4

Implications of New Learning Technologies for Adult Literacy and Learning

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The spread of both personal computers and access to the Internet during the late 20th and early 21st centuries has profoundly changed the ways in which we create, store, distribute, and retrieve information and has thereby also changed the ways we work, live, and learn. Especially widespread is the use of e-mail and the World Wide Web in American homes, schools, workplaces, and communities. Likewise in adult literacy and learning, computers connected to the Internet and other new learning technologies[1] are being used in a variety of ways to support educational activities.

[1] One indication of the newness of the new educational technology (and the inability of our language to keep pace with the changes it is fomenting) is the mutability of terms used to describe technology and its applications. Terms like *online learning* and *e-learning* (or *electronic learning*), *computer-mediated communications,* and *computationally mediated communications* are used interchangeably. This array of terms bespeaks a fragmented discourse even among those who specialize in the field. In the interest of simplicity, but recognizing the likelihood of changes in terminology in the near future, I use the term *new*

In some respects, the new learning technologies of the early 21st century are not all that new. Multimedia instructional tools have been around for a long time. What is new about the new learning technologies is the widespread access to them (making possible learning anytime, anywhere, as one U.S. Department of Education funding program put it). Telephones, computers, and televisions are gradually merging into a single information and communication technology (ICT) system. For adult learners, the pervasiveness of this technology represents not just an opportunity but a challenge. Keeping up with the technological skills demanded in entry-level jobs is increasingly difficult for adults with low levels of formal education, low-level literacy skills, and/or limited proficiency in English. At the same time, the ability to use information and communication technology is required for an increasing variety of occupations (Bruce, 2002; Murnane & Levy, 1996). Although ICT has spread rapidly, it has not spread evenly throughout society (the so-called digital divide is growing, with disparities in access across lines defined by income, educational attainment, and ethnicity), and within educational systems it has spread more slowly than elsewhere. Nonetheless, by the end of the 1990s, personal computing and the Internet had become standard tools in formal schooling (Becker, Ravitz, & Wong, 1999) and to a lesser extent in adult literacy education (Hopey, Harvey-Morgan, & Rethemeyer, 1996; Rosen, 2000).

Current theory and research provide guidance for designing learning technologies that are effective for adult literacy and learning. Theory and research can also be applied to the problem of overcoming barriers to access to learning technologies. The multimedia capabilities of computers connected to the Internet can give adult learners choices between text, audio, and visual presentation modes for new information. The options to customize information and to search and retrieve information in electronic databases allow learners and instructors great latitude in directing learning toward individual goals and interests. Access to online communications can provide opportunities for learning through social interaction both locally and globally. Finally, learning how to use computers and the Internet and learning how to learn with computers and the Internet are important basic skills for life in the 21st century. In these ways, the new learning technologies are well suited to learner-centered, goal-driven, socially interactive, and authentic applications in support of adult literacy and lifelong learning (Hopey, 1998; Stites, Hopey, & Ginsburg, 1998).

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learning technologies throughout this chapter. Although the term *learning technology* can be interpreted broadly, when used in the context of this chapter it refers primarily to applications of personal computers connected to the Internet.

This review of the research literature on new learning technologies summarizes findings from theory and research in the following areas:

1. *Effectiveness:* What does research tell us about the effectiveness of learning with computers and the Internet?
2. *Access:* What patterns of societal access to computers and the Internet are revealed by research?
3. *Barriers to effectiveness and access:* What can research tell us about the barriers to effective application of and expanded access to new learning technologies?

The chapter concludes with a summary of the implications from the research for designing effective applications and expanding access to new learning technologies for the purposes of adult literacy and lifelong learning.

EFFECTIVENESS OF LEARNING TECHNOLOGIES

In an essay that appeared in volume 1 of *The Annual Review of Adult Learning and Literacy,* David Rosen (2000) concluded that there was "almost no research on the effectiveness of technology in adult literacy education" (p. 312). This is still true, especially with respect to research findings that bear directly on questions of the effectiveness of new learning technologies in adult literacy education. In fact, the research that is available is primarily about the efficacy of computers (not computers connected to the Internet) for learning in formal educational settings. Research on the effectiveness of using computers and the Internet in support of informal learning and for learning by adults is still in its infancy.

To get an idea of how quickly the world of educational technology applications for adult literacy has changed, one need only look back at the state of the art in research-based knowledge contained in the 1993 Office of Technology Assessment (OTA) publication *Adult Literacy and New Technologies: Tools for a Lifetime.* Compiled little more than a decade ago, this otherwise excellent synthesis of contemporary theory, research, policy, and practice on technology for adult literacy contains scant mention of e-mail and no mention of the Web.[2] This absence is quite natural

[2]The OTA report does feature a description of the Outreach and Technical Assistance Network (OTAN), the Sacramento County Office of Education's path-breaking electronic support network for adult basic education (see http://www.otan.us/login/login.cfm).

given that early in the 1990s the Internet was being used by a relatively small number of university-based researchers for e-mail and that it was not until 1991 that Tim Berners-Lee developed the World Wide Web.

Since the mid-1990s, the proliferation of personal computers and rapidly expanding access to the Internet and the Web have created a tremendous interest in understanding how to harness these new technologies most effectively in support of learning at all levels. Researchers and policymakers have made concerted efforts in recent years to synthesize knowledge from theory, research, and practice; as a result, there is an emerging consensus about effective applications of new learning technologies (see International Society for Technology in Education, 2001; President's Committee of Advisors on Science and Technology, 1997; Software and Information Industry Association, 2000; and the discussion in the concluding section of this chapter). This consensus is informed by a growing body of research on the use of computers and the Internet in K–12 settings. Although results are mixed, overall, this research has shown that the use of computers can have positive effects on learning outcomes (see J. A. Kulik, 1994; Means & Olson, 1995; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; and the discussion that follows; for a dissenting interpretation of the research, see Parr, 2000). In addition, an emerging body of research has looked at how computers and the Internet can be used most effectively for educational purposes. Although little of this research has been on uses of learning technology for informal learning, the findings from recent research on effective designs for new learning technologies in formal educational settings are likely to apply to adult literacy and lifelong learning as well. This is so because the designs for learning with new learning technologies that have been shown to be the most effective are consistent with the goals and principles of adult learning theory and the desires of the adult education community for change and improvement in adult basic education (ABE).

Effects of Computer Use on Achievement

Personal computers have been used long enough in education to allow for a sizeable accumulation of research studies on their effectiveness. In the 1980s and 1990s, researchers conducted many studies to address the question of whether the use of computers in classrooms led to higher levels of achievement. By the early 1990s, hundreds of such studies had been completed, making it possible to conduct meta-analyses (quantitative comparisons and syntheses of results across multiple studies) to synthesize the findings of this body of research on the overall effectiveness of the computer as a tool for learning. Using statistical techniques to synthesize the results of several hundred individual research studies on computer-based instruction with students ranging from kindergarten to higher education, the most comprehensive of these meta-analyses (C. C. Kulik & J. A. Kulik, 1991) shows that, on average, such instruction had a significant positive effect on achievement. A second meta-analysis of 120 studies of computer-assisted instruction in settings from kindergarten through higher education (Fletcher-Flinn & Gravatt, 1995) looked at the impact of a range of factors on achievement and concluded that of the factors considered (including educational level, course content, and same or different teacher), only the quality of computer-assisted instructional materials was linked to higher learning gains. (Note that quality was operationalized as designed with clear instructional objectives, sequenced with individual feedback, and encouraging participation and activity, p. 230.) A third meta-analysis (Bangert-Drowns, 1993) synthesized results from 32 research studies on the impact of word processing as a tool for writing instruction and concluded that incorporating word processing in writing instruction (in settings ranging from elementary school to higher education) had a significant positive effect on improvement of writing skills. Finally, J. A. Kulik (1994) aggregated the results from 12 meta-analytic studies covering more than 500 individual research studies on computer-based instruction. He concluded that students in the computer-based instruction groups on average scored higher on achievement tests than control groups whose members did not use computers, learned more in less time, and had more positive attitudes toward their classes.[3]

Effective Applications of New Learning Technologies

Beginning in the mid-1990s and continuing to the present, the Internet has grown from a tool for e-mail that was available to a select few to a tool for

[3]Further summary of the large research literature on the effectiveness of computer-assisted instruction and integrated learning systems is beyond the scope of this chapter. The majority of these studies look at effects of neobehaviorist (programmed instruction) instructional applications on achievement in K–12 subject areas. The relevance of this research to adult literacy applications is questionable. It has been argued (see Millar, 1996; Thomas & Buck, 1994) that neobehaviorist instructional designs are incompatible with adult learning theory and best practices in adult basic education. Those interested in a comprehensive review of impact studies of computer-assisted instruction and integrated learning systems in K–12 settings should see Parr (2000).

multimedia information exchange that is available to almost anyone, anywhere, and anytime. The effects of the Internet on learning are only partly related to the quantity (massive) and quality (both good and bad) of the information it so readily provides. A new wave of educational technology research is being conducted to consider questions beyond that of whether Internet experience is associated with higher scores on traditional measures of achievement. Instead, the focus has been on changes in how learning takes place as well as on changes in what is learned. Early research and development often focused on drill-and-practice applications of computers (as in integrated learning systems) to support basic skills and discrete knowledge development, but researchers now see potential for computers and the Internet as tools to support higher order thinking, problem solving, creativity, and integrated skills development. Roschelle et al. (2000) reviewed this emerging body of research and concluded that the overall impact of new learning technologies in improving learning is mixed and that the most effective applications of learning technology are those that adhere to four fundamental characteristics of learning:

1. Active engagement of learners.
2. Participation in groups.
3. Frequent interaction and feedback.
4. Connection to real-world contexts.

