articulation of curriculum considerations as opposed to evidence of student outcomes). Far less emphasis is placed on those things that should be causally connected to the learning of students, largely because they are not formally established in the design of educational organizations. In comparison, when accreditation or accountability standards move too rapidly toward a focus on student outcomes, their proponents face the opposite problem—educational organizations that have not evolved sufficiently to deliver those outcomes.

In education, reform usually involves policy, plus technology, plus professional development over time. The problem is that the parts never seem to arrive at the same time or fit together. We provide access to technology without a parallel effort to train and support staff adequately. The technology is underused despite the incredible expense required to put it in place. This type of reform results in a failure to make demonstrable improvement in the core activity of schools—learning by students. The

result is a stream of initiatives that orbit the periphery of educational systems and rarely penetrate the core of individual organizations or the classrooms of individual schools, making legitimate evaluation exceptionally difficult (Elmore, 1996; Pogrow, 1996).

Reform efforts should consider space, cost, teachers' roles, leadership, policy, the curriculum, infrastructure, evaluation, and professional development as interlocking pieces of a puzzle. The issue with this approach is that our reform mechanisms are not geared to take the longer view required for systemic reform, nor do most reformers possess the skills, resources, and frequently the patience for the long road. Systemic reform in a single school or department can be a 10-year, high-risk process. It is hard to scale up rapidly and depends heavily on a change agent for much of the time. Despite these huge issues, a growing awareness exists that Option A is a dead end and that we need to at least start asking questions about Option B.

Despite this somewhat pessimistic perspective about reform, there exists a remarkable opportunity to design better programs that incorporate sound evaluation practice. We possess a powerful long-standing technology of teaching, learning, and evaluation and a strong body of research on organizations and organizational behavior. We are right in the middle of an information revolution that offers us amazing tools to take care of the logistics of better program design and evaluation, and we have the historical precedent associated with the professional ascent of other fields as a guide. Collectively these assets should provide us with the toolbox to address the vexing questions we face in education related to program design and evaluation.

To capitalize on these assets, we first need to recognize that our enthusiasm for evaluation in education transcends our technology for designing and influencing the objects of our evaluation. We have three challenging questions to answer first: What is the design methodology that will allow schools and colleges to identify the salient and tangible practices and processes that they will use to define their programs? How can we make a powerful technology of evaluation part of the design? How do we get those new designs and programs in place by reconciling the human and technical sides of change in a strategic methodology for innovation? (e.g., Evans, 1996; Fullan, 1997).

This paper focuses on the first and second questions—the need to bring greater clarity to the core competencies and expected outcomes of programs to make evaluation purposeful.

How do we move our definition of educational programs from those that focus on the perceived correlates of students' success to those that are causally connected to that success? How do we create the clarity of program design and implementation that brings legitimacy to evaluation and, more important, enhances student learning? There are some straightforward albeit courageous steps that can be taken to make programmatic reform meaningful and evaluable. The following five key steps use examples derived from a longitudinal school reform project

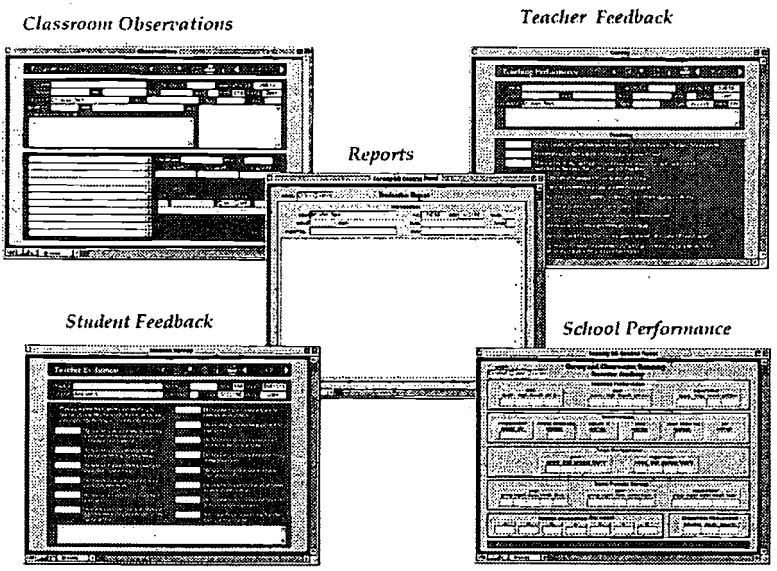
Establish the Core Competencies

Establish the pedagogical and curricular core competencies of the school or teacher education program. What practices does the school believe will influence the learning of students? How will it prepare faculty to deliver those practices and support them in their professional growth? For example, if a college professor is convinced that peer mediation should be taught in a methods course on teaching practice, then that faculty member should be able to train students to use it and should employ the practice in the course itself. As obvious as it seems, taking such a step requires a significant movement away from the prevailing journalistic approach to college teaching toward a model of clinically focused training.

A core competency approach requires that mission and policy be articulated in practice. To extend the previous example for the purpose of illustration, in a core competency approach contemporary research on peer mediation is examined and the salient characteristics identified. Those salient characteristics are incorporated into the position descriptions and roles and responsibilities of faculty. Training is provided to introduce and teach peer mediation techniques in addition to the provision of ongoing support and feedback about the use of the practice. Even the design of physical space may be informed by a clear definition of practice.

What becomes possible when these "simple" steps are taken and then aggregated over all areas of competency is quite remarkable. First, the secret of "best practices" is liberated for all to see and share, or, maybe more cynically, the emperor gets dressed. Second, meaningful evaluation becomes a possibility.

The following screen shots of a suite of evaluation tools were developed based on a school's definition of core competencies in teaching, curriculum design, collaboration and teamwork, professional growth, and the



School Tools Evaluation System™

use of technology. The tools have been used for two years to build collaborative performance reports, gather and analyze surveys, and conduct classroom observations over a school network. Teachers can go on-line to observe peers, complete surveys, receive and give feedback to peers and administrators, and receive feedback from students. More than 6,000 teacher evaluations by students have been gathered and analyzed over 2 years. Each tool is based on well researched practice in the field, multiple evaluation approaches are used to tap the domains of interest, and the perspectives of all stakeholders are included. Each stakeholder group is evaluated while also serving as evaluators.

