NCREL Viewpoints 12

Using Technology to Improve Student Learning

LEARNING POINT Associates™

A Print and Audio Resource for Education Leaders

NCREL

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NCREL
Viewpoints Vol. 12

Using Technology to Improve Student Learning

Using Technology to Improve Student Learning

INTRODUCTION

Viewpoints is a multimedia package containing two audio CDs and a short, informative booklet. This volume of *Viewpoints* focuses on how technology can help improve student learning.

The audio CDs provide the voices, or viewpoints, of various leaders from the education field who work closely with technology issues. Their voices represent perspectives on the uses of technology in education and provide an overview of the current issues around education technology.

This booklet offers background information explaining the issues surrounding technology in education. It presents some findings of recent research on the effectiveness of technology in improving student learning and teacher effectiveness and outlines current efforts designed to help us realize technology's potential. The booklet also provides a list of technology resources—including tools, publications, and research studies—to assist educators with the systemic integration of education technology for promoting student achievement.

THE ISSUE

When we speak of education "technology," we refer not only to computers but also to a wide range of tools and processes for learning—including large data systems, audio and video capacity, and online learning. Technology has enabled schools to offer students, teachers, administrators, and parents a variety of experiences that were impossible only a short time ago. With the growing understanding of achievement gaps, additional use of standardized testing, and increasing focus on accountability, it is more important than ever that schools use information technology effectively to make a difference in student learning.

THE BOOKLET: A GUIDE TO CONTENTS

The essay "Using Technology in Education" serves as a companion to the CDs. It offers a brief overview of technology use in education, discusses the growing body of research dedicated to how technology can promote student learning and teacher effectiveness, and outlines current efforts designed to help us realize technology's potential. It also suggests resources that can assist educators as they work to use technology effectively for the benefit of all students. You may find it helpful to read the booklet as an introduction to the topic before listening to the interviews presented on the CDs.

Using Technology in Education

By Ginger M. Reynolds, Ph.D.
Policy Associate
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By 2002, virtually all public schools and 92 percent of classrooms nationally had access to the Internet. Ninety-four percent of these schools used broadband connections, and 23 percent used wireless Internet connections. Each instructional computer with Internet access served an average of 4.8 students, and 8 percent of public schools lent laptop computers to students (Kleiner, Lewis, & Green, 2003). Such improvements in connectivity allow users prompt and straightforward access to enormous amounts of information through the Internet. Advances in technology and declining costs have made it possible for classrooms to have multiple computers and for students and teachers to use school-supplied hand-held devices to supplement daily instruction. These technologies are just a sampling of the manner in which billions of dollars have been spent on information technology infrastructure for our schools (Pea, Wulf, Elliott, & Darling, 2003), and significant additional time and money have been spent maintaining it.

When we discuss education "technology," we refer not only to computers but also to a wide range of tools and processes for enhanced learning—including large data systems, audio and video capacity, and online learning. Technology has enabled schools to offer students a variety of experiences that were impossible only a short time ago. Where once we were able to give students access to computers for word processing, basic skill development, and educational games, it is now possible for students to view original historical documents, communicate with experts all over the world, take virtual "field trips," create virtual models to test hypotheses, and much, much more. Teachers, administrators, and parents with Internet access can utilize technologies in a myriad of ways—from immediate access to detailed and manipulatable data on student achievement and demographics, to virtual communities for improving teaching and administrative practices, to daily and direct synchronous interaction (such as instant messaging and videoconferencing) and asynchronous interaction (such as e-mail and newsgroups) between teachers and parents.

As technology has evolved, and as keeping up with the newest and fastest technology has increased expenditures (even though some technologies have dropped in price), policymakers have become ever more insistent that technology costs must be justified by data that demonstrate increases in student achievement. To this situation, add the fact that the education climate

overall has shifted toward increased accountability for schools. Together, these changes have created the expectation that technology be used to make schools more effective through the use of data to make decisions. This kind of technology use involves systemic changes in schools—including changes in instruction, assessment, expectations, teacher and student roles, and administrative direction.

With recent technology, it now is possible to monitor the achievement and follow the progress of individual students on standardized tests. This form of accountability is popular with policymakers for its straightforwardness and its ostensible equity. The landmark No Child Left Behind (NCLB) Act specifically addresses technology as a way to enhance education (see "NCLB Goals for Enhancing Education Through Technology" on page 5). It establishes the goal that all students will be technologically literate by the end of eighth grade (NCLB, Title II, Part D, Section 2402). The U.S. Department of Education has an Office of Educational Technology and has awarded $15 million in grants earlier this year to states for, among other things, the study of technology's impact on student achievement. Technology is part of our society's daily life, and the education community is working to ensure that technology is effectively incorporated into our education system.

The most important issues for educators today revolve around using information technology effectively to make a difference in student learning. The next section provides a brief overview of technology use in education as viewed through three different frameworks.

Technology Use in Education

To understand the scope of the issues around technology and to appreciate the potential impact and value of technology in education, it may be useful to discuss what we mean by *education technology use*. Presented here are three different frameworks for categorizing technology use proposed by authorities in the field. Each framework sorts technology use differently and offers its own perspective for understanding the influence that technology can have on education.