These characteristics should look familiar to adult educators. They are, in fact, quite similar to the characteristics of effective adult learning that have long held sway in adult learning theory (see, e.g., Knowles, 1990). They are also grounded in recent advances in cognitive science theory and research (see National Research Council, 1999b). Cognitive science-based principles for effective designs of learning technologies are congruent with adult learning theory principles that take into account the characteristics of adults as learners, the goals of adult learning, and the contexts of adult learning (Bingman & Stein, 2001; Stites, 1998). Thus, research showing the effectiveness of learning technologies in support of active engagement of children and social interaction in K–12 settings is strong evidence of the potential for technology to support learner-centered and social interactive approaches to adult education. Likewise, research showing the effectiveness of new learning technologies in support of K–12 approaches to learning that include frequent feedback and are connected to real-world contexts are sound evidence of the potential for new learning technologies to support purposeful and authentic approaches to adult learning.

Active Engagement. Much of the recent theory and research in cognitive science has been guided by the assumption that learning is a social interactive process that involves active (and most often cooperative) construction of new knowledge and skills. Researchers have shown that knowledge that is acquired in *passive learning activities* (in which students are simply told new information as opposed to engaging in argumentation and reflection to solve problems) may remain *inert knowledge* (knowledge that is not easily retrieved and applied to new learning and problem-solving situations; see Bransford, Franks, Vye, & Sherwood, 1989). A number of studies have shown a positive effect from properly designed use of new learning technologies in supporting the active construction of knowledge in the context of math and science education. For example, studies of the impacts of the technology-based mathematics problem-solving program called The Adventures of Jasper Woodbury (Cognition and Technology Group at Vanderbilt, 1992; Pellegrino, Hickey, Heath, Rewey, & Vye, 1992) conducted in 11 school districts in 9 southeastern states have shown positive results in student acquisition of basic math concepts, student abilities to solve word problems, student planning (in terms of generation of subgoals), student attitudes toward mathematics and problem solving, and teachers' and parents' responses to the program. Roschelle et al. (2000, p. 79, and footnotes 20, 21, 22 on p. 94) cite nearly 2 decades of studies on incorporating computers into active, constructive learning in math and science (under a design called the Microcomputer-Based Laboratory [MBL]). This research has shown that the MBL has resulted in significant gains in students' motivation and in their abilities to interpret graphs and understand scientific concepts.

Participation in Groups. The knowledge that the Internet can facilitate social interaction has been used to design learning technologies that support collaborative learning. Wartella, O'Keefe, and Scantlin (2000) reviewed current research on what is known about the use of interactive media by children and adolescents in a report prepared for the Markle Foundation. Wartella et al. focused their review on *media socialization*—a framework for understanding how and what children learn from interactive media that is grounded in views of language socialization (Schiefflin & Ochs, 1986), social cognitive development (Vygotsky, 1962), and the role of communications in learning (Scribner & Cole, 1981). They cited research showing that use of computers and the Internet outside of classroom-like settings (in unstructured learning environments, e.g., the home, a recreation center, or a museum) offers more varied learning opportunities and more risk taking and experimentation, thus facilitating development of creativity and other forms of higher order thinking skills (Kirkman, 1993; Schalle & Skeele, 1995, cited in Wartella et al., 2000). Use of computers to support social interaction has also been shown to be an effective support for teaching and learning higher order thinking skills in school. One of the most extensively researched applications of learning technologies employing an active, collaborative, and intentional learning design is the Computer Supported Intentional Learning Environment (CSILE).[4] CSILE is designed to support "intentional learning as progressive problem solving" by facilitating classification (student's classify their notes as "problem," "what I already know," "new learning," and "my theory"), storage, and sharing of knowledge representations as texts or graphics in a database (Oshima, Scardamalia, & Bereiter, 1996, p. 126). The CSILE database is public (available to all students) and so facilitates interpersonal problem-solving activities. Research studies have shown that students in K–12 classes using CSILE for science, history, and social studies outperform control group classes not using the technology on standardized tests and on measures of deep understanding of the subject matter (Scardamalia, Bereiter, & Brett, 1992). CSILE has also been shown to have positive effects on students' self-concept, self-regulatory behavior, and critical-thinking abilities (Ryser, Beeler, & McKenzie, 1995).

Frequent Interaction and Feedback. Another potential benefit of the new learning technologies is related to the adaptive and interactive capacities of computers and the Internet. Computers and the Internet can be used to search and manipulate information in real time. In traditional classroom modes of learning and instruction, feedback on learner performance is often slow in coming, if available at all. Learning technologies can be a tool to provide more frequent and immediate feedback on learning. According to research summarized by Roschelle et al. (2000; also see National Research Council, 1999b, chap. 9), learning technologies can support effective learning designs that give students frequent opportunities to apply the ideas they are learning and to get almost immediate feedback on the success or failure of the application of their ideas in the following three ways:

1. Computer tools can respond immediately to student input—for example, in interactive graphing of a mathematical model.

[4] See the CSILE Web site at http://csile.oise.utoronto.ca/ (The Ontario Institute for Studies in Education, 1991–1995).

2. Computer tools can engage students for extended periods of time on their own or in small groups.
3. Computer tools can assess individual learner performance and provide timely and targeted feedback.

The last of these three points—the application of learning technologies for adaptive testing and assessment—is of particular interest in today's policy climate of standards and assessment-driven educational improvement and accountability. Two recent advances in cognitive science have set the stage for the development of new forms of automated (computer-based) testing systems. The first of these advances is the development of detailed models of student learning, cognition, and performance. The second is an advance in measurement theory and methodology that makes it possible to create assessment methods and statistical models that combine multiple and varied data inputs in the evaluation of complex performance. Together, these advances are enabling development of testing technologies that can be closely aligned with instructional activities and can provide learners and instructors with feedback that can be directly applied to further learning, instruction, and performance improvement (see Baker, 1998; Baker & Mayer, 1999; Bennett et al., 1999; Lin, Hmelo, Kinzer, & Secules, 1999; National Research Council, 2001).

One such cognitive model-based and technology-supported assessment and instructional guidance system has been developed by the Berkeley Evaluation and Assessment Research (BEAR) Center (Wilson & Sloane, 2000; also see National Research Council, 2001, pp. 108–111). The BEAR Center system was developed for use in a middle-school science curriculum called Issues, Evidence, and You (IEY). The system is organized around five progress variables (designing and conducting investigations, gathering evidence and making tradeoffs, understanding concepts, communicating scientific information, and taking part in group interaction). Assessment takes place by means of tasks embedded in instructional activities, short-answer tests linked to the progress variables, scoring guides used to assess student progress on the variables, and exemplars (samples of actual student work). Scores in these tasks are then used to produce progress maps using GradeMap software developed for this purpose (Wilson, Draney, & Kennedy, 2001). The progress maps provide an ongoing graphic representation of student progress on the five progress variables in the IEY curriculum.

Connection to Real-World Contexts. New learning technologies have the capacity to simulate activities in a wide range of contexts. In addition, computers and the Internet are themselves tools that must be mastered for effective performance in an increasingly broad spectrum of everyday life and work contexts. From the perspective of effective learning, connecting learning activities to real-world contexts is important, as research has shown that transferring learning from one context to another is especially difficult. The research suggests that an authentic context for learning is critical for transfer and retention of knowledge and competence (Bransford & Schwartz, 1999; also see National Research Council, 1999b, chap. 3). New learning technologies make it possible to bring real-world problem solving into educational settings in a number of ways. The use of video- and computer-based programs such as The Adventures of Jasper Woodbury (see Cognition and Technology Group at Vanderbilt, 1992) is one example of how this can be done effectively. Real-world problems can also be brought into the classroom by making use of the communications capacities of new learning technologies. For example, the Global Lab project[5] (developed by TERC, in Cambridge, Massachusetts, with funding from the National Science Foundation) makes use of the Internet to connect student researchers (in Grades 7 through 9) from more than 200 schools in 30 countries with working scientists. By collecting, sharing, and, with the help of the scientists, analyzing local data on environmental conditions, students contribute to the society's understanding of global environmental phenomena (Berenfield, 1993).