Because the focus of the tools is the core competencies, the professional lexicon associated with best practices becomes the domain of interest of all stakeholders. The questions on the student survey ask for specific feedback on students' perceptions about their teachers' demonstration of the core competencies in each domain of interest. The items on self, peer, and supervisory surveys are aligned with the student survey and the results triangulated with classroom observation and the permanent product in the form of curriculum. The focus and clarity in the definition of the evaluation object raises the collective intelligence of the organization (Engelbart,

1998) by creating a common understanding of those things the community believes exert an influence on learning. Students, teachers, and parents all learn about good practice because it is no longer a mystery. The organization builds institutional mastery and leverages what it values as best practice (Senge,1994).

Consider the rich dialogue that can occur during an evaluation when teachers and students talk about the most effective way to organize groups in a cooperative learning lesson and their place in a curriculum unit, or how to best recognize individuals and groups. Compare such evaluation with "has good rapport with students" and "uses technology or teaching approaches effectively" that so often characterize evaluation in many educational settings, where the essence of what constitutes effective practice remains undefined.

Place yourself in the position of supervisor, teacher, or student and consider also how much more productive a dialogue about collaboration and teamwork or the use of technology could be when those well researched characteristics of the approach are brought into the conversation through training, supportive feedback, and valid evaluation mechanisms. From a teacher's perspective, the expectations are clear and the conversation authentic; from an administrator's perspective, the expectations for supervision are unambiguous and the interaction between teacher and supervisor based on a common understanding and lexicon of professional practice. For students, the benefit is better learning and the opportunity to learn about their learning as they work with teachers who demonstrate a consistent and demonstrable understanding of their professional skills (Bain, 1999).

In the core competency approach, good practice in teaching is not the only thing that is leveraged. Because the evaluation object is defined, we can meaningfully leverage those best practices in evaluation, including multimethod approaches (e.g., ratings, observations, surveys, permanent products, collaborative conversation) that triangulate legitimate information from multiple sources (e.g., students, peers, supervisors, parents). In addition, we leverage the use of information technology. The clarity of purpose allows us to build powerful tools that can address the well documented logistical challenges associated with valid and timely appraisal of performance.

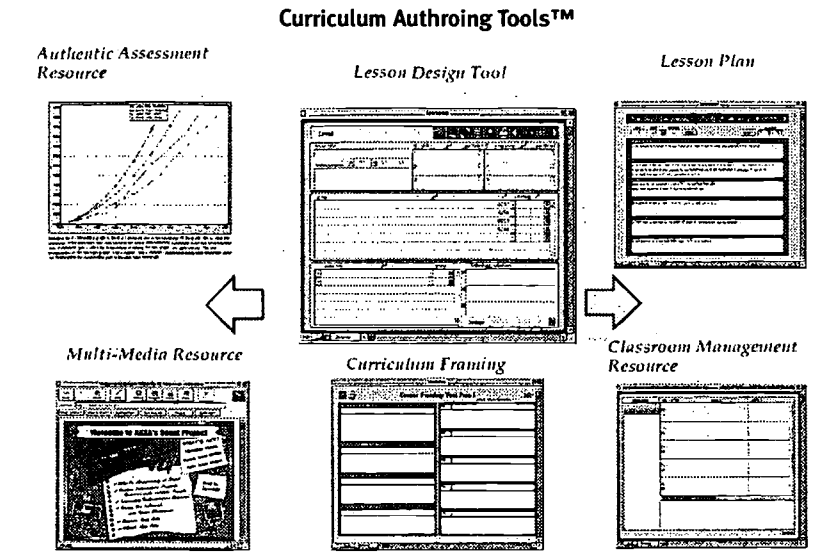
We also preclude the need for the magic score. The technology provides for easy triangulation and reporting, allowing qualitative and quantitative

data to remain in their original form. The tools build a powerful picture of performance based on multiple perspectives and sources. The evaluation product is rich in perspective and provides a validity that does not need to be reduced to a single statistical indicator. The information gathered serves not only as a basis for individual feedback but, when aggregated across the school or program, also as a way to take the pulse of the institution in the areas associated with the core competencies.

Build a Defined Curriculum Model

Build a curriculum model around the core competencies. Quality programs clearly are more than the aggregation of sets of best practices. Among other factors, the developmental course of curriculum and learner characteristics must be considered. But the same research driven competency-based approach can be employed to build a curriculum model that integrates pedagogical approaches such as cooperative learning into a developmental curriculum model. With such a model, not only the sum of the parts but also the model itself can be evaluated.

The following example shows what is possible when the core competencies associated with teaching and the curriculum are defined in a school setting. The screens are from a suite of curriculum authoring tools used in a



secondary school by faculty across disciplines to build and deliver curriculum. The tools are designed to integrate contemporary research on curriculum design, including frameworks, authentic and portfolio assessment (e.g., Wiggins, 1998), effective teaching (e.g., Slavin, 1990; Rosenshine, 1986; Greenwood & Delquardi, 1995), heterogeneous grouping (Wheelock, 1992), adapting instruction to deal with individual differences, and multilevel instruction and classroom management. The tools translate the school's core competency and curriculum design approach into a manageable design and delivery system for classroom use. They flatten the learning curve for faculty in their acquisition of knowledge in all areas associated with curriculum design and implementation by establishing a common lexicon of best practices and a common design methodology. And they reflect the items, methods, and values described previously in the evaluation tools.

Consider the implications of this example from a technological perspective. The powerful use of technology is possible only because the core competencies are defined. The school has articulated what it believes to be best practices in assessment, teaching, and curriculum design and in doing so has enabled the creation of a curriculum design tool that in turn leverages the core competencies by translating them into manageable classroom practice. Instead of a generic lesson planner, we have an authoring system infused with research on teaching and learning.

Support the Model With Organizational Design

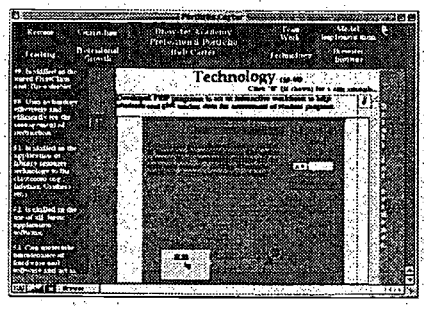
Build those structures that support the growth of faculty with the core competencies. If we reflect on the necessary prerequisite conditions to implement the two pieces of software described in the preceding examples, we can see the absolute need for a systems approach to our thinking with regard to the design and evaluation of educational organizations. Neither would be possible to implement unless they were first connected; even more important, those mechanisms to train support and recognize excellence in their use need to be part of the organizational structure. Consider trying to implement the curriculum software using the linear model described earlier. It would be management suicide to bring such a curriculum reform on board without also addressing those factors in the design of a school that establish, support, and encourage the use of the model.