FRAMEWORK 1: PHASES OF TECHNOLOGY USE

One technology framework, provided by Valdez, McNabb, Foertsch, Anderson, Hawkes, and Raack (2000), divides technology use and expectation into three distinct phases that, to some degree, are evolutionary. The phases are not mutually exclusive, however, and education practices in each phase can be used (and are used) concurrently and effectively in schools. Briefly, the phases are as follows:

NCLB Goals for Enhancing Education Through Technology

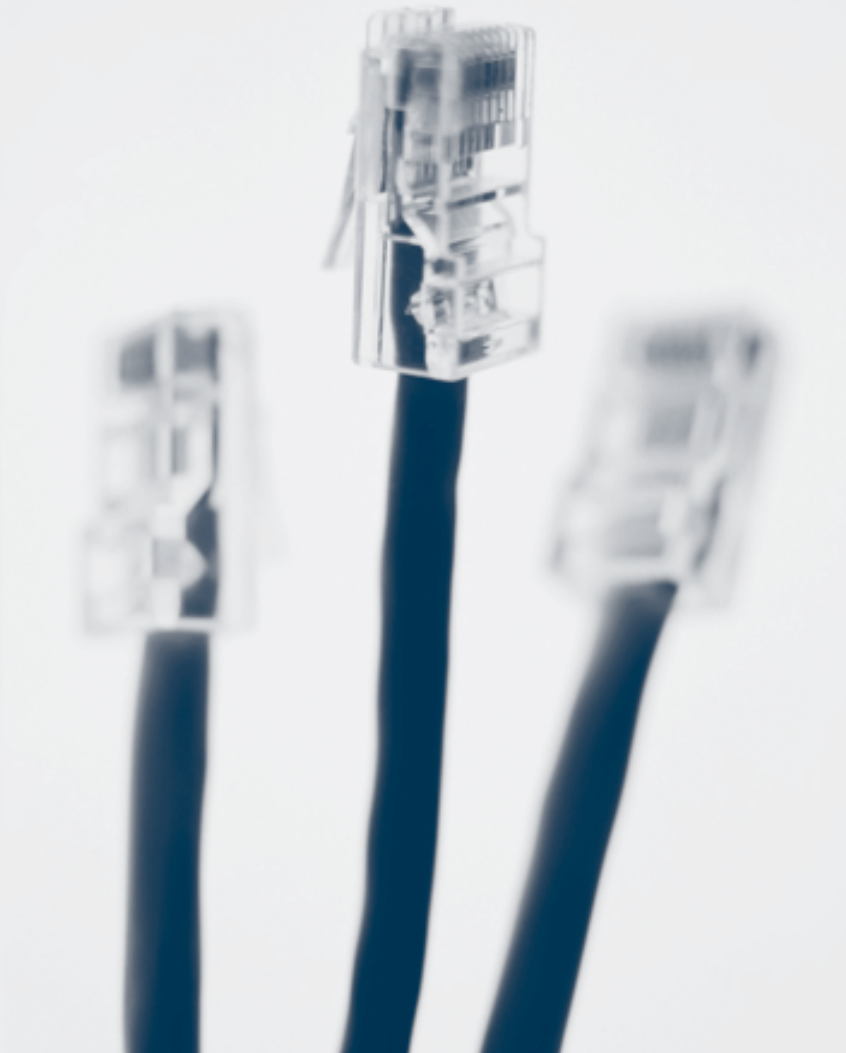
The technology goals specified in the No Child Left Behind Act, Title II, Part D—Enhancing Education Through Technology—are as follows:

1. PRIMARY GOAL—The primary goal of this part is to improve student academic achievement through the use of technology in elementary schools and secondary schools.

2. ADDITIONAL GOALS—The additional goals of this part are the following:

    a. To assist every student in crossing the digital divide by ensuring that every student is technologically literate by the time the student finishes the eighth grade, regardless of the student's race, ethnicity, gender, family income, geographic location, or disability.

    b. To encourage the effective integration of technology resources and systems with teacher training and curriculum development to establish research-based instructional methods that can be widely implemented as best practices by state educational agencies and local educational agencies.



Phase I: Print Automation

In Phase I, technology is used for instruction on computers. This instruction is characterized by software that relies on basic skill development exercises to teach segmented content and skills. Educational software in this phase generally can be characterized as textbooks in electronic print formats with short, self-contained lessons. Student interaction with computers is typically limited to individual use for basic skill development on segmented and isolated skills (Valdez et al., 2000).

In the 1980s, a number of meta-analyses found that in general, classrooms with computers used to support Phase I instruction showed gains in student standardized achievement tests (see, for example, Bangert-Downs, Kulik, & Kulik, 1985; Burns & Bozeman, 1981). These studies also found that computer-assisted instruction was more effective if the applications delivered content in an area with defined structure, such as mathematics. Educators making technology-related decisions should recognize that Phase I technology applications can be most effective in certain types of education situations. Valdez et al. conclude that this type of technology use is most appropriate when teacher content knowledge and skills are low and when students need remediation (see Sivin-Kachala & Bialo, 1993). Phase I technology application is likely to be most successful when the software, instructional purpose, and learning objectives correspond to teachers' understanding of learners' needs to memorize and respond to predetermined answers. It is also important that learner skill and knowledge match the software requirements (Valdez et al., 2000).