ACCESS TO LEARNING TECHNOLOGIES

According to a 1999 survey conducted by National Public Radio (NPR), the Kaiser Family Foundation, and the Kennedy School of Government,[6] more than two thirds (68%) of working Americans were using a computer at work, and 84% of these people said that using a computer was essential to their work. The same survey found that more than one third of working Americans (34%) had access to the Internet on the job, and 63% of these respondents said the Internet was essential to their work. Using census data, the National Telecommunications and Information Administration (NTIA, 2002) reported that as of September 2001, 65 million of the

[5] See the Global Lab Web site (http://globallab.terc.edu/). See in References, TERC (2001).

[6] The NPR/Kaiser/Kennedy School Poll is a nationally representative telephone survey (see National Public Radio/Kaiser/Kennedy School of Government, 1999).

115 million employed Americans over the age of 25 (56.7%) were using a computer at work, and 48 million (41.5%) were using the Internet at work. The rise in use of the Internet at work has been rapid. According to the NTIA (2002), just 17.6% of working adults over age 25 were using the Internet at work in 1997. The rise in the use of computers and the Internet in homes, schools, and communities has also been rapid. As more Americans make use of the Internet, the amount and variety of content available have grown at an explosive pace.[7]

Among the population served by the ABE system, many of whom do not have jobs or work in low-wage jobs, technology is not nearly as pervasive as it is among the population at large. The digital divide poses important challenges for all levels of education, but it is particularly salient to ABE. The widespread use of information technology in the workplace presents a challenge to ABE on two fronts. First is the gateway challenge. Acquiring skills in the use of information technology and acquiring the attitudes and strategies that enable continual learning of new technology skills are critical to employability. Second is the challenge of keeping up with changes in technology. Educational systems in general lag far behind the workplace in terms of access to the latest technology. Although many employed adults have the advantage of access to the latest technology in the workplace, recent surveys by the NTIA (1995, 1998, 1999, 2000, 2002) in the U.S. Department of Commerce show this is less likely to be true for the target ABE population, whose access to computers and the Internet is limited at home, in the community, and in the workplace.

Household and Individual Access

Surveys by the NTIA (1995, 1998, 1999, 2000, 2002) have tracked patterns of access to computers and the Internet in the U.S. population in an effort to depict and begin to address the digital divide. These surveys have revealed markedly uneven patterns of access to computers and the Internet across geographic, economic, educational, ethnic, and age divisions in American society. The October 2000 report (NTIA, 2000), titled *Falling Through the Net: Toward Digital Inclusion,* found access to the Internet

[7] Figures compiled by the Internet Software Consortium (ISC; see www.isc.org) show that the Web has grown from just under 5 million hosts (a *host* is a computer that makes information available on the Internet—e.g., the content of a site on the Web) in January 1995 to just under 150 million hosts in January 2002. See the ISC Domain Survey results at http://www.isc.org/ds/WWW-200201/index.html. See in References Internet Software Consortium (n.d. and 2002).

and computers had increased for all Americans in the 20-month period between December 1998 and August 2000 but that some groups of Americans lagged in access to technology. By August 2000, 116.5 million Americans (and 41.5% of households) were online, an increase of 31.9 million individuals (and up from 26% of households) over the December 1998 figure. The percentage of homes with computers had also increased, from 42.1% in December 1998 to 51% in August 2000. The February 2002 report (NTIA, 2002), titled *A Nation Online: How Americans Are Expanding Their Use of the Internet,* reporting figures for September 2001, showed further increases, with 56.5% of U.S. households having a computer (see Table 4.1) and 50.5% of households having access to the Internet (see Table 4.2). The February 2002 NTIA report also tracked changes in individual use of computers and the Internet. Although growth in use of computers and access to the Internet has been rapid and steady across all demographic categories, disparities remain, and the digital "have nots"—individuals from low-income households and with low levels of education, minority groups (particularly Blacks and Hispanics), and older people (especially those not in the workforce)—continue to lag far behind national trends in computer and Internet use.

As shown in Tables 4.1 and 4.2, the growth in the percentage of households with a computer and with Internet access has been relatively even across rural, urban, and central city areas of the United States. The most persistent gaps in computer and Internet access are across income (see Table 4.3), educational level (see Table 4.4), and race (see Table 4.5).

As shown in Tables 4.3 and 4.4, household income and educational level are closely correlated with access to computers and the Internet. Although computers are nearly ubiquitous and Internet access has become the norm in households with middle- to high-income levels and with high levels of educational attainment, in low-income households with lower levels of educational attainment, Internet access is rare. Only 4% of households earning less than $15,000 annually and with the most educated member possessing less than a high school education had Internet access in August 2000 (NTIA, 2000).

Looking at patterns of individual use of the Internet clearly reveals persistent gaps in use across race–origin (see Table 4.5) and age (see Table 4.6). According to the September 2001 figures, for Blacks, computer use (55.7%), and Internet use (39.8%) remain well below the national averages. For Hispanics, rates of computer use (48.8%) and Internet use (31.6%) are even further below the national averages. At the same time, computer and Internet use by Whites (70% and 59.9%, respectively) and

TABLE 4.1
Growth in Percentage of U.S. Households With a Computer, 1994–2001

Year	*U.S.*	*Rural*	*Urban*	*Central Cities*
2001	56.5%	55.6%	56.7%	51.5%
2000	51.0%	49.6%	51.5%	46.3%
1998	42.1%	39.9%	42.9%	38.5%
1997	36.6%	34.9%	37.2%	32.8%
1994	24.1%	22.1%	24.8%	22.0%

Note. From National Telecommunications and Information Administration and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed online at http://www.ntia.doc.gov/ntiahome/dn/hhs/HHSchartsindex.html

TABLE 4.2
Growth in Percentage of U.S. Households With Internet Access, 1998–2001

Year	*U.S.*	*Rural*	*Urban*	*Central Cities*
2001	50.5%	48.7%	51.1%	45.7%
2000	41.5%	38.9%	42.3%	37.7%
1998	26.2%	22.2%	27.5%	24.5%

Note. From National Telecommunications and Information Administration (2002) and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed at http://www.ntia.doc.gov/ntiahome/dn/hhs/HHSchartsindex.html

by Asian American/Pacific Islanders (71.2% and 60%, respectively) are well above the national averages. Furthermore, these gaps widened between the October 1997 and the September 2001 surveys. Rates of Internet use by Blacks were 9 percentage points below the national average in 1997 and 14.1 percentage points below the average in 2001. For Hispanics, the gap widened from 11.2 percentage points below the average in 1997 to 22.3 percentage points below in 2001. These gaps in computer and Internet use by race and Hispanic origin reflect language differences as well as educational attainment and income differences. For example, for persons of Hispanic origin living in households in which Spanish was the only language spoken, the rate of Internet use was 14.1%, whereas the rate for the same group living in households in which Spanish was not the only language spoken was 37.6%. This difference may be partially explained by

TABLE 4.3
Percentage of U.S. Households With a Computer and Internet Access, by Income, 2001

	Annual Income								
	Under $5,000	*$5,000–$9,999*	*$10,000–$14,999*	*$15,000–$19,999*	*$20,000–$24,999*	*$25,000–$34,999*	*$35,000–$49,999*	*$50,000–$74,999*	*$75,000+*
Homes with computer	25.9%	19.2%	25.7%	31.8%	40.1%	49.7%	64.3%	77.7%	89.0%
Homes with Internet	20.5%	14.4%	19.4%	23.6%	31.8%	42.2%	56.4%	71.4%	85.4%

Note. From National Telecommunications and Information Administration (2002) and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed at http://www.ntia.doc.gov/ntiahome/dn/hhs/HHSchartsindex.html

TABLE 4.4
Household Internet Access by Education Level, 1998–2000

Year	*Less Than High School*	*High School*	*Some College*	*Bachelor's Degree*	*Postgraduate Degree*
2000	11.7%	29.9%	49.0%	64.0%	69.9%
1998	5.0%	16.3%	30.2%	46.8%	53.0%

Note. From National Telecommunications and Information Administration (2000) and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed at http://www.ntia.doc.gov/ntiahome/fttn00/Falling.htm#2.1