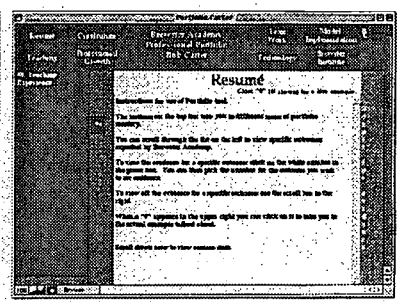
Senge (1994) describes personal mastery and collaboration as essential characteristics of effective learning organizations. In our educational

organizations, we need to ask ourselves what kind of organizational characteristics will support individual mastery of the core competencies and enable more than just the heroes to follow a path to better practice. This approach involves reconciling the personnel and professional growth structures in the organization with demonstrated excellence in the core competencies, career, merit pay, faculty rewards, portfolio assessment, an integrated evaluation model, and collaborative organizational structures that devolve responsibility. Devolution becomes an exciting prospect when the individuals to whom authority is devolved have the skills necessary to assume that responsibility.

The following screen shots are from an electronic portfolio completed by a faculty member as part of career progression. The portfolio is set up as an authentic record of excellence in all areas associated with the school's model of curriculum and its core competencies. Salary and advancement are based on a demonstrated facility with the core competencies, which develops over time. The portfolio also shows evidence of the connectedness necessary in overall school design.

The curriculum model and evaluation tools described previously make the form of the portfolio possible, and the definition of program makes the portfolio valid. A portfolio focuses the organization's attention on what it values and ensures that personal learning is central to the school's success.





Build a Technological Operating System

Use technology to enable reform by translating the essential elements of the reforms into practical tools that teachers, students, and parents can use. A secondary goal of this paper is to show how technology can be used to meaningfully empower change in schools when we use educational solutions

for educational problems. The value of both evaluation and curriculum tools is based on the extent to which their design is infused with best practices in fields related to educational systems. Both are part of an operating system for a school. The system takes the essential aspects of the school's design and places them in a format that teachers and administrators use daily to build curriculum, evaluate the program, and interact with students. When the stakeholders use the tools, they further the school's vision and program. School improvement is practical. The tools translate the vision into a classroom reality and in doing so allow us to test the reform itself. Technology, when used in this way, forces us to answer "what do you mean by that?"—so often left unanswered in school reform. The technology forces us to consider the ergonomics of our innovation. The tools have to work in clear and simple ways if they are to serve faculty—and you can guarantee the reformers will hear all about it if they do not (Cuban, 1993).

Build the Connections

Employ principles of effective practice to connect the teaching and learning processes. Making sophisticated connections between the learning process and the product is clearly the final piece of the puzzle. How do we build the kind of sophistication necessary to link the organization's performance to students' learning? In exactly the same way and using the same methods to build the curricular model and the school's overall design. "Quality learning to teach is the same as quality learning to learn" is a liberating idea. Those things that are important for student learning are equally compelling for faculty, including authentic assessment, mastery learning, understanding our learning styles, collaboration, and teamwork. In a true learning community, we all benefit from a shared understanding of the learning process. We all use best practices. While faculty members employ personal portfolios to document the excellence in their teaching practice and career growth, students produce portfolios to graduate from the school using the same authentic assessment approach. Just as the evaluation tools described previously reflect those processes that are connected to quality teaching, so too do our measures of school related behavior that predict students' success in school, college, and beyond.

The concern with reductionist measures of teacher appraisal is analogous to the backlash regarding the preoccupation with standardized test-

ing as the metric of students' success in school. The model described in this paper uses standardized test scores as only part of student evaluation; they are triangulated with portfolio evaluation and measures of social growth and community participation that include students' learning about how to learn. This evaluation is undertaken in ways that are similar to the evaluation of teachers learning about teaching. Using this approach, the organization finds a consistent point of reconciliation around its learning priorities that is reflected in the processes, programs, and practices it adopts for the growth of both students and teachers. The ultimate goal may be to blur this distinction.

The most important purpose of this discussion is to emphasize the essential need for simultaneous attention to all aspects of a learning organization and the need for program clarity as a prerequisite to legitimate evaluation. To do so requires a systemic approach to the creation and reform of learning organizations, and to make such an approach viable, we need to try out our models and ideas, which requires the engagement of research practitioners who are prepared to translate their models into practice by identifying the associated core competencies, building tools for implementation, and expending the energy necessary to build the human capital in schools and colleges that makes the rubber hit the road. None of it is easy. But after years of reform initiatives that have failed to make a sustainable difference in schools' core activities beyond the idiosyncratic exemplar, what other choices do we have?

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Preliminary Deliberations of the Future Learning Initiative

■ Cecilia M. Garcia

> Fifty years hence we may well conclude that there was no "crisis of American education" in the closing years of the twentieth century—there was only a growing incongruence between the way twentieth century schools taught and the way late twentieth century children learned (Drucker, 1999, p. 50).

The Benton Foundation has long-standing interest and experience in communications technology and the telecommunications policies that have unleashed the forces that, properly harnessed, can lead to extraordinary changes in the way we teach and learn. It is within the context of the enormous changes made possible by the digital revolution that the issues surrounding the measures used by schools, colleges, and departments of education to determine the success of teachers and teacher education programs must be addressed.

Benton's Future Learning initiative regularly convenes a leadership group in the philanthropic sector to study these issues. This project began to take shape on October 30, 1997, when the Neustadt Center brought together 25 leaders of education organizations, directors of corporate philanthropies, and policy makers to discuss the findings of Benton's publication, *The Learning Connection: Schools in the Information Age,* and to explore how collaboration across sectors could make educational technology effective in the classroom.

The Learning Connection encourages the development of a "human infrastructure," which must be built at the same pace as wiring schools. The late Jan Hawkins of the Center for Children and Technology told the assembled leaders that "for the past decade or so, we've been neglecting teachers . . . thinking that the technologies themselves would deliver educational change," and we are seeing now the shortsightedness of that thinking. Others at that meeting agreed, and pointed to the schools of education as a logical place to focus energy and resources.