Phase II: Expansion of Learning Opportunities

In Phase II, computers are used as tools for learner-centered practices that can allow group work, rather than as isolated content-delivery systems. Teachers can use Phase II technology to engage learners in working groups and to structure activities around producing and sharing products. Technology in this phase is interactive and can involve several forms of media, including programs for publishing, databases, maps, animation, and so on. Such options for technology use permit teachers to structure lessons that are better suited to a variety of learning styles. One obstacle to achieving these ends is that teachers need professional development to learn how to use technology tools in ways that allow for this kind of learning. It also is important that curriculum and instructional goals reflect this kind of learning, and that teachers understand and accept the goals.

Phase II technology use also can assist teachers. Technology tools can make lesson planning more efficient so that teachers have more time for interaction with students. In addition, computer-mediated communications enable communication without time constraints, and the interaction does not necessitate that participants are at the same location. This kind of communication allows teachers to work together in learning communities to improve teaching practice in ways that previously had not been accessible.

Research on this phase of technology use is complicated by the fact that the skills it engenders are not easily measured through standardized tests. Valdez et al. cite Sivin-Kachala and Bialo (1993), Jones, Valdez, Nowakowski, and Rasmussen (1995), and Valdez and McNabb (1997) to conclude that computer-based instruction and multimedia applications are most effective if the goals of instruction, the characteristics of the learners, the design of the software, the technology, and the implementation decisions made by teachers are aligned. Valdez et al. also conclude from Sivin-Kachala and Bialo (1996) that student achievement as measured through standardized tests can be positively affected by instructional technology use in all major subject areas, at all levels, and for typical students as well as those with special needs.

Phase III: Data-Driven Virtual Learning

In Phase III, technology is used by both students and teachers to make data-driven decisions so that teaching and learning can be more effective and accountability expectations can be met. Technology use in this phase includes the use of technology resources on the Internet through virtual learning, multimedia presentation tools, relational database programs, and intranets to address data-driven issues and opportunities that can inform instructional decisions.

Valdez et al. (2000) conclude from the research literature that Phase III technology can assist student learning in the content areas in several ways. Reading and writing across the curriculum can be enhanced through the interactivity enabled by hypertext and hypermedia, and individual learner needs can be more adequately addressed using technology to adapt content. Computer-mediated communication can alter the control structures between students and teachers, and Internet access allows for the development of virtual communities that exist online. Moreover, technology allows for the manipulation of data and concepts that is not possible in the physical world. Becker (1999) found that quality connectivity,

teacher computer expertise, teacher pedagogical beliefs and practices, adequate teacher professional development, and teacher home access and age influenced teachers' Internet use.

In summary, for technology to be used most effectively in schools, Valdez et al. (2000, pp. 26–27) believe the following factors must be given consideration:

- Technology-related professional development for teachers is essential if technology is to be successful in increasing student achievement.
- Software design along with instructional methods should coincide with intended purposes and learning goals.
- Research suggests that at least one computer for every four or five students is necessary for significant impact.
- Computers should be connected to the Internet and in classrooms rather than only in difficult-to-access libraries or computer labs.

FRAMEWORK 2: FUNCTIONS OF TECHNOLOGY

A second technology framework, developed by Means (1994), uses the functions of technology as an organizational tool and categorizes them as they are used for instruction. She delineates four functions of technology:

- **Technology as *tutor*—**as in computer-assisted instruction, instructional television, and some multimedia systems. Technology functions as a tutor through systems "designed to teach by providing information, demonstrations, or simulations in a sequence determined by the system" (p. 11). This kind of technology might display a phenomenon or procedure, or it may invite the student to answer questions or solve problems.
- **Technology as a *means to explore*—**as in Internet searches, modeling software, and simulation software. Technology functions as a means to explore when it facilitates learning by providing a context for student discovery of facts, concepts, or procedures through information, demonstrations, or simulations at the request of the student.
- **Technology as *tools to create, compose, store, and analyze data*—**as in database software, desktop publishing, and digital visual and audio production. These are general-purpose technologies that also are found in the home or workplace.
- **Technology as a *means to communicate*—**as in e-mail, online learning systems, and electronic mailing lists. Technology functions as a means to communicate through systems that allow the sending of information and data through, for example, networks.