TABLE 4.5
Internet Use by Race and Hispanic Origin, 1997–2001

Year	*U.S. Total*	*White*	*Black*	*Asian–Pacific*	*Hispanic*
2001	53.9%	59.9%	39.8%	60.4%	31.6%
2000	44.4%	50.3%	29.3%	49.4%	23.7%
1998	32.7%	37.6%	19.0%	35.8%	16.6%
1997	22.2%	25.3%	13.2%	26.4%	11.0%

Note. From National Telecommunications and Information Administration (2002) and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed at http://www.ntia.doc.gov/ntiahome/dn/html/anationonline2.htm

TABLE 4.6
Computer and Internet Use by Age Group, 1997–2001

		All Ages 3+	*3–8*	*9–17*	*18–24*	*25–49*	*50+*
2001	Computer	65.6%	71.0%	92.6%	71.3%	70.2%	42.5%
	Internet	53.9%	27.9%	68.6%	65.0%	63.9%	37.1%
2000	Internet	44.4%	15.3%	53.4%	56.8%	55.4%	29.6%
1998	Internet	32.7%	11.0%	43.0%	44.3%	40.9%	19.3%
1997	Computer	53.5%	59.0%	85.1%	58.2%	57.7%	27.6%
	Internet	22.2%	7.2%	33.2%	31.6%	27.1%	11.2%

Note. From National Telecommunications and Information Administration (2002) and the Economics and Statistics Administration, U.S. Department of Commerce, using U.S. Bureau of the Census Population Survey supplements accessed at http://www.ntia.doc.gov/ntiahome/dn/html/anationonline2.htm the fact that there is little Spanish-language content on the Internet, but it is also related to differences in income and education (NTIA, 2002, p. 23).

As shown in Table 4.6, age is highly correlated with computer and Internet use. A majority of Americans over the age of 3 (65.6%) and nearly everyone in the 9 to 17 age group (92.6%) was using a computer in 2001. The majority of Americans over age 3 are also using the Internet, with the highest rates of use among the 9 to 27 (68.6%), 18 to 24 (65%), and 25 to 49 (63.9%) age groups. Persons over age 50 are still much less likely to use computers (42.5%) and the Internet (37.1%; NTIA, 2002).

Adult Learner Access

The patterns revealed by the NTIA analyses of census data show that the target population for ABE (adults who have low levels of educational attainment and are unemployed or have low incomes) lags the population at large in access to and use of computers and the Internet. As just noted, the majority of Americans with jobs use computers at work (and more than one third also use the Internet at work). It seems reasonable to assume that a good number of the working Americans who do not have access to computers at work occupy low-wage, low-skill positions. Recent surveys have shown that using a computer and the Internet at work is a strong predictor of having a computer and Internet access at home, independent of income and educational level (Becker, 2000; Turow, 1999). So where do adults who do not have access to computers and the Internet at work (or are unemployed) find such access? According to the 2000 NTIA report, public libraries were the most important place for Internet use for the unemployed. Far more unemployed (4.2%) than employed persons (1.8%) reported using the Internet in a public library. Not surprising, an important reason cited for using the Internet in the library was searching for a job.

Although it is not surprising that the population of adults in most need of ABE services is among the least likely to have access to computers and the Internet, new learning technologies have good potential to play an important role in extending learning opportunities to these adults. Community access to computers and the Internet (in public libraries, community centers, and elsewhere) has been shown to be an effective way of extending access to learning technology to adults who lack such access in the home. The 1998 Community Technology Centers Network (CTCNet) technology center national survey (Chow, Ellis, Mark, & Wise, 1998), an analysis of 817 survey responses from 44 community technology centers in 14 states and the District of Columbia, revealed some interesting patterns in the demographics of those using the centers. Among these findings were the following:

- About two thirds of the sample were women.
- About two thirds were people of color.
- About one half were between the ages of 20 and 49.
- About three fourths had household incomes below the U.S. average.
- About two fifths had not completed high school.
- About one fifth had a high school diploma or equivalent.
- Almost half of the adults were either unemployed or retired.

The CTCNet survey also found that a large majority of participants had taken classes to improve their job, literacy, and language skills; received help with homework; or participated in programs to obtain their credential of general educational development or other ABE programs (Chow et al., 1998). Studies have shown that community technology centers are perceived as safe, supportive environments that provide community members with valuable resources (Ba, Culp, Green, Henriquez, & Honey, 2001; Kim & Penuel, 2000). These studies and others reviewed in the next section of this chapter also reveal some of the remaining barriers to expanding access to and improving the effectiveness of learning technologies for adult literacy and English-language learners.

OVERCOMING BARRIERS TO EFFECTIVENESS AND ACCESS

As computers and the Internet become more commonplace features of our homes, schools, and workplaces, the question of whether as opposed to how these new learning technologies are effective as learning tools seems increasingly irrelevant. Like paper and pencils, computers and the Internet are simply a part of our lives. The central questions are how we might provide all adults with the skills and access they need to use these tools and how we might design and best use these tools for information creation and exchange. Research has highlighted a number of the challenges involved in providing adults who are learning basic literacy and English-language skills with opportunities to benefit from the new learning technologies. These challenges are related to (a) the limitations of the Internet and Web as an educational infrastructure, (b) issues of teacher professional development and integration of technology into the ABE system, (c) issues in designing technology and delivery systems to fit the needs of adults learning basic literacy and English-language skills, and (d) broader issues of systemic change and improvement.

Limitations of the Internet and the Web

Although declining costs for computers and efforts to make computers and the Internet available to all in public libraries and community technology centers are helping to reduce the digital divide, several characteristics of the new learning technologies may limit their value as tools for adult literacy and learning. The standard argument for the value of the Internet and the Web as learning tools often consists of three points: first, that these new technologies can make learning more accessible; second, that they can improve learning; and, third, that they can reduce costs (see, e.g., Owston, 1997). In May 1998, the Center for Innovative Learning Technology (CILT)[8] hosted a workshop for more than 100 researchers, educators, and technology developers to discuss the current status of the Internet and the Web as an educational infrastructure. In a summary of the workshop discussions, Roschelle and Pea (1999) pointed out problems raised by workshop participants related to the degree to which the Internet and the Web can make learning more accessible, improve learning, and reduce costs.

1. Problems with making learning more accessible. CILT workshop participants (Roschelle & Pea, 1999) pointed out that the barriers of distance and time are not the most important to overcome in making learning accessible. Offering information that is at the right level for students and that fits learning goals and objectives is far more important; in this regard, the Internet and Web often fall short. Furthermore, workshop participants noted that searching for and retrieving information on the Internet and the Web is overly text-dependent. To learn effectively using the Internet too often requires high-level and specialized reading competence. The multimedia capabilities of the Web (allowing for presentation of information in visual and auditory formats) are underutilized. Finally, the Internet and Web may offer too much access to information of the wrong kind. The Web contains a great deal of erroneous and misleading information as well as information that most people would find offensive, so there is little doubt that some of the information on the Internet will be offensive to or

[8]The CILT is a virtual center funded by the National Science Foundation and led by researchers from SRI International; Vanderbilt University; the Concord Consortium; and the University of California, Berkeley (see http://www.cilt.org). See in References, CILT (n.d.).

inappropriate for some adult learners. Many adult learners will have difficulty coping with the information overload that comes from the amount and chaotic organization of information on the Web. Needed information is also often accompanied by distracting and unwelcome commercial advertising.

2. Problems with improving learning. The CILT workshop participants (Roschelle & Pea, 1999) also noted problems with the capacity of the Internet and the Web to improve learning. These problems included a general lack of organization of information and loose connections between information on the Internet and curriculum content. Workshop participants also felt that the Internet's capacity to support collaboration had been overrated. In fact, most Internet applications and Web pages are not designed to support interaction between groups of learners effectively. Finally, workshop participants concluded that the Web by itself does not necessarily foster higher order skills such as problem solving, critical thinking, or teamwork.

3. Problems with cost reduction. CILT workshop participants (Roschelle & Pea, 1999) responded to the argument that the Internet and Web can help to reduce educational costs by noting two cost factors beyond expenses related to purchase of hardware and software. The first is the weakness of the educational market for software. The market for educational technology has not been strong enough to support development of new companies and products that would serve the needs of the education community. Second, the fact that the Internet and the Web, as well as most software, have not been developed for applications in particular educational markets means that teachers have been forced to expend considerable time and effort to make effective use of learning technologies not specifically designed to meet their needs.

The issues raised by the CILT workshop participants have been echoed by others concerned with applications of new learning technologies for adult literacy and lifelong learning (see Hopey et al., 1996; National Center on Adult Literacy, 1999; Wagner & Hopey, 1998). For the ABE target population and the ABE system, the limitations of the Internet and the Web are amplified. The costs of developing appropriate content (that does not currently exist) and accessible applications (that do not currently exist) are thus greater because they must be built from the ground up.