Educators, funders, and education reform advocates widely agree that communications technology alone is not enough. For technology investments to really pay off, they have to be matched by similarly substantial commitments in six areas: content, curricula, teachers' competence, assessment, equity, and community involvement. Since that initial meeting, Future Learning participants identified the importance of integrating technology into teacher preparation as the group's primary focus of concern.

The concern about teachers' preparedness is not new. In 1994 the National Commission on Teaching and America's Future noted that by 2005, approximately half of America's teaching force will be new teachers. The commission and others in the field of education see this time as critical for evaluating how we prepare teachers to teach, given the dawn-

ing of the digital age. How are schools of education integrating communications technologies in their curricula?

The American Association of Colleges for Teacher Education surveyed its members in 1996 on the use, integration, and availability of technology in schools, colleges, and departments of education. The results indicate that fewer than half the respondents require students of teacher education to design and deliver instruction that incorporates technology in their coursework on campus. Fewer than 30% require students to design and deliver instruction incorporating various technologies during their student teaching, and 31% have no requirement at all that student teachers incorporate technology (Persichette, Tharp, & Caffarella, 1997).

A report entitled *Technology and the New Professional Teacher: Preparing for the 21st Century Classroom* (National Council for Accreditation of Teacher Education, 1997) points to shortcomings in the approach many schools of education take regarding technology and teaching:

> To what degree are higher education institutions meeting their responsibility for preparing tomorrow's classroom teachers? Bluntly, a majority of teacher preparation programs are falling far short of what needs to be done. Not using technology much in their own research and teaching, teacher education faculty have insufficient understanding of the demands on classroom teachers to incorporate technology into their teaching. Many do not fully appreciate the impact technology is having on the way work is accomplished. They undervalue the significance of technology and treat it as merely another topic about which teachers should be informed. (p. 6)

The NCATE report cites various factors for this climate that include lack of the necessary hardware, software, and technical support that serious technology integration requires. The report also points to "an academic culture that rewards and recognizes individuality among faculty" (p. 7). Future Learning participants echoed the sentiment that such an environment hinders the integration of technologies that can foster cooperative learning, noting that the culture of education does not allow teachers to make mistakes, despite the fact that to really learn, people have to be able to make a few mistakes and learn from them.

The NCATE report recommends that serious attention be paid to the National Standards for Technology in Teacher Preparation developed by the International Society for Technology in Education. ISTE believes that teacher education programs must "provide [tomorrow's teachers with] fundamental concepts and skills for applying information technology in educational settings" (1998, p. 7). It also believes that teachers must be competent in basic computer and technology operations, in personal and professional uses of technology, and in the application of technology for instruction. Moreover, it believes that these competencies should be required by schools, colleges, and departments of education for students of teacher education to become certified or endorsed by their programs.

Future Learning participants agree that such standards are valuable and have charted a course of work that will examine what factors are necessary for a broad adaptation of them.

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The Measures Used by Schools, Colleges, and Departments of Education in Determining the Success of Teachers and Teacher Education Programs

■ Sandi Kirshner

One of the measures frequently used by colleges of education to determine the success of their education programs is the recruitment of potential teachers. Colleges and universities are focusing on the problem of recruiting and training the 2 million new teachers who will be needed in the classroom over the next decade. But Merrow (1999) says we have misdiagnosed the problem. The problem is not the recruitment of prospective teachers but the retention of beginning teachers. A 1998 survey of more than 300,000 entering college freshmen showed that 10% of the students stated they planned to teach after graduation. Statistics show, however, that 30% of education graduates do not go into teaching. Some of them never intended to go into education, but they knew it would be an easy degree and they could always teach if other options did not materialize. Other graduates abandoned the thoughts of teaching when they could not find jobs in the location they wanted. In addition, "many who become teachers don't stay long. An estimated 30 percent leave the field within five years; in cities, the exit rate is an astonishing 50 percent" (p. 48).

What is causing this high rate of attrition for beginning teachers? Critics of teacher education programs that prepare teachers and school districts who hire teachers offer several reasons for this inefficient use of human resources. One reason is the poor training they receive in universities and in school districts. Merrow (1999) and others believe parent universities tend to treat colleges of education as their cash cows because of the revenue the large enrollment generates. Many of them, however, divert tuition paid by education majors into law, medicine, or engineering. Stanford University professor Linda Darling-Hammond notes, "If you are preparing to be a teacher, you can expect about half of the tuition money you put into the till to come back to support your preparation" (cited in Merrow, 1999, p. 48). Therefore, education programs often do

not have the financial support to reduce class size and provide more faculty to teach and supervise education majors.

Another reason offered for the attrition is the lack of attention paid to subject content areas. Teachers who are not knowledgeable in mathematics, science, social studies, and language arts, despite knowing effective methodology, will not be able to help students achieve academic excellence. In addition, some preservice teachers are not provided with enough hands-on student teaching experiences in K-12 schools to gain the skills they need to succeed. Secretary of Education Riley and the Department of Education hosted a forum on September 15 and 16, 1999, for college and university presidents. Riley urged the presidents of colleges and universities to improve teacher education programs and to encourage greater coordination among the faculties of education, the faculties of arts and sciences, and the K-12 schools hiring the graduates, noting "Given that educators are responsible for preparing the workforce of tomorrow, teacher-preparation programs should instead be the cornerstone of academic institutions" (cited in Blair, 1999, p. 22).

In addition, administrators in K-12 districts contribute to the high attrition rate of beginning teachers by assigning the new educators the most challenging students, scheduling the teachers out of field, giving them multiple preparations, and not providing them with mentoring by a veteran teacher during the first three or four critical years. Beginning teachers who are not supported and provided the resources they need drop out of teaching. "Simply put, we train teachers poorly and treat them badly—and so they leave in droves" (Merrow, 1999, p. 64).

If schools, colleges, and departments of education are going to succeed in preparing teachers for the 21st century, they should implement some of the following options:

Departments of Education

1. Require teachers to take a large percentage of courses related to their specific content areas to receive and retain teacher certification.
2. Allow teachers to engage in professional development options such as study groups, mentoring, action research projects, professional portfolios, curriculum development, and national board certification to extend their skills, meet their professional goals, and meet state certification requirements.