FRAMEWORK 3: PURPOSES OF TECHNOLOGY

One final example of a technology framework comes from Bruce and Levin (1997), who organize technology in terms of media. They outline four ways that technology use supports integrated learning:

- **Media for *inquiry*.** This category includes using technology as media for thinking and theory building—as in data and mathematical models, visualization software, and virtual reality environments. In addition, it includes technology as a way to access data and connect to the world of text and video—as in hypertext and hypermedia environments, library access, and databases. This category also includes technology for data collection, as a way to extend the capabilities of senses—as in micro-computer-based laboratories, video and audio recording, and remote scientific instruments. Last, this category includes data analysis—as in technologies for statistical analysis, spreadsheets, and image processing.
- **Media for *communication*.** This category encompasses document preparation using technologies such as word processors, graphics, and presentation software. It includes more direct communication technologies such as e-mail, asynchronous and synchronous conferencing, and the World Wide Web. The category also includes teaching media, such as tutoring systems and instructional simulations.
- **Media for *construction*.** This category includes technology uses such as robotics, computer-aided design, and the construction of graphs and charts.
- **Media for *expression*.** This category includes technologies used for drawing, composing music, creating animation, and constructing hypermedia.

These three frameworks demonstrate examples of the numerous ways technology can enhance education as well as the variety of ways we can organize thinking around technology. The next section provides an overview of recent research on the effectiveness of technology in improving student learning.

What the Research Says

Despite the large outlay of dollars for technology in education, not enough is known about its effects on student achievement and teacher effectiveness. Waxman, Lin, and Michko (2003), in conducting a meta-analysis on the impact of technology on student learning and achievement, criticized the quality of the available research related to teaching and learning with technology.

They found few recent quantitative studies of quality and few studies that used randomized, experimental design. They also lamented the lack of details (such as specifics about software and technology components) in published studies.

One of the reasons that technology's impact on student learning is difficult to gauge is that the skills it can affect—skills such as higher-order thinking and research ability—are more difficult to measure in a quantifiable way. Another impediment is that technology and its uses are changing so quickly that technology use in schools today is very different from technology use only a few years ago, suggesting that its impact may have changed dramatically as well. Yet another reason for the lack of clear research is that technology is not a solution in itself. Rather, it is a tool whose effectiveness relies on the expertise of the user—on the teacher to use it effectively as a teaching tool, on the administrator to use it effectively as a data resource, and so on.

Nonetheless, there is a growing body of research dedicated to understanding the impact of technology. Some research indicates that technology can have a positive effect on student learning and achievement. For example, the Waxman, Lin, and Michko (2003) meta-analysis found that teaching and learning with technology has a small, positive effect on student outcomes when compared to traditional instruction. Further, this study found that technology's results can be generalized across a wide variety of conditions and across student, school, and study characteristics. Other recent meta-analyses include Blok, Oostdam, Otter, and Overmaat (2002), which found that computer-assisted instruction programs have a small positive effect in supporting beginning readers, and Lou, Abrami, and d'Apollonia (2001), which found that students working in a small group using computer technology had more positive effects than students working individually using computer technology.

Other studies reported mixed results. Wenglinsky (1998) used data from the 1996 National Assessment of Educational Progress (NAEP) to study the relationship between different uses of educational technology and various educational outcomes. For eighth graders, he found that teacher professional development in technology and the use of computers to teach higher-order thinking skills were both positively related to student achievement in mathematics. However, he also found that the use of computers to teach lower-order thinking skills was negatively related to student achievement in mathematics, as was the frequency of school computer use. For fourth graders, Wenglinsky found that using computers for learning games was positively related to academic achievement in mathematics, but only

negligibly; he also found that the frequencies of home and school computer use were negatively related to academic achievement in mathematics.

Clearly, the research cited here is just a beginning in helping us understand what we need to know about using technology effectively in education. There is much more to learn. The next section introduces some efforts currently underway to help us realize technology's potential for helping all students learn.

Current Efforts to Help Realize Technology's Potential

Many in the education technology field are concerned that we have not yet begun to realize the potential that technology holds for transforming education. The potential benefits include enabling learning to higher standards, individualizing instruction, and fostering continuous teacher professional development.

To assist in the realization of technology's potential and to strategically address the effective use of technology in improving student achievement, the U.S. Department of Education is developing a long-range national strategy and guide. The secretary of education has been charged by the NCLB Act with the development of the nation's third National Education Technology Plan, which is one piece of this national initiative. (More information about the plan can be found at the *National Education Technology Plan* Web site at www.nationaledtechplan.org.)

Other portions of the NCLB Act include the U.S. Department of Education's grants to individual states, allowing states to distribute funds to individual school districts on a multiyear basis pursuant to a formal plan of action. (See "Educational Technology State Grants Program" on page 12.)

In addition, the U.S. Department of Education is funding a three-year National Study on the Effectiveness of Educational Technology Interventions. The study, conducted by Mathematica Policy Research Inc. and SRI International, will determine (1) if educational technology is effective in improving academic achievement, and (2) which conditions and practices are related to the effects of educational technology. Ultimately, this study should help the education community target its technology funds toward the most valuable resources and practices available. (For more information on this study, visit edtech.mathematica-mpr.com.)