The problems of accessibility and appropriateness of content are particularly thorny ones for adult literacy and English-language learners. According to a report from the Children's Partnership (Lazarus & Mora, 2000), most of the content on the Web cannot be understood by readers with limited literacy skills. The Web also contains very little community-specific information. The Children's Partnership undertook a study of what underserved Internet users want and could find on the Web (*underserved* was defined as Americans who have low incomes, live in rural communities, have limited education, and are members of racial or ethnic minorities). Interviews were conducted with 12 groups of low-income technology users as well as with directors of community technology centers and other experts, and the content of roughly 1,000 Web sites was analyzed. From interviews, the Children's Partnership researchers (Lazarus & Mora, 2000) found that low-income and underserved adults wanted the following kinds of content on the Web:

- Practical community-related information (e.g., local job listings with entry-level skill requirements, listings of affordable housing options, and information about local schools and neighborhood events).
- Information at a basic literacy level (e.g., guidance on preparation for high school equivalency, low-literacy reading materials, and technology tutorials).
- Content for non-English speakers (e.g., instructional materials, translation programs, and information in native languages).
- Cultural information (e.g., information related to ethnic interests and health information targeted toward specific ethnic groups).

Lazarus and Mora (2000) found very few sites that provided such content. The little low-literacy-level content they did find was mostly designed to meet the needs and interests of children, listings for local jobs with entry-level skills were rare, and the small amount of content available in a language other than English was almost entirely in Spanish. Table 4.7 shows the number and percentage of sites the researchers found that had content devoted to areas of interest to underserved Americans.

Despite the dearth of appropriate content for adult literacy and English-language learners on the Web, there is evidence of a demand for access to computers and the Internet among the ABE target population (see community technology center user profiles in the CTCNet survey by Chow et al., 1998). The findings of the Children's Partnership research and the CTCNet survey suggest that adult literacy and English-language learners would make good use of new learning technologies if these technologies were accessible in terms of both physical access and accessible content. Effective learning for adult literacy and English-language learners using

TABLE 4.7
Web Sites That Contain Content
of Interest to Underserved Americans

Content Area	*Number*[a]	*Percentage*
Local information	61	6%
Local jobs	9	1%
Local housing	8	1%
Limited literacy	10	1%
Multilingual	20	2%
Cultural	5	1%

Note. Adapted from *The Children's Partnership Report,* Chart 4, by W. Lazarus and F. Mora, 2000. Copyright 2000. Adapted with permission of the author.

[a]$N = 1{,}000$.

new learning technologies will also require effective teacher training and integration of technology into educational programs as well as effective designs for adult learning and instruction.

Teacher Change and Technology Integration

The amount of research on teacher change and development in the context of technology integration is substantial. This research has shown that teachers pass through a series of stages when learning to integrate technology into their classrooms. One of the earliest formulations of these stages of change came out of the Apple Classrooms of Tomorrow (ACOT) project. Based on more than 10 years of research, ACOT project workers developed a five-phase framework for describing the instructional evolution through which teachers typically progress: entry, adoption, adaptation, appropriation, and invention (Apple Computer, 2001). Another group, the Milken Family Foundation, constructed a three-stage framework (see Table 4.8) based on the concepts developed by the ACOT team (Coughlin & Lemke, 1999). The Milken Exchange's Professional Competency Continuum (PCC) not only describes the stages of instructional evolution but does so in detail for five target areas of skill: core technology skills; curriculum, learning, and assessment; professional practice; classroom and instructional management; and administrative competencies. It is designed to provide advice, recommendations, and resources for improvement. The Milken Family Foundation also sponsors a Web

Table 4.8
Milken Stages of Progress in Technology Integration

Stage 1 Entry	Educators and students are aware of the possibilities that technology holds for improving learning, but learning, teaching, and the system remain relatively unchanged. Educators at this level lack access to technology and the requisite skills to implement and sustain significant changes in practice.
Stage 2 Adaptation	Technology is thoroughly integrated into the classroom in support of existing practice. Educators have developed skills related to the use of technology but have primarily applied these skills to automate, accelerate, and enhance the teaching and learning strategies already in place.
Stage 3 Transformation	Technology is a catalyst for significant changes in learning practice. Students and teachers adopt new roles and relationships. New learning opportunities are possible through the creative application of technology to the entire school community.

Note. Adapted from *Professional Competency Continuum: Professional Skills for the Digital Age Classroom,* by E. Coughlin and C. Lemke, 1999. Copyright 1999. Adapted with permission of the authors.

site[9] where teachers can conduct an online assessment of their professional skills (see Coughlin & Lemke, 1999).

Using various change models, researchers studying professional development in technology programs have found that as a result of training, teachers shift their focus away from the technology itself and toward concerns about maximizing its effects and modifying its use on the basis of students' experiences. These studies have also found that teachers with different levels of technology skills need different types of support and training. Teachers with little or no prior knowledge of and experience with technology need a slower pace and more instruction in basics than teachers who need to improve existing technology skills. The two types of teachers will be frustrated if they are grouped together in one training course. In addition, support after initial training has proven to be essential to professional development that leads to changes in teaching practices (Dooley, 1999; Gunn, 1998; Hope, 1997; Means & Olson, 1995; Wentworth, 1998).

Given the large number of part-time positions and the scarce opportunities for professional development among teachers of ABE and English for

[9] The PCC assessment tool can be downloaded from the Milken Family Foundation Web site (see http://www.mff.org/publications. See in References, Milken Family Foundation (2000).

speakers of other languages (ESOL), these teachers will need substantial support to acquire the skills they need to integrate new learning technologies effectively into their teaching practice. Johnston, Young, and Petty (2001) found that a major new Internet-based innovation for adult learners had very low levels of use in a nationwide test of its efficacy despite extensive efforts to prepare the teachers years ahead for the new curriculum. In response to a recent national survey of professional adult educators (selected to represent the most committed and most stable group of ABE instructors), only 45% of respondents said they felt prepared to integrate technology into their teaching (Sabatini et al., 2000).

Program Design

Although there is still not much research on the effectiveness of new learning technologies in support of ABE, an emerging body of formative evaluation literature can be drawn from to provide guidance in designing effective applications of learning technologies for adult learners (see Sabatini, 2001). In their evaluation of the LiteracyLink/Workplace Essential Skills (WES)[10] materials, Johnston and colleagues (Johnston & Petty, 2001; Johnston & Young, 1999; Johnston et al., 2001) identified a number of issues related to the quality of the instructional design and use of multimedia components. The WES materials consist of a video series of 26 programs, workbooks, and a Web site designed to address the learning of work-related basic skills in reading, writing, communication, and mathematics, as well as job search, career planning, and workplace orientation issues. Johnston and Young (1999) investigated the design of the WES videos, workbooks, and online resources and drew conclusions on whether any of these products should be adjusted to enhance their acceptance by and usefulness to the target audience of adult learners. In general, they found that both teachers and students were pleased with the materials (especially the online materials). In looking at the question of potential improvements, Johnston and Young called attention to the following features of the WES product design:

[10]The LiteracyLink WES learning system, launched in September 1999 (see http://www.pbs.org/literacy/wes/view_wes.html), is a joint venture of the Public Broadcasting System, Kentucky Educational Television, the National Center on Adult Literacy at the University of Pennsylvania, and the Kentucky Department of Education. The LiteracyLink project is funded through the U.S. Department of Education Star Schools grants program, and it combines text, video, and Web-based learning materials in a multimedia learning system (see http://www.pbs.org/literacy/). See in References, PBS LiteracyLink (1998, 2001).

- Redundancy among the components: There appeared to be more duplication of content in the print and online materials than was needed.
- Reading level of the print and online components: The reading level was seen as being above the target level (fifth to eighth grade).
- Instructional design issues and value of the video, print, and online components as stand-alone products.
- Navigation of the online materials: Learners sometimes had difficulty knowing where they were and what they should do on the Web site.

In a later pilot study of a nonclassroom (without the benefit of an instructor or other students) implementation of the LiteracyLink WES curriculum in Pennsylvania, Johnston and Petty (2001) found that successful implementation required attention to learner recruitment strategies, orientation of learners, computer access, computer training of learners, and support for learners who are not in a class and do not have an instructor. Among their key findings were the following:

- Face-to-face orientation sessions prior to beginning distance work are essential.
- Most adults need computer training before they can handle online learning.
- Adults need motivation and feedback on performance to persist in distance learning.