Colleges of Education

1. Recruit education professors who have had experience teaching in public schools, especially urban settings.
2. Award tenure on the basis of quality teaching in addition to research and publications.
3. Require all professors of education to spend time periodically teaching in public schools to keep abreast of problems in teaching. In particular, they need to learn more about classroom management, as that area is cited as the number one reason teachers leave the profession.
4. Encourage all faculty to attend workshops and courses in best practices in education such as performance assessment, standards-based curriculum, problem-based learning, and cooperative learning.
5. Require that all education majors spend 6 to 9 months student teaching in public schools under the supervision of a qualified mentor teacher. The internship should provide opportunities to teach different ability levels and a diverse population.
6. Require all graduates of the colleges of education to document evidence of meeting teaching standards by keeping a portfolio and a videotape as part of their evaluation review.
7. Require graduating seniors to score high on education exams. Monitor the scores and adjust the program continuously to ensure the students are meeting the standards.

School Districts

1. Insist that prospective teachers provide administrators with a portfolio that documents the graduate has met the applicable standards in his or her field.
2. Request a video of the prospective teacher or provide an opportunity for him or her to teach a lesson with students.
3. Assign a qualified mentor to the beginning teacher for 3 to 4 years.
4. Monitor the professional development plan of the beginning teacher to provide assistance in areas of need.
5. Provide the human and material resources needed to assist beginning teachers in meeting the needs of their students and fulfilling their own professional goals.
6. Extend the years to achieve tenure from 3 to 4 to certify the teacher is fully competent, caring, and committed to helping students.

7. Retain and reward quality teachers and deny tenure to teachers who have not demonstrated competence and growth over the 4-year probation period.

One of the primary measures we can use to determine the success of teachers and teacher education programs is the retention of quality teachers. "The teacher remains the key. . . . Debates over educational policy are moot if the primary agents of instruction are incapable of performing their functions well. No microcomputer will replace them, no television system will clone and distribute them, no scripted lessons will direct and control them, no voucher system will bypass them" (Lee Shulman, 1983, cited in Darling-Hammond, 1997, p. 293). It is imperative that schools, colleges, and departments of education take immediate steps to attract qualified college of education candidates through recruitment, prepare them appropriately for the rigors of the teaching profession, and then nurture their growth through lifelong professional development.

Teachers who demonstrate a deep understanding of teaching, a love of lifelong learning, and a commitment to students will thrive in the profession. The retention of dedicated and competent teachers is a critical element by which we can measure the success of our educational system as well as the academic achievement of our students.

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Action Research as a Measure for Evaluating Technology Integration Projects

■ Mary A. Lundeberg

How will future teachers know whether they are successful in integrating technology projects in their classrooms? How do teachers or professors assess the effects of using new information technologies on students' understanding? One measure for determining the success of teachers and of teacher education programs is to assess the extent to which future teachers can design action research projects to evaluate technology integration in classrooms. Action researchers collaborate to examine phenomena from a variety of perspectives with the goal of reflecting on and improving practice. Involving future teachers in action research projects along with professors and/or teachers to evaluate technology projects may provide insights for future teachers that more traditional performance and test measures do not encourage.

Too often, measures such as achievement tests or grades provide little information regarding what students are actually thinking, learning, or doing in collaborative multimedia learning environments. Technology can change both how students learn and how their learning can be assessed. Using technology to collect and analyze qualitative data (e.g., interviews with students, Internet discussions, Web-based research posters, journals, or small-group discussions) may contribute to our understanding of the effects of instructional technology on learning and facilitate future teachers' assessment of student learning. Assessment requires multiple methods based on multiple forms of learning and multiple perspectives. Furthermore, the kinds of insights gained by future teachers collaborating in action research mirror important standards (such as those from the National Council for Accreditation of Teacher Education [NCATE] and the International Society for Technology in Education [ISTE]), which are often missing from teacher education programs (Milken Exchange & International Society for Technology in Education, 1999). One of NCATE standards' main goals is to prepare teacher candidates to integrate technology in classroom instruction and evaluation based on solid pedagogical principles. The focus needs to shift toward assisting future teachers in classrooms to integrate the use of tech-

nology meaningfully with standards in a particular discipline, to evaluate the effectiveness of new instructional technology on student learning, and to reflect on ways to refine classroom practice. There is much to learn about using instructional technology well.

This paper discusses the benefits and challenges of using future teachers to evaluate the use of open-ended investigative simulations in science education, specifically, a National Science Foundation project, Case It! (see Bergland, Klyczek, Lundeberg, Mogen, & Johnson, 1999, for a complete description of this project; Case It! may be downloaded from the Web at no cost to educators at http://www.uwrf.edu/caseit/caseit.html). The overall goal of Case It! is to develop a framework for collaborative case-based learning in molecular biology using interactive computer simulations, and to have students from around the world participate in Web-based "poster sessions" via Internet conferencing. To evaluate what university students in biology were learning from this project, an interdisciplinary team consisting of biology professors, education professors, and future science teachers devised research questions, assessment procedures, and instruments for use in biology sections using Case It! Over the past several years, the team has shifted questions and methodologies based on what it learned in previous years, and the biology professors have changed their pedagogy based on assessment results. Recently the team compared the effects of engaging in live poster sessions versus Web-based poster sessions on students' understanding of data interpretation, genetic diseases, ethical reasoning, motivation, and confidence. Future science teachers met in a seminar with a biology professor and the author to provide direction in collecting and analyzing biology students' case test, survey, observational, interview, and Web conferencing data. Students reflected on what they thought about the assessment of technology integration in science classrooms.

Students' understanding of science and pedagogy improved through their participation in action research. In their journals, future teachers stated they improved their understanding of genetics, genetic testing, the relationship among science, technology, and society, and pedagogy (specifically, a better appreciation of the value and challenges of using multimedia, Web posters, research using the Internet, and cooperative group projects). One student wrote, "As a future teacher of science, [I found] working on the Case It! project has benefited me in the following

ways: increased my understanding of genetics and disease; increased my sensitivity to ethical issues and student concerns/response to these issues; [increased] sensitivity toward using technology, poster sessions, and student responses to these different types of instruction; [and] improved my technological skills." Another student wrote, "As a future teacher, I think I will take many aspects of this project with me and incorporate them into my career, knowing the power of such multimedia software on learning. I think I have a better idea of how to incorporate such [a] curriculum into my classroom and what to look for when it comes down to assessment. . . . I had never really seen students working with technology before; that in itself was an eye opener. I have a better idea of what students need to begin work on a computer based project."