One of the major endeavors to realize technology's potential for student learning was created by the International Society for Technology in

Educational Technology State Grants Program

The Office of Elementary and Secondary Education (2002) describes the Educational Technology State Grants Program, which is discussed in Title II, Part D, Subpart 1, of the No Child Left Behind Act:

> The principal goal of the Educational Technology State Grants Program is to improve student academic achievement through the use of technology in elementary and secondary schools. It is also designed to assist every student in becoming technologically literate by the end of eighth grade and to encourage the effective integration of technology resources and systems with teacher training and professional development to establish research-based instructional models. The program targets funds primarily to school districts that serve concentrations of poor students. (p. 85)

> The program supports improved student academic achievement through the use of technology in schools by supporting high-quality professional development; increased access to technology and the Internet; the integration of technology into curricula; and the use of technology for promoting parental involvement and managing data for informed decision-making. Districts are required to spend 25 percent of the funds they receive on professional development, though a state may exempt a district that demonstrates [it] already provides high-quality professional development in the integration of technology. In addition, the program will support national activities for disseminating information regarding best practices and providing technical assistance to states and districts and a rigorous, long-term study of the conditions and practices under which educational technology improves teaching and learning. (p. 86)

For more information on the Educational Technology State Grants Program, see *No Child Left Behind: A Desktop Reference* (www.ed.gov/admins/lead/account/nclbreference/page_pg28.html).

Education (ISTE) in 1998. That endeavor, the National Educational Technology Standards (NETS) for Students, was designed to provide teachers, technology planners, teacher preparation institutions, and educational decision makers with frameworks and standards to guide them in establishing enriched learning environments supported by technology. (See "NETS for Students" on page 14.)

Since the creation and implementation of ISTE's NETS, changing perspectives aided by new research-based information has presented educators with the need to capitalize on technology models. The National Research Council's Committee on Improving Learning With Technology (Pea, Wulf, Elliott, & Darling, 2003) argues that if changes are truly to be systemic, we must recognize the interplay among many factors: student characteristics; classroom groups, tasks, and assessments; curriculum, teacher capacity and professional development; school leadership; and community involvement. And because education decisions are made at various levels and much is left to local control, we also must recognize the interplay at and between various levels of influence, including the classroom, school, district, state, and federal levels.

To begin to capitalize on these new technology models, the Committee on Improving Learning With Technology has distinguished "five classes of use for information technologies in K–12 education that are grounded in the learning sciences:"

1. Supporting learning in real-world contexts, such as in inquiry projects that allow students to collect scientific data in the national environment.
2. Connecting learners to experts and communities of other learners.
3. Providing scaffolds and tools to enhance learning, such as visualization and analysis tools that enable students to utilize complex data for higher-order thinking.
4. Providing opportunities for feedback, reflection, and revision in the acquisition and construction of knowledge, such as in intelligent tutoring systems.
5. Expanding opportunities for teacher learning, using methods such as on-line communities of practice and best-practice case studies. (Pea et al., 2003, p. 4).

NETS for Students

The National Educational Technology Standards (NETS) Project is an ongoing initiative of the International Society for Technology in Education (ISTE) and a consortium of distinguished partners and cosponsors. ISTE (1998) describes the technology foundation standards for students, which are part of the National Educational Technology Standards for Students:

> The technology foundation standards for students are divided into six broad categories. Standards within each category are to be introduced, reinforced, and mastered by students. These categories provide a framework for linking performance indicators within the Profiles for Technology Literate Students to the standards. Teachers can use these standards and profiles as guidelines for planning technology-based activities in which students achieve success in learning, communication, and life skills.
>
> **Technology Foundation Standards for Students**
>
> 1. Basic operations and concepts
>   - Students demonstrate a sound understanding of the nature and operation of technology systems.
>   - Students are proficient in the use of technology.
> 2. Social, ethical, and human issues
>   - Students understand the ethical, cultural, and societal issues related to technology.
>   - Students practice responsible use of technology systems, information, and software.
>   - Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
> 3. Technology productivity tools
>   - Students use technology tools to enhance learning, increase productivity, and promote creativity.
>   - Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
> 4. Technology communications tools
>   - Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
>   - Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
> 5. Technology research tools
>   - Students use technology to locate, evaluate, and collect information from a variety of sources.
>   - Students use technology tools to process data and report results.
>   - Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.
> 6. Technology problem-solving and decision-making tools
>   - Students use technology resources for solving problems and making informed decisions.
>   - Students employ technology in the development of strategies for solving problems in the real world. (pp. 14–15)

Through intelligent use, the Committee on Improving Learning With Technology (Pea et al., 2003) argues, technology has the potential to fundamentally change student achievement and teacher effectiveness in several ways. By linking both teachers and students to larger, dispersed communities of educators and learners, teachers and students can access a much broader and more significant knowledge base. In addition, teachers can more accurately and frequently guide instruction for individual students through immediate access to data from formative assessments. Teachers also can help all learners—as opposed to merely advanced learners—master complex, higher-order concepts and skills through the ease of visualization techniques. As systemic reforms resulting from these and other innovative technology applications begin to take hold, it is likely that even further innovation and potential for teacher and student impact will develop.