Issues in the design of multimedia learning resources for use by adult literacy and English-language learners are also being addressed by the Cyberstep Project.[11] Among the recent products of the Cyberstep development team is a list of principles and indicators for multimedia development in adult literacy (Wrigley, 2001). The online version of this list has numerous links to adult literacy multimedia products online to illustrate the 12 principles and indicators (see Fig. 4.1 for a list of the 12 principles and indicators as well as Web locations for sites that exemplify some of the principles and indicators).

Issues in designing learning supported by new learning technologies for English-language learners such as those listed in Fig. 4.1 and elsewhere

[11]Cyberstep is a partnership of the Sacramento County Office of Education, the Los Angeles Unified School District, the Adult Literacy Media Alliance, and Aguirre International (see http://www.cyberstep.org).

1. **Adult learning requires a clear focus.**

   Indicators:

   Objectives and/or potential outcomes are clearly explained.
   There are various paths for students to follow.
   Activities appear as part of skill bundles or are connected to themes.
   Student work culminates in projects or products.

   Example on the Web:

   TV411 (Web site for the Adult Literacy Media Alliance's Video Series): http://www.tv411.org

2. **Adult learning requires that learners take ownership of what is to be learned.**

   Indicators:

   Learners can explore their own interests and set goals.
   Learners can design their own learning plans and follow a path that leads them to success.
   Learners can choose from a set of skills, an array of themes and/or various modes of learning (inductive, deductive, controlled, and exploratory).
   Group projects are offered as a possibility.

   Example on the Web:

   Slides from Heide Wrigley's TESOL 2000 Presentation, *Perspectives on Computer Assisted Language Learning for Project-Based Learning: Principles and Opportunities:* http://www.cyberstep.org/TESOL/

3. **The goal of adult learning is to help adults apply knowledge, skills, and strategies in real-life contexts.**

   Indicators:

   Knowledge, skills, and strategies are contextualized and connected to learners' lives.
   Application activities encourage learners to use skills beyond the course and report back (e.g., planning a trip and making a budget).
   Learners see how things work (through photographs, animation, or streaming video) without having to get mired in print.

   Example on the Web:

   Maricopa Center for Learning and Instruction, "Ubuyacar" problem-based learning Web page: http://www.mcli.dist.maricopa.edu/pbl/ubuystudent/

(Figure continues)

FIG. 4.1. Principles and indicators to assist in the development and evaluation of technology-based materials.

4. **Language and literacy development require fluency and accuracy (but not at the same time).**

   Indicators:

   Learners get the opportunity to write what is on their mind, using their own language.

   Learners have access to resources such as spell checks, dictionaries, thesauruses, and encyclopedias.

   Learners get a chance to edit and correct earlier drafts.

   Examples on the Web:

   Library of Congress, American Dreams Project: http://www.internet-catalyst.org/projects/amproject/toc.html

   SCALE Health Action Team Project, Inquiry Map Example: http://www2.wgbh.org/mbcweis/ltc/sccc/Nutrlmap/example.html

5. **Language and literacy development are social processes that depend on interaction with others.**

   Indicators:

   Learners get to know each other and are part of a community.

   Learners can communicate with each other via e-mail or through developed projects.

   Learners tell their stories and listen to or read the stories of others.

   Surveys and polls allow learners to see what others think.

   Example on the Web:

   Susan Gaer's e-mail Projects: http://www.otan.us/webfarm/emailproject/email.htm

6. **Language and literacy development require hypothesis testing and risk taking.**

   Indicators:

   Students are invited to discover principles of writing, grammar rules, or spelling conventions by looking for patterns (task-based learning).

   Students get a chance to move from a zone where they are relatively comfortable to new areas that are a bit scary (posting an e-mail, sending an electronic postcard, posting a story, and creating a video).

   Example on the Web:

   Blue Mountain Interactive Birthday Cards: http://free.bluemountain.com/eng3/interbrth/

(Figure continues)

FIG. 4.1. *(Continued)*

7. **Language and literacy processes are nonlinear and develop in fits and spurts.**

   Indicators:

   Texts are highly engaging and propel students forward.

   Information is recycled and instruction is layered so that knowledge, skills, and strategies are reinforced through various themes.

   Examples on the Web:

   Decisions, Decisions Online, Debates on Current Events (for students in grades 5–10): http://ddonline.tomsnyder.com/

   KidsHealth for Kids, How Do People Get AIDS: http://www.kidshealth.org/kid/talk/qa/aids.html

8. **Language and literacy are multidimensional.**

   Indicators:

   Materials offer various modalities (visual, musical, analytic, naturalistic, interpersonal, and intrapersonal)

   Learners are encouraged to move beyond print in their work.

   Example on the Web:

   Poetry Society of America, Favorite Poem Project (site combines print, sound, and video): http://www.favoritepoem.org/

9. **Language and literacy grow through both serendipitous learning and explicit learning.**

   Indicators:

   Learners get a chance to immerse themselves in interesting work (reading, writing, and problem solving).

   Demonstrations illustrate how things work.

   Learners have access to information on an as-needed basis.

   Examples on the Web:

   The Evil Landlady Action Maze (problem solving for English learners): http://www.uefap.co.uk/landlady/llady1.htm

   Cuisine Magazine, Cuisine at Home, Favorite Recipes: http://www.cuisineathome.com/recipes/index.html

(Figure continues)

FIG. 4.1. *(Continued)*

10. Language and literacy learning require both success and challenges.

Indicators:

Learners get a chance to see what others have done (models) before attempting their own work.

Learners are invited to use learning strategies with material that becomes progressively more complex.

Learners see or read about the ways in which others process or create texts (cognitive apprenticeship).

Example on the Web:

TV411 Writing Page (Web site for the Adult Literacy Media Alliance's Video Series): http://www.tv411.org

11. Language and literacy develop more deeply if ideas are situated in a specific context or theme.

Indicators:

Skills and strategies are contextualized.

Learners are invited to explore a theme from various angles.

Learning materials can be accessed by skill area or by theme.

Examples on the Web:

The Farmworkers Web Site: http://www.farmworkers.org/

National Institutes of Health, National Institute of Allergy and Infectious Diseases, Fact Sheet on HIV/AIDS Statistics: http://www.niaid.nih.gov/factsheets/aidsstat.htm

12. Language and literacy grow through both emotional engagement and cognitive involvement.

Indicators:

Needs assessment seeks to determine themes that matter to learners (parenting, health, and money).

Some themes address controversial topics that a teacher may not want to address (AIDS, cancer, and domestic violence).

Learners have opportunities to discuss issues, share information, and ask questions.

Examples on the Web:

Safe Horizon Domestic Violence Shelter Tour and Information Site: http://www.dvsheltertour.org/

Talking With Kids, Talk With Your Kids About Tough Issues Site: http://www.talkingwithkids.org/

Note. From *Principles and Indicators to Assist in the Development and Evaluation of Technology-Based Materials: A Design Framework for Multimedia Development in Adult Literacy,* by H. S. Wrigley, 2001. Copyright 2001. Reprinted with permission of the author.

FIG. 4.1. *(Continued)*

(see Bermudez & Palumbo, 1994) are currently being addressed in a number of research and development projects, including Cyberstep's English for All multimedia learning system (see California State University Institute, 1999; Cyberstep, 1999; and the English for All Web site[12]) and the LiteracyLink Project CONNECT (Comprehensive Offerings Now for the New English Communicators using Technology). The final results of these projects were not available at the time of this writing, but they promise to be fruitful for guiding the design of new learning technologies for adult literacy and learning.

Effective learning designs for the use of computers and the Internet by ABE students must also address issues of instructional program quality. A review of the available research on technology use in low-income communities conducted at the Center for Children and Technology (Ba et al., 2001) indicates that community technology centers can serve as a good base from which to expand access. They offer a number of benefits to underserved communities, including the following:

- A meaningful and challenging learning environment.
- A sense of community among center users.
- Help finding new employment opportunities.
- Increased job skills and access to employment.
- Improved outlooks on learning and educational goals.
- Use of technological literacy as a means of achieving personal goals.
- Increase in civic participation.
- Increase in social and community connections beyond the center.

Further case studies of community technology centers being conducted by the vStreets Research Group at SRI International (Kim & Penuel, 2000) are also beginning to reveal promising program practices. Intensive case studies of six effective community technology programs in the California Bay Area revealed that these programs shared the following practices:

- Coordination of youth and adult services.
- Ongoing reflection and program improvement through regular involvement of stakeholders in discussions of program practices.
- Development of new part-time staff through hiring and training of program participants.

[12] The English for All Web site can be found at http://www.myefa.org. See in References, English for All (2002).

- Use of project-based, informal, and extended approaches to learning (e.g., group compilation and desktop publication of a cookbook as opposed to basic skills instruction).