Students' understanding of ways to evaluate their future teaching efforts became more complex. For example, these future science teachers reported understanding more about the complexity of assessing students' understanding by observing students, listening to their interactions, using poster sessions and Web conferencing as evaluation tools, and evaluating themselves as they incorporate changes into their teaching. One future science teacher stated that experience in this action research taught her how to use multiple measures in evaluating students' learning and the importance of assessment to lead to improvement in pedagogy: "I learned how to analyze for learning, including things like interviews, tests, observations, Internet conferencing, and live poster sessions. . . . I also learned there is always room for improvement and change. . . . This project increased my quantitative and qualitative research skills."

In summary, involving future teachers in the evaluation of this project provided an opportunity for future teachers to be involved with excellent biology teachers who were concerned about pedagogy, used cases to foster scientific inquiry, and provided disciplinary specific classroom examples of models of technology integration and evaluation. It does, however, take time and energy to involve undergraduates in research; future teachers need supervision and practice in data collection and analysis. Good assessment is more complex than calculating gain scores on tests. As Einstein said, "Not all that is counted, counts. Not all that counts can be counted." We should not limit our use of technology in assessment to only support collection, storage, analysis, and application of quantitative assessment data. Technology can be used to facilitate authentic assessment

methodologies (e.g., products of problem based learning, student portfolios, rubrics) as well. Will this experience in collaborative action research influence future teachers' integration and evaluation of technology use, and refinement of classroom practice? What changes are of value and how do we measure them?

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An Invitation to Collaboration and Integration

■ Susan O. Mitchell

"What teachers know and can do is the most important influence on what students learn" (National Commission on Teaching and America's Future, 1996, p. vi). With these words, the teaching profession, schools, colleges, state departments of education, and, most important, P-12 students and their parents were reminded that teaching is, and always has been, about student learning. Surely we have always known it, but vision has been obscured by multiple constraints that have diverted our attention and divided us from one another. Now it appears that a tidal wave of momentum from all quarters is on our side. It is time to recommit to our shared vision and goals related to student learning. The task thus becomes clear. The measures used by schools, colleges, and departments of educa-

tion in determining the success of teachers and teacher education programs must be coordinated, integrated and shared, grounded in the research, reliable and valid, based on teacher and student performances, and founded on an agreed upon framework of what constitutes effective teaching and learning and how best to consistently assess these processes in a multitude of contexts. We have to work together to accomplish the monumental task before us, and we are not there yet.

We must begin or continue a thoughtful dialogue and take action around the following requirements:

1. Require that all teacher education candidates in every teacher preparation program complete:

- A professional development plan as part of a professional portfolio built around each state's standards for initial certification/licensure, appropriate P-12 student standards, *and* an agreed upon nationally adopted framework with evaluation rubrics for effective professional teaching practice (Danielson, 1996). Such a plan begins to instill the idea that teaching is a developmental activity and that one can advance from basic, even unsatisfactory, to exemplary performance with planning, assessment and evaluation, guidance, mentoring and coaching, reflection, and further study.
- Comprehensive and rigorous performance assessments by trained evaluators to document and validate the candidate's progress.
- A process- and product-oriented portfolio that includes an emphasis on technology applications to teaching and learning where appropriate.
- Videos of the candidate's work with students and written reflections as part of each portfolio.
- Multiple formative and summative assessments in the teacher education program tied to an agreed upon level of candidate performance. The issuance of an institutional recommendation to state departments of education or other credentialing agency for each candidate is based on summative assessments linked to the professional development plan, portfolio, and state standards for teachers and students.

2. Require the following of every novice teacher:

- An induction period and program that include the continued use of the professional development plan and portfolio. Create a cadre of master

teachers, administrators, and university faculty to assist beginning teachers in the formulation and assessment of goals and objectives for continuing professional growth. This practice continues the link between schools and colleges.

- An agreed upon framework for effective professional practice in the induction period linked to a school's teacher evaluation system. Ensure that the framework is aligned with the teacher evaluation tool and assessments used in the preservice program and make sure the goal for teachers is the acquisition and demonstration of progressively sophisticated accomplishments, competencies, and knowledge.
- Professional development activities tied to the above.
- Continued employment contingent on the achievement of goals and objectives for professional growth outlined in the professional development plan and outcome of performance evaluations.
- The period of induction continuing until a beginning teacher has achieved an agreed upon level of performance as measured by trained evaluators or leaves employment. Tenure must mean something more than years of service!

3. Also require:

- All states' implementation of a tiered system of certification/licensure and recertification/relicensure that allows for and requires increasing pedagogical and content competence and demonstrations of knowledge to move a teacher from basic to exemplary.
- Recertification/relicensure dependent on an agreed upon level of gradually increasing performance, including competence in subject matter and teaching skills as outlined in one's professional development plan.
- Reemployment linked with an agreed upon level of gradually increasing performance, including knowledge of subject matter and competence in teaching skills as outlined in one's professional development plan.
- Achievement of national board certification for most teachers by emphasizing the work sample methodology (Clewett, 1998), action research, assessment, self-assessment, and reflection as regular aspects of a teacher's work life.
- A link with the National Board for Professional Teaching Standards to establish a plan to create pathways between its processes and products

with those required by states for recertification/relicensure, colleges' master's programs, and district's teacher evaluation systems.

4. Require that all of these requirements be grounded in continuous documented evidence of each teacher's ability to impact P-12 student learning in an agreed upon positive way that is aligned with states' student achievement standards.

These recommendations create a professional, cooperative, and integrated culture for teaching that places the appropriate emphasis on the teaching/learning process for preservice and in-service teachers irrespective of place of residence. They put the appropriate focus for schools, colleges, and departments of education on P-12 student learning and place accountability for student learning with all these stakeholders. These recommendations create a comprehensive and articulated plan for the education, licensing, and continued employment of teachers, the "integrated tapestry" referred to by the National Commission on Teaching and America's Future (1996). They absolutely require that all of us demonstrate the will to cooperate, to resolve disagreements, put aside egos, and keep our eyes on students' learning.

Technology can be a cornerstone of these recommendations. It can ease the work of performing content analyses of states' certification/licensure standards, districts' teacher performance evaluations, and colleges' formative and summative standards and assessments to help us all see how closely aligned we already are in our thinking and work. In addition, technology should be infused in all aspects of teacher education, novice teacher induction programs, and experienced teacher expectations by states and schools (Barron & Goldman, 1994). What is paradoxical or perhaps just intuitive is that goals related to the use and integration of technology may prove to be more challenging than reaching an agreement about points 1 through 4 above (see *Education Week,* 1999).