The Committee on Improving Learning With Technology (Pea et al., 2003) also characterized two themes, or "transformations," that are necessary to improve education for all students through research-based technology applications. The first transformation is "the integration of cheap, fast, robust computers into instruction for every student in the United States" (p. 6). Accomplishing this "transformation" involves the following:

- The development and support of new, appropriate technology hardware and software.
- Continuing professional development for teachers so they can effectively use the available hardware and software.
- Equitable access to software for curriculum development.
- Ease of access to technology hardware and software resources outside the school environment for students and parents.

According to the committee, it also is necessary to integrate technology systemically through the curriculum, pedagogical practices, and technical support of each school and to establish technology as an essential component of teacher training and professional development. To enable such activity, the committee believes technology proponents must be able to demonstrate the value of technology in increasing student achievement and teacher effectiveness to a broad base of educators and the public.

The second necessary "transformation" involves applying what we know through science about how people learn to the capabilities of education technology—including development, implementation, and professional development. To facilitate this transformation, the committee believes it

necessary to define technology research and development goals along with intermediate milestones so progress is apparent to a larger community and education leaders are able to accomplish the following:

- Provide for large-scale and long-term research and development work.
- Create new assessments that can measure skills engendered by technology, such as complexity management.
- Promote collaboration between technology developers and educators to create a more robust market for education technology.

In these ways, we will be able to combine advances in the science of learning with those in technology to make a difference in student learning. To promote this goal, the National Research Council's Committee on Improving Learning With Technology (Pea, Wulf, Elliot, & Darling, 2003) has developed a list of 10 essential technology requirements. (See "National Research Council Technology Requirements" on page 17.)

Still, there is a great deal of work to be done if we are to capitalize on the potential that technology holds to improve student achievement and teacher effectiveness. This work must involve researchers, policymakers, administrators, teachers, and parents working together to understand and implement innovative, proven applications of technology. Organizations such as the International Society for Technology in Education, the National Research Council, and the U.S. Department of Education are in the process of addressing the matter in various ways.

In addition, the North Central Regional Educational Laboratory (NCREL), a wholly owned subsidiary of Learning Point Associates, has developed a wide array of resources—including tools, publications, and research studies—for using technology to improve student achievement and teacher effectiveness. Information and access to these resources can be found in the next section.

National Research Council Technology Requirements

The National Research Council established the Committee on Improving Learning With Technology (Pea, Wulf, Elliott, & Darling, 2003) to promote the effective development and application of technology in education to improve student learning. This committee developed a list of 10 requirements for technology to be broadly applied to improve student learning. Those requirements are as follows:

1. The importance of focusing the use of IT [information technology] on improving the teaching and learning of academic skills, content, and higher order thinking rather than on learning how to use the technology.

2. The importance of providing a one-to-one student/computer ratio to enable IT to be fully integrated into teaching and learning.

3. The importance of providing reliable and easy-to-use IT that both maximizes the time students can spend using the technology to learn and minimizes the support cost to keep that technology operational.

4. The importance of teachers understanding the benefits of fully integrating IT into their work compared with current approaches and tools in the classroom. The most important benefits from embracing the new technologies would be improved student learning and superior work flow management—from standards-based lesson planning and media use, to implementing and supporting student learning activity customized to needs, to assessment and next-step responsive teaching.

5. The importance of providing easy ways for teachers to locate appropriate software for IT that provides high-quality learning and teaching.

6. The importance of addressing the disconnect in the educational hardware and software markets between the products currently developed and offered by industry and the kind of products that teachers could use effectively to improve student learning. As technology continues to develop, it may become practical and appropriate to develop IT hardware specifically targeted to the need of the education market.

7. The importance of addressing IT-related change with systemic approaches that better align and integrate curriculum, instruction and assessment, and appropriate teacher development.

8. The importance of investigating the possible use of hardware and software developed for consumer markets, such as cell phones and gaming systems, for supporting learning and education applications as well.

9. The importance of exploiting the significant and still unrealized opportunity to employ emerging evidence from the learning sciences to improve the effectiveness of IT applications.

10. The importance of defining and investing in long-term research to develop and test new approaches for improving student learning with IT that can be replicated and adapted for use by many student audiences. It is also important to bring them to a scale of use that would benefit students and educators in many more educational environments than happens traditionally by means of government-sponsored research activities. (Pea et al., 2003, pp. 7–8).

Learning Point Associates Technology Resources

Through its subsidiary NCREL, Learning Point Associates has developed a wide array of resources—including tools, publications, and research studies—to assist educators, administrators, policymakers, and other education stakeholders with the systemic integration of education technology to improve student learning.

TOOLS

E-Learning Knowledge Base

www.ncrel.org/tech/elearn/

E-learning, also known as *Internet-based hybrid learning or distance learning*, is one of the most significant new learning technologies to emerge in the last 10 years. In response to this growing interest, the *E-Learning Knowledge Base* Web site provides a review and synthesis of current literature on e-learning. The site is updated often, reflecting research on the effectiveness of various environments and strategies, and synthesizing the results into procedural knowledge that educators can use to apply online collaboration in the classroom and in professional development activities.

enGauge®: A Framework for Effective Technology Use

www.ncrel.org/engauge/

The *enGauge*® framework is a Web-based tool that helps schools and districts plan and evaluate their systemwide use of educational technology. It provides a comprehensive view of critical factors, including equity, that strongly influence the effectiveness of educational technology for all students. The framework also provides online assessments to help schools and districts gauge their progress with learning technology and to develop an informed plan of action. It is geared for K–12 administrators and teachers, technology coordinators, educational policymakers, and educational researchers.