In its analysis of effective program practices and learning in the community technology centers, the vStreets Research Group has adopted a multiliteracies framework (see New London Group, 1996) that includes an expanded set of literacy skills that are important to consuming and producing information using digital media (see also National Research Council, 1999a). This multiliteracies framework emphasizes the following four modes of effective learning in community technology centers:

- Meaningful practice: Because participants often have little prior experience with technology, it is important to give them opportunities to practice on the computer in meaningful ways that are tied to their goals and interests.
- Direct instruction: Many of the technical skills associated with effective use of new learning technologies (e.g., using e-mail) are best learned through specific guidance in performing difficult tasks.
- Critical reflection: Participants benefit from opportunities to think critically about what they are learning and about the ways in which their lives are influenced by new technologies. Participants thus become producers of digital information as well as critical consumers.
- Social connection: Community technology centers are most effective when they see their mission as being broader than promoting individual learning and when they use technology to help build a sense of community and to empower participants (Penuel, 2001).

Systemic Change and Improvement

Barriers to effectiveness and expanded access to new learning technologies for adult literacy and lifelong learning cannot be overcome in a piecemeal fashion. Roschelle et al. (2000) argued that new learning technologies can become effective only when they are embedded in a broader context of educational reforms that include changes in teacher training, changes in curriculum and assessment, and an enlarged capacity for institutional change. This broader context of change is as salient to consideration of the effectiveness of learning technologies for adult literacy and lifelong learning as it is to considerations of technology effectiveness in the context of K–12 schooling. Ultimately, the effectiveness of learning technologies depends on the quality of the educational contexts for which they are designed and in which they are applied. This is not a technology design issue but a learning design issue. A comprehensive model of program quality (e.g., that laid out in *Results That Matter: An Approach to Program Quality Using Equipped for the Future* by Bingman & Stein, 2001[13]) or a model of effective informal learning (e.g., that described by the vStreets group in Penuel, 2001) is necessary to the effective application of new learning technologies.

IMPLICATIONS FOR RESEARCH, PRACTICE, AND POLICY

It is clear from the research review that developing effective designs for new learning technologies to support learning by adults with low-level literacy skills and limited English-language ability is a complex and multifaceted endeavor. Developing such designs to enable access and effective use of new learning technologies for adult literacy and English-language learners is nonetheless imperative. Without such designs, the digital divide —which is, in fact, not so much a distinction of access to hardware and software as it is of educational, employment, personal growth, and community development opportunities—will continue to widen. The following discussion highlights key implications for research, practice, and policy.

Research

The research reviewed in this chapter has shown that computers and the Internet can be effective learning tools. Meta-analyses of hundreds of individual research studies have shown that computers can have a positive impact on achievement when used in classroom settings. The key questions facing researchers now have to do with how computers and the Internet can most effectively be used to support learning in classrooms and in informal learning environments, for both children and adults.

To support effective development and applications of new learning technologies for adult literacy and learning, researchers will need to design studies to address two areas. The first area involves investigating the impacts of applications of new learning technologies that incorporate principles of good adult learning design, including:

[13] This report can be downloaded at http://www.nifl.gov/lincs/collections/eff/eff_publications.html.

- Active engagement of learners.
- Participation in groups.
- Frequent interaction and feedback.
- Connection to real-world contexts.

Developing appropriate measures of learning outcomes will be an important task in this research. These measures should permit the assessment of integrated knowledge and skills and complex performance under conditions that closely mirror real-world performance. Only by developing such measures will researchers be able to assess fully the value of new designs for learning technologies for adult literacy and learning.

A second critical area of investigation involves strategies for overcoming barriers to broader access to learning technology for adults. Survey research and analyses of census data continue to show persistent societal gaps in access to and use of computers and the Internet. Although access and use have been increasing steadily for all segments of American society, some gaps in access and use are widening. The unemployed and persons with low-wage jobs; persons with low levels of educational attainment; members of racial, ethnic, and/or linguistic minority groups; and older Americans disproportionately lack opportunities to use information technology to better their lives. Research has shown that this digital divide results not only from a lack of physical access to computers and the Internet. It also results from the lack of opportunities to acquire the skills needed to use information technologies effectively and from the problems attending the fact that the content and information that information technologies provide is not suited to the needs and interests of adult literacy and English-language learners. Further research is needed to identify promising practices and approaches for overcoming these barriers to access to learning technology.

Practice

The key implications of this review of research are in the areas of effective integration of new learning technologies into adult education and teacher professional development. These two areas are closely intertwined, as effective integration of learning technologies will only be achievable if adult educators increase their levels of competence in the use of new technologies to support their own as well as their students' learning.

Systemic reform and improvement of ABE programs and services are needed to provide the context in which new designs for learning technologies and higher levels of teacher development and technology integration can be implemented effectively. As research and development makes available new designs for learning with computers and the Internet, particularly for self-supported learning beyond the classroom (in homes, communities, and the workplace), these new learning technologies (and learning opportunities) must become an integral part of adult literacy and ESOL service delivery systems. As noted, there is a growing body of research accumulating in community technology centers (and elsewhere) that has identified effective approaches to providing support for informal and formal opportunities for adults to learn about and learn with computers and the Internet. This research holds lessons for designing learning and instruction, as well as for selecting and applying learning technologies to support adult learning (see Fig. 4.2 for a summary of indicators of engaged adult learning and indicators of high-performance technology). This experience makes clear that inserting technology into poorly organized instructional programs and learning environments will not by itself improve learning and instruction. The key to effective technology integration is understanding effective adult learning and instruction plus understanding the limits and potential of learning technologies to support effective adult learning.

Developing such an understanding among adult educators will require expanded professional training and professional development. It is widely recognized that human resources (people who know how to use information technology) are as important as material resources (computers, software, and network infrastructure) in achieving effective integration of learning technology in adult literacy education (or in any educational system). Competence in the use of information technologies and understanding of how to make good use of information technology in learning and instruction should be the goal for current and prospective adult educators. The diversity of backgrounds and degrees of professionalism among adult educators will require developing a wide variety of programs, contexts, and materials to support learning about and learning with new learning technologies.

Policy

Research and development of effective applications of new learning technologies for adult literacy and lifelong learning are only beginning. Research-based policy from the much larger world of K–12 education can help to guide the work that will be needed to expand access to and design effective technologies for adult literacy and English-language learners.

	Indicators of Engaged Adult Learning	
Variable	*Indicator of Engaged Learning*	*Indicator Definition*
Vision of learning	Responsible for learning	Learner involved in setting goals, choosing tasks, and developing assessments and standards for the tasks; learner has the big picture of learning and next steps in mind.
	Strategic and transformative	Learner actively develops repertoire of thinking and learning strategies and critical awareness to empower pursuit of individual and collective goals.
	Energized by learning	Learner is not dependent on rewards from others and has passion for learning.
	Collaborative	Learner develops new ideas and understanding in conversation and work with others.
Tasks	Authentic and builds on experience	Pertains to real world, addresses personal interest, and rooted in lived experience of learner.
	Challenging and rewarding	Difficult enough to be interesting but not totally frustrating, usually sustained, and conveys clear and tangible benefits to the learner.
	Integrative	Involves integrating information of many types and from a variety of sources to solve problems and address issues related to daily life and work.
Assessment	Performance based	Involving a performance or demonstration, usually for a real audience and useful purpose.
	Generative	Assessments having meaning for learner; they may produce information, product, or service.
	Seamless and ongoing	Assessment is part of instruction and vice versa; learners learn during assessment.
	Equitable	Assessment is culture fair.

Instructional model	Interactive and accommodates learning differences	Instructor or technology program is responsive to learner needs and requests (e.g., is menu driven) and adapts instructions to suit a variety of learning styles and preferences.
	Generative	Instruction oriented to constructing meaning and to providing meaningful activities and experiences.
Learning context	Collaborative	Instruction conceptualizes the learners as part of a learning community; activities are collaborative.
	Knowledge building	Learning experiences are set up to bring multiple perspectives to solve problems such that each perspective contributes to shared understanding for all; this goes beyond brainstorming.
	Empathetic	Learning environment and experiences set up for valuing diversity, multiple perspectives, and strengths.
Grouping	Heterogeneous	Small groups with persons from different ability levels and backgrounds.
	Equitable	Small groups organized so that over time all learners have challenging learning tasks and experiences.
	Flexible	Different groups organized for different instructional purposes so each person is a member of different groups; this works with different people.
Instructor roles	Facilitator	Engages in negotiation, stimulates and monitors discussion and project work but does not control.
	Guide	Helps learners to construct their own meaning by modeling, mediating, explaining when needed, redirecting focus, and providing options.
	Colearner/co-investigator	Instructor considers self as learner, is willing to take risks to explore areas outside his or her expertise, and collaborates with other instructors and practicing professionals.