I am confident that we have the will to work together with the shared vision of continuing higher levels of achievement for P-12 students by increasing teachers' competence. The measures that schools, colleges, and departments of education can use in determining the success of teachers and teacher education programs are available. Many states, colleges, and schools have pieces of the puzzle ready to be put together into an integrated whole. That is the work before us. The technology will follow.

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Significant Changes in the Measures Used to Assess the Success of Teachers and Teacher Education Programs

■ John M. Nagle

The Argument

The measures used to assess the success of teachers and teacher education programs are steadily shifting in focus from measures of input and process to measures of outcome and results. During the next decade, this focal shift will have a dramatic impact on both teachers and teacher education programs, for it will increasingly require teachers in P-12 classrooms and faculty in teacher education programs to strengthen the now tenuous and sporadic connections made between teaching and learning. Teachers in elementary, middle, and secondary schools will increasingly be required to demonstrate their ability to produce learning gains among P-12 students, and faculty in teacher education programs will increasingly be

required to document both their own increased focus on P-12 student learning and the ability of their teacher candidates and program graduates to positively impact that learning.

Both philosophically and operationally, this increased focus on P-12 student learning will require a sea change in how we think about "teaching." Rather than focusing attention on "what teachers know and are able to do" (the current mantra for effective teaching), increasingly the focus will be on learning gains that teachers stimulate and effect among students in P-12 classrooms. Teachers—and thus faculty in teacher education programs—will increasingly be held accountable, not for teaching per se but for the explicit and demonstrable effects of that teaching on learning among P-12 students.

The times indeed are a-changing. And the implications of these changes for both teachers and teacher educators are substantial.

Evolving Measures of Successful Teaching and Teacher Education Programs

For years, we have tended to think of "teaching" as what teachers do when they are involved with groups of learners. The focus has been on teachers' ability to motivate students, present and explain ideas, organize instruction, and create positive learning environments for all students. And when we have sharpened this focus, we have examined the ability of teachers to write educational objectives, identify relevant instructional materials, design and implement curricular units, prepare daily lesson plans, manage students' behavior, maintain grade books, and communicate effectively with both students and parents. In effect, we have tended to measure teachers' effectiveness in terms of their pedagogical knowledge, skills, and predispositions.

In a closely related way, we have tended to measure the success of teacher education programs in terms of the quality of courses, clinical experiences, and other educational opportunities they provide to prospective and practicing teachers to help them develop and hone these pedagogical competencies. More specifically, we have examined the criteria and procedures used to admit students to teacher education programs, the conceptual framework undergirding the program, the coherence and integrity of its curriculum, the content of its course syllabi, the organization and diversity of its clinical experiences, the quality of advisement of its students, and the preparation, professional experience, and scholarship

of its faculty. Then, based on our evaluation of these program inputs, components, and processes, we have made judgments about the quality of teacher education programs. For years, the criteria used by states to "approve" teacher education programs so that graduates can be licensed, the criteria used by content specialty area associations to evaluate the curricula of teacher education programs, and the criteria used by the National Council for Accreditation of Teacher Education to award national accreditation to colleges and universities with high quality professional education units have focused primarily, if not exclusively, on program inputs, components, and processes rather than on the actual teaching competencies of the program's students and graduates.

During the past decade, these traditional measures of program success have increasingly been supplemented with performance measures of the pedagogical skills of prospective and practicing teachers. Can these teachers actually design a curriculum unit that has clear instructional objectives, relevant instructional content and materials, and ways of evaluating the unit's educational benefits to students? Can teachers create a lesson plan and then successfully deliver it to a class of students? Can they manage a classroom and effectively discipline students who disrupt the learning of others? Can they maintain a grade book and effectively discuss a student's classroom performance with his or her parents? To a large extent, the standards of the Interstate New Teacher Assessment and Support Consortium for beginning teachers and the standards of the National Board for Professional Teaching Standards for accomplished teachers focus on these measures of teachers' pedagogical expertise and on the instructional knowledge and skills they bring to their teaching.

More recently, teachers' content expertise has jumped to center stage. Are teachers well grounded in the discipline and subject matter they are expected to teach? Did they complete a college major in their teaching field, and is their GPA in that major sufficiently high to warrant licensure and teaching in that field? And, increasingly, can they pass a standardized test in the subject area for which they are seeking licensure? Increasingly today the focus in Congress, state legislatures, state boards of education, and local school districts—especially in states that have adopted high stakes testing and accountability systems—is on the content knowledge and expertise of both beginning and experienced teachers. This new demand that teachers demonstrate their content expertise has tended to

marginalize attention to the more traditional domains of pedagogical knowledge, skills, and predispositions.

During the next decade, the traditional interest in teachers' pedagogical expertise and the more recent interest in their content expertise will undoubtedly continue, but a new and much more significant criterion for measuring the success of teachers and teacher education programs will be added: evidence of learning gains among the P-12 students taught by these teachers and evidence that teacher education programs contribute to the ability of teacher education candidates and program graduates to effect these learning gains. As this new focus sharpens and the pressure increases to connect teaching to learning, the paradigm of what it means to teach will also shift. While content and pedagogical expertise will continue to be elements of effective teaching, they will no longer be the ultimate measures of effective teaching and successful programs. Rather, the ultimate measures of success for both teachers and teacher education programs will be measures of learning gain among P-12 students, and measures of what teachers know and can do will be credible only when they are linked explicitly to measures of P-12 student learning.

Implications of These Changing Measures

As the measures of successful teaching and successful teacher education programs shift from teachers' pedagogical skills and content expertise to their measurable impact on P-12 student learning, the implications for both teachers and teacher education programs are substantial.

First, as already argued, how we think about teachers and teaching will change dramatically. Teaching will no longer be defined primarily in terms of what a teacher does and with only glancing attention to the effects of that teaching on P-12 learners. Rather, teaching will increasingly be defined in terms of what students know and can do as a result of a teaching intervention. That is, teaching will increasingly be connected to student learning, and the focus will shift from what teachers do to what students learn as a result of what teachers do. The significance of this shift in focus—extending beyond a teacher's content expertise and pedagogical skills to his or her impact on learners—cannot be overemphasized. Over the years, a teacher's success has rarely been explicitly linked to measures of student learning, but new standards-based curriculum and high stakes testing programs in P-12 education are clearly driving in this direction.