Leadership and Learning With Technology Web Site

www.ncrtec.org/pd/llwt/

This Web site contains modules that support educators in their journey toward effective technology integration. The six interrelated module frameworks focus on the planning and actions essential for implementing, managing, and supporting education technology in schools. Each module

provides goals and resources for creating a workshop. The resources include a wide range of technology-oriented analysis, planning, and skill development.

Learning With Technology Profile Tool

www.ncrtec.org/capacity/profile/profwww.htm

This online tool, developed by the North Central Regional Technology in Education Consortium (NCRTEC) at Learning Point Associates, supports schools in technology planning and integration. It presents indicators of engaged learning and technology, helping educators think carefully about their practice in these areas. For each indicator, there are three choices that educators can compare to their own practice. When finished, educators can view the results in a graphic format to help identify their strengths and weaknesses.

Technology Professional Development Web Site

www.ncrel.org/tech/tpd/

This planning resource for technology professional developers, school technology specialists, and K–12 administrators is organized around the following themes: visualizing technology-supported engaged learning, current reality, effective staff development, evaluation, and implementation. The planning-support materials can be used either sequentially or selectively to support specific planning activities.

PUBLICATIONS

Computer-Based Technology and Learning: Evolving Uses and Expectations

www.ncrel.org/tplan/cbtl/toc.htm

The authors of this booklet document the three distinct phases of educational technology use—print automation, expansion of learning opportunities, and data-driven virtual learning—and provide cumulative findings around each use to better understand the impact of technology on learning. The following questions are asked in each phase: (1) What evidence is there that the use of computer-based technology had a positive impact on learning? (2) What significance do the findings have for educators today as they try to make technology-related decisions that have an impact on student learning?

enGauge® 21st Century Skills: Literacy in the Digital Age

www.ncrel.org/engauge/skills/skills.htm

This publication, based on the *enGauge*® framework (see page 18) represents an important first step toward Digital Age readiness. It uses the *enGauge*® 21st Century Skills as a platform for the shifts in school policy and practices necessary to give students the education they require in a knowledge-based, global society.

Literacy Learning on the Net: An Exploratory Study

This report reveals what literacy researchers and lead teachers think about Internet-based curricular activities and instructional practices used to enhance students' literacy. It identifies a number of educational benefits associated with using the Internet. Available free through the Learning Point Associates Product Catalog at www2.learningpt.org/catalog/cart/item.asp?productID=51

Pathways Critical Issues

Pathways to School Improvement is a multimedia publication that examines particular issues being addressed by educators engaged in school improvement. The following *Pathways* Critical Issues relate to improving student achievement through technology:

- **Using Technology to Improve Student Achievement**
  www.ncrel.org/sdrs/areas/issues/methods/technlgy/te800.htm
  This Critical Issue examines how technology can support higher-order thinking by engaging students in authentic, complex tasks within collaborative learning contexts.
- **Promoting Technology Use in Schools**
  www.ncrel.org/sdrs/areas/issues/methods/technlgy/te200.htm
  This Critical Issue discusses the essential factors for using educational technology effectively.
- **Providing Professional Development for Effective Technology Use**
  www.ncrel.org/sdrs/areas/issues/methods/technlgy/te1000.htm
  This Critical Issue examines professional development for technology use, asserting that initial inclusion in the technology plan ensures that professional development is considered an essential factor in using technology to improve teaching and learning.
- **Technology Leadership: Enhancing Positive Educational Change**
  www.ncrel.org/sdrs/areas/issues/educatrs/leadrshp/le700.htm
  This Critical Issue discusses the impact of research and best practices on technology leadership and educational productivity.

***Policy Issues* No. 11**
Virtual Schools and E-Learning in K–12 Environments: Emerging Policy and Practice
www.ncrel.org/policy/pubs/pdfs/pivol11.pdf

This edition of *Policy Issues* presents a summary of the critical e-learning issues related to education policy, an overview of what works, relative start-up costs, evidence of impact, a profile of America's first public virtual high school, and several policy recommendations to support decision makers and policy leaders.

***Policy Issues* No. 15**
Making Educational Technology Work: State Policies in the North Central Region
www.ncrel.org/policy/pubs/pdfs/pivol15.pdf

This edition of *Policy Issues* highlights the findings of a study that analyzed state education technology policies in the North Central region. Also included are policy recommendations, examples of best practices, and a policy implementation rubric.

***Quick Key* No. 3, Technology Integration**
www.ncrel.org/tech/qkey3/qktech.pdf

This brochure highlights the significant technology elements of the No Child Left Behind (NCLB) Act. Title II, Part D, of NCLB emphasizes the improvement of student achievement with the use of technology in elementary and secondary schools through technology integration initiatives, access, accessibility, and parental involvement. The brochure provides sample technology literacy standards, answers to questions about statewide implementation of NCLB-related programs, and resources in alignment with NCLB.