(Figure continues)

FIG. 4.2. Indicators of engaged adult learning and of high-technology performance for adult learning.

Variable	*Indicator of Engaged Learning*	*Indicator Definition*
Learner roles	Explorer	Learners have opportunities to explore new ideas and tools; they can push the envelope in ideas and research.
	Cognitive apprentice	Learning is situated in relationship with mentor who coaches learners to develop ideas and skills that simulate the role of workers in the real world.
	Teacher	Learners are encouraged to teach others in formal and informal contexts.
	Producer	Learners develop products of real use to themselves and others.

Indicators of High-Technology Performance for Adult Learning

Variable	*Indicator of High-Technology Performance*	*Indicator Definition*
Access	Connective	Learning contexts are connected to the Internet, Web, and other resources.
	Ubiquitous and available in functional context	Technology resources and equipment are pervasive and conveniently located for individual (as opposed to centralized) use and are useable in daily life and work settings.
	Interconnective	Learners and instructors interact by communicating and collaborating in diverse ways.
	Designed for equitable use	All learners have access to rich, challenging learning opportunities and interactive, generative instruction.
Operability	Interoperable and convergent	Capable of exchanging data easily between diverse formats and technologies (including integration of diverse information and communication technologies).
	Open architecture	Allows users easy access to third-party hardware or software.
	Transparent	Users are not—and do not need to be—aware of how the hardware/software operates.

Organization	Distributed	Technology and system resources are not centralized but exist across any number of people, environments, and situations.
	Designed for user contributions	User can provide the technology and system with input and resources on demand.
	Designed for collaborative projects	Technology is designed to facilitate communication between users with diverse systems and equipment.
Engagability	Access to challenging and appropriate tasks	Instructor, program, or Web site is responsive to learner needs and requests (e.g., is menu driven) and meets needs and interests corresponding to particular age categories and life situations.
	Enables learning by doing	Instruction oriented to constructing meaning and providing meaningful activities or experiences.
	Provides guided participation	Technology responds intelligently to user and is able to diagnose and prescribe new learning.
Ease of use	Effective help	Technology provides help indices that are more than glossaries; it may provide procedures for tasks and routines.
	User-friendliness/user control	Technology facilitates user and is free from overly complex procedures; user can easily access data, Internet and Web locations, and tools on demand.
	Fast	Technology has a fast processing and downloading or uploading speed and is not down for long periods of time.
	Available training and support	Training is readily and conveniently available, along with ongoing support.
	Provides just enough information just in time	Technology allows for random access, multiple points of entry, and different levels and types of information.

(Figure continues)

FIG. 4.2. *(Continued)*

Variable	*Indicator of High-Technology Performance*	*Indicator Definition*
Functionality	Diverse and robust tools	Technology enables access to full diversity of generic, context-specific, and portable tools basic to learning and working in the 21st century.
	Media use	Technology provides opportunities to use full range of multimedia technologies.
	Promotes programming and authoring	Technology provides tools (e.g., wizards and authoring software) that are used to make other tools.
	Supports project design skills	Technology facilitates the development of skills related to project design and implementation.

Note. From *Assessing Lifelong Learning Technology (ALL-Tech): A Guide for Choosing and Using Technology for Adult Learning,* by R. Stites, C. E. Hopey, and L. Ginsburg, 1998. Copyright 1998. Reprinted with permission of the authors. The ALL-Tech indicators are adapted from the framework for evaluating technology effectiveness in K–12 described in *Plugging In: Choosing and Using Technology* (Jones, Valdez, Nowakowski, & Rasmussen, n.d.).

FIG. 4.2. *(Continued)*

In a 1997 report on the use of technology to strengthen K–12 education, the President's Committee of Advisors on Science and Technology (PCAST) Panel on Educational Technology (PCAST, 1997) made a number of recommendations based on a broad review of research and expert testimony. These recommendations represent a succinct statement of current research-based knowledge of the issues and challenges shaping the design, implementation, and effective use of learning technologies in K–12 schooling, and they have direct implications for designing effective uses of new learning technologies for adult literacy and lifelong learning.

The major findings and recommendations of the PCAST report can be summarized as follows:

1. Focus on learning with technology, not about technology. This recommendation is a response to the common problem of differentiating technology as subject matter (learning about technology) and technology as learning tool (learning with technology). Acquiring technology skills is an important goal for K–12 education (and even more important for ABE because of the need to support informal learning and the value of technology skills in the workplace), but the focus should be on applying computing and networking technologies to improve learning in all areas.

2. Emphasize content and pedagogy, not just hardware. Here again, the PCAST members argue for a goal that exceeds the common perception of lack of access to technology as the major problem in need of remedy. Access remains a vital concern for ABE, but increasing the distribution of hardware alone will not improve learning opportunities. More hardware and greater connectivity are necessary but not sufficient conditions for expanding learning opportunities. Adults will require new content and new learning designs, as just noted in the discussion of implications for research and practice.

3. Give special attention to professional development. The PCAST members point out that K–12 teachers need support if they are to integrate technology effectively into their teaching. Likewise, ABE teachers need professional development opportunities and ongoing support to make effective use of new learning technologies. Investment in human resources is the most important step that policymakers can take to improve the quality of ABE. New funding is needed to support professional development programs that instruct teachers how to use technology and integrate it into their teaching.

4. Engage in realistic budgeting. The PCAST members called for a significant increase in technology-related expenditures in K-12 education

(recommending that spending on technology relative to overall spending in K–12 be increased from 1.3% to roughly 5% or from $3.4 billion to $13 billion in 1996 dollars). Given the comparatively low level of public funding for ABE, it is difficult to judge what realistic budgeting would mean for this system. Would 5% of the roughly $500 million (or $25 million) in federal funding that is distributed to states through the Workforce Investment Act make a difference if applied to technology-related expenditures? As noted, the key to wise use of available money is not to allocate it to the purchase of more software and hardware. The key is supporting programs that will cultivate expertise in the use of technology and the distribution of this expertise throughout the system.

5. Ensure equitable, universal access. As already noted, ensuring equitable and universal access to low-income and underserved adults may be even more difficult and more critical to ABE than it is to K–12 education. Much as the well-known Matthew effect in early reading development creates a growing knowledge gap between children who learn to read early and those whose reading development is delayed, differential access to technology and differences in ability to use it to support lifelong learning are the wedges that widen societal gaps in opportunity. Adults who are fluent in English, are highly literate, and can afford home access to computers and the Internet have wonderful opportunities to learn with new learning technologies. Others adults with limited education, income, or English do not have the same opportunities to learn. Expanding access through such venues as community technology centers and creating new designs and new content for these technologies (as just discussed) so that all Americans can take advantage of this new information infrastructure should be a priority for public policy.

6. Initiate a major program of experimental research. PCAST members pointed out the alarmingly low level of funding that has been devoted to research on the efficacy and cost-effectiveness of learning technology and called for sufficient funding to support a large-scale program of well-articulated research studies. The panel further recommended that funding for research be expended at the federal level to avoid systematic underinvestment. Here again, the PCAST recommendations for K–12 seem equally applicable to ABE.

The last item in the PCAST list of recommendations—the call for a major research program on the efficacy and cost-effectiveness of educational technology—is a point of particular interest. For the field of adult literacy and learning, the questions that have not yet been adequately addressed by research have to do with how to provide all Americans with opportunities to benefit from the power of new learning technologies to support learning anywhere and anytime. The barriers to such opportunity for the ABE target population are particularly high and can be overcome only with substantial commitment and investment in new research and development. The existing research has revealed the limitations of the new learning technologies (problems with accessibility, learning designs, and costs), but research has also shown how these problems may be overcome with new, more accessible, and more effective designs for learning technologies for adult literacy and lifelong learning. These new designs will incorporate better instructional models for adult learning (not just drill-and-practice but also interactive, learner-centered, integrated skill development that transfers to improved performance in the real world). Access can be increased through programs that bring technology into the community, as do community technology centers, and through the development of cheaper, more portable, and more practical devices. Researchers, educators, and policymakers are just beginning to understand the potential of new learning technologies. In the short run, the costs of researching and developing new applications of learning technologies to meet the needs of adult literacy and English-language learning will be high, but the benefits—and savings—in the future will be well worth the investment. If we fail to invest in making learning with new learning technologies available to all Americans, we risk increasing societal gaps in wealth and opportunity. Equal access to education is the bedrock of a healthy democracy and a healthy economy, and in the 21st century equal access to education cannot be achieved without opening opportunities for all to benefit from the lifelong learning that new learning technologies can afford.

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