Second, given this new focus on gains in student learning as the ultimate measure of successful teaching, teachers will need to be far better assessors and diagnosticians of student learning than they currently are. In the future, teachers' curricular and instructional decisions will increasingly need to take their cues not from what they personally would like to teach or are able to teach but from what a particular group of learners in a particular learning context at a particular time need to learn because a preassessment has identified that learning need. Following instruction targeted to the learning need, teachers will also need to assess the students' knowledge and skills, analyze the pre- and postassessment measures skillfully, and identify additional instruction that will help students meet the original learning objective. Making new, explicit connections between teaching and learning will unequivocally require teachers to develop, hone, and use new measurement and assessment skills at increasing levels of complexity and sophistication.

Third, while good assessment skills require intuition, initiative, and creativity, they also require a solid knowledge base in measurement theory and a repertoire of skills for designing valid and reliable ways of assessing both individual and group learning gains. Helping both prospective and practicing teachers develop this knowledge base and the related skills will increasingly be a major expectation of teacher education programs, which in turn will require teacher education faculty members to develop new expertise in measurement and assessment. Methods courses, which have traditionally dealt primarily with ways of teaching and only minimally with ways of assessing the learning that results from that teaching, will become assessment and curriculum courses or assessment and instruction courses. Clinical experiences will increasingly involve prospective teachers in developing and practicing assessment skills, and culminating student teaching or internship experiences will increasingly provide clear evidence that teaching during these experiences does indeed connect to student learning.

Fourth, given this new focus on learning gains among P-12 students and the generation of multiple measures of these gains, teachers will need to learn how to use technology to create and manage computer based systems for collecting, storing, and using multiple pieces of assessment data for multiple learners over extended periods of time. Traditional grade books will no longer suffice. Rather, teachers will need to be both knowledgeable and skillful in creating computer based data systems for manag-

ing, analyzing, and reporting learning gains. In a very real sense, teachers will need to become sophisticated creators and managers of their own classroom based student information systems. While they may be able to involve teacher assistants, volunteers, and perhaps even students in inputting and reporting these pre- and postassessment measures of learning, classroom teachers will need to become much more proficient than they now are in using computer hardware and software to create and maintain databases that explicitly connect teaching to learning.

Fifth, as suggested earlier, the generation of multiple measures of student learning before and after instruction will make entirely new demands on the diagnostic skills of classroom teachers. They will need to be able to analyze measures of student learning thoughtfully and insightfully, draw valid conclusions, and then modify curriculum and instruction in such a way that these changes positively affect future student learning. Most teachers today do not have these statistical and analytical skills. They do not know how to compute measures of central tendency, test for significant differences, analyze data across multiple variables, and communicate findings and results to parents, students, and colleagues. And most teachers do not know how to use the many new computer software packages that are now available to analyze multiple student measures over time and display and communicate these analyses to others.

Sixth, given the pervasiveness of technology in the 21st century, teachers will increasingly need to be as technologically proficient as the students they are teaching. *Growing Up Digital* (Tapscott, 1998) suggests that, in terms of technology, we face not a generation gap but a generation *lap* in which those born since the early 1980s (the Net generation) have simply overtaken the rest of us in their comfort, skill, and almost natural use of technology. For teachers, this generation lap is especially problematic, and so it will become increasingly essential that all teachers develop and use not only basic computer skills associated with word processing, databases, spreadsheets, networking, and communications but also a whole range of advanced technology skills especially relevant to teaching, such as accessing curricular software, drawing on the vast resources available through the Internet to enrich instruction, and using appropriate software to collect, store, and analyze measures of P-12 student learning.

Finally, to ensure that prospective teachers have these necessary technology skills, successful teacher education programs in the future will

need to incorporate technology in all aspects of their curriculum for both prospective and experienced teachers. Evidence of basic computer skills will increasingly be a prerequisite for admission to a teacher education program. Using computer technology to design and deliver instruction in one's teaching field will increasingly be a part of the curriculum. And at least for graduation, if not for licensure, teacher candidates will be expected to demonstrate both basic computer skills and more advanced skills in using technology to design curriculum, enhance instruction, assess the learning of P-12 students, and connect their own acts of teaching with valid and reliable measures of P-12 student learning.

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Recommendations for Action

1. Evaluation models for assessing the success of teachers and teacher education programs should recognize the relationship between teachers' content and pedagogical expertise and their impact on student performance. Further, those designing evaluation models should:

- Make P-12 student learning a focus for evaluating teachers, schools, and teacher education programs.
- Involve entire learning communities in proactive design processes that yield articulated and consensual policies, student learning outcomes, curriculum design models, and teaching models.
- Ensure that high stakes decision-making benefits all students and teachers, and is based on assessment models that reflect a broad understanding of the learning process and employ multiple methods and perspectives.
- Ensure that the evaluation model is both part and product of the design process. The evaluation model clarifies and supports the rela-

tionship between content, pedagogy, and student outcomes as articulated in the design.

- Ensure that teachers (and administrators) understand and can create multiple methods of assessment, and can effectively link appropriate assessment with desired learning.
- Structure teacher preparation programs to expand sequential knowledge and skills in assessment within foundation courses, method courses, and clinical experience.
- Ensure that the voice of the faculty is heard in defining the student learning process.
- Use criteria and measures of learning outcomes that do not discriminate on the basis of race, gender, ethnicity, or socioeconomic status.
- Ensure that teachers (and administrators) can reflect critically on the role of power in the assessment process, including the political nature of assessment.
- Address the impediments of cost, time, and complexity inherent in designing and operating valid and reliable evaluation systems.
- Ensure that assessments focus learning, but do not inappropriately narrow the curriculum to only that which is measured or measurable.

2. Ensure that teachers integrate higher-order uses of technology in the curriculum for all students (e.g. collaborative, project-based, inquiry-based, authentic learning).

- Employ technology to articulate the design in practice with tools and processes that advance the relationship between content, pedagogy, and student outcomes (e.g., curriculum authoring, collaborative performance appraisal and reporting, and student and professional portfolios).
- Use technology to facilitate authentic assessment methodologies (e.g., products of problem-based learning, student portfolios, professional portfolios, and rubrics).
- Use technology to support collection, storage, analysis, and application of assessment data for both the instruction and evaluation of students.
- Use technology to communicate expectations, resources, and materials for tests.

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