Technology Connections for School Improvement: Planners' Handbook
www.ncrel.org/tplan/handbook.pdf
Technology Connections for School Improvement: Teacher's Guide
www.ncrel.org/tplan/guide.pdf

Technology Connections for School Improvement has two parts: a *Planners' Handbook* and a *Teacher's Guide*. The *Planners' Handbook* describes eight overarching dimensions of the technology planning and implementation process. These eight dimensions can help technology planners develop vision and policy, analyze technology needs, focus on student-centered learning, involve parents and the community, support professional development, build a technology infrastructure, establish multiyear funding

strategies, and evaluate processes and outcomes. The *Teacher's Guide* is designed to assist classroom teachers who are beginning to integrate technology into their daily practices, are seeking to align their personal technology vision with their school's technology vision, and are taking a professional development approach to learning in order to improve classroom practices.

Technology Standards for School Administrators
www.ncrtec.org/pd/tssa/tssa.pdf

To optimize the effective use of education technology, the Collaborative for Technology Standards for School Administrators facilitated the development of a national consensus on what PK–12 administrators should know and be able to do. The standards focus on the role of leadership in enhancing learning and school operations through the use of technology.

RESEARCH STUDIES

Children's Access to Computers and the Internet Through 21st Century Community Learning Centers: Preliminary Findings From a National Telephone Survey of Center Directors
www.ncrel.org/tech/access/index.html

NCREL conducted a national survey of 21st Century Community Learning Center (CCLC) directors, asking them about the intersection of technology and beyond-the-bell learning opportunities in their centers. This is the resulting preliminary report on the technology infrastructure of these programs from the perspective of 21st CCLC directors. The report addresses the survey's first question: What is the technology infrastructure (computers and Internet connectivity) in 21st CCLCs?

Children Learning With Technology Beyond the School Bell and Building: What Do We Know Now?
www.ncrel.org/tech/child/index.html

Before- and after-school programs, summer school, community technology centers, and public libraries are increasing children's opportunities to learn outside the regular school day, school year, and school building. Through an extensive review of print and online sources, researchers found that these programs also are increasing children's opportunities to learn with —and about—technology. Although relevant research and evaluation are increasing, there is still much to understand about children learning with technology beyond the bell and about the educational differences created by such learning.

Keeping Pace With K–12 Online Learning: A Snapshot of State-Level Policy and Practice

www.ncrel.org/tech/pace/index.html

This study, directed and funded by partnering organizations—Colorado Department of Education, Illinois Virtual High School, Learning Point Associates, and Wisconsin Virtual School—ascertains what states are doing to address the need for policy guidance. In particular, the report provides information on specific topics of K–12 online learning policy and practice, as well as analysis and discussion of those issues.

A Meta-Analysis of the Effectiveness of Teaching and Learning With Technology on Student Outcomes

www.ncrel.org/tech/effects2/

In 2003, NCREL commissioned a meta-analysis by Hersh Waxman, Meng-Fen Lin, and Georgette Michko to study the effects of teaching and learning with technology on student outcomes. The results of this meta-analysis are generally encouraging. They indicate that the overall effects are nearly twice as large as other recent meta-analyses conducted in the area of instructional technology, and so suggest that the overall effects of technology on student outcomes may be greater than previously thought. The meta-analysis indicates that teaching and technology processes either may directly impact student outcomes or may interact with technology features and indirectly impact outcomes.

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Audio CDs: A Guide to Contents

The CDs provide various perspectives on the effective use of technology to increase student learning.

CD 1 – INTERVIEWS (in order of appearance)

1. **James Sweet**, senior research associate in technology, Learning Point Associates.
2. **Cheryl Lemke**, CEO, Metiri Group.
3. **Dr. Don Knezek**, CEO, International Society for Technology in Education.
4. **Dr. Christopher Dede**, Wirth Professor of Learning Technology, Harvard Graduate School of Education.
5. **Dr. James Pellegrino**, professor of cognitive psychology in education and codirector of the Center for the Study of Learning, Instruction, and Teacher Development at the University of Illinois at Chicago.

CD 2 – INTERVIEWS (in order of appearance)

1. **Barbara Allen**, director of the LemonLINK Network, and **Daryl LaGace**, director of Information Systems for the Lemon Grove (California) School District.
2. **Patricia Diaz**, principal, Harms Elementary School, a technology-advanced inner-city school in Detroit, Michigan.
3. **Edward Dieterle**, former teacher and currently a doctoral candidate in learning and teaching at the Harvard Graduate School of Education.
4. **Dr. Daniel Light**, researcher at EDC Center for Children and Technology in New York City, reporting on a study of the Union Grove (New Jersey) School District's restructuring through technology efforts.
5. **Dr. Holly Hart** and **Dr. Elaine Allensworth**, authors of the Consortium on Chicago School Research study *Educational Technology: Availability and Use in Chicago's Public Schools*.
6. **Dr. Lisa Petrides**, president, Institute for the Study of Knowledge Management in Education.

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