Learn Inq (2007) 1:41–49
DOI 10.1007/s11519-007-0001-5

The paradoxical future of digital learning

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Received: 27 September 2006 / Accepted: 10 January 2007 / Published online: 13 March 2007

Abstract What constitutes learning in the 21st century will be contested terrain as our society strives toward post-industrial forms of knowledge acquisition and production without having yet overcome the educational contradictions and failings of the industrial age. Educational reformers suggest that the advent of new technologies will radically transform *what* people learn, *how* they learn, and *where* they learn, yet studies of diverse learners' use of new media cast doubt on the speed and extent of change. Drawing on recent empirical and theoretical work, this essay critically examines beliefs about the nature of digital learning and points to the role of social, culture, and economic factors in shaping and constraining educational transformation in the digital era.

Keywords Technology · Computers · Internet · Digital · Learning

The future of learning is digital. In the US, the national student–computer ratio for public schools has fallen from 168:1 in 1983 (Anderson & Ronnkvist, 1999) to 3.8:1 in 2005 (Market Data Retrieval, 2005), with movement accelerating toward one computer per child programs, based on laptops or other mobile devices (Greaves & Hayes, 2006; Warschauer, 2006). Businesses, the military, and other institutions have computerized at an even more rapid pace (Castells, 1996; Lanham, 1993); and home computers and high-speed Internet access are now becoming commonplace in not only high but also low-income US households (Rainie & Horrigan, 2005).

There is little doubt that this rapid diffusion of new technologies will broadly impact the nature of learning and literacy. As Ong (1982) wrote, "Technologies are not mere exterior aids but also interior transformations of consciousness, and never more than when they affect the word" (p. 82). For a historical example, it is useful to consider the development of the printing press, which contributed to a major transformation of literacy, learning, and scholarship in the second half of the last

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millennium. In the centuries after the Gutenberg revolution, the notion of reading changed from oral performance to silent comprehension; the notion of writing changed from copying manuscripts to original creation; and the notion of scholarship changed from mastery of a few religious texts to examination of a wide field of knowledge (Eisenstein, 1979).

There is reason to believe that digital technologies will in the long run have as much impact on learning and literacy as the printing press had (see, for example, discussion in Harnad, 1991), and, indeed, this transformation is already under way (see Leu, Lankshear, Knobel, & Coiro, in press). However, technology does not transform learning and literacy by itself, but only in conjunction with other social and economic factors. For example, the earlier changes in learning and literacy mentioned above occurred over several centuries and resulted not only from the invention of the printing press but also from the Protestant Reformation and the industrial revolution (Eisenstein, 1979).

With a broad post-industrial social and economic transformation well under way (see Castells, 1996), at least in the US and other industrialized countries, the transition to digital literacy may well occur faster than the earlier transition to print literacy. But it will not be instantaneous. We thus find ourselves in a transition between what Bolter (1991) called *the late age of print* and others (e.g., Attewell & Winston, 2003) have called a *post-typographic society*.

This transitional stage suggests that the future of learning in the 21st century will be quite complex, as we strive toward post-industrial forms of knowledge acquisition and production without having yet overcome the educational contradictions and failings of the industrial age. In the remainder of this essay, I examine the paradoxes that emerge when we examine three widely accepted beliefs about the future of digital learning, related to what people learn, how they learn, and where they learn in the digital era.

The what paradox: new versus traditional literacies

The first paradox relates to what students need to learn in the new digital classroom. A wide range of organizations (e.g., North Central Regional Educational Laboratory & the Metiri Group, 2003; Partnership for 21st Century Skills, 2004) and individuals (e.g., Gee, 2003, 2004; Lemke, 1998) have argued that the literacies of the print era are being superceded by a new set of digital-age literacies, the most frequently mentioned of which are information literacy and multimedia literacy.

Information literacy refers to the ability to define what sorts of information are needed; locate the needed information efficiently; evaluate information and its sources critically; incorporate selected information into one's knowledge base; understand the economic, legal, and social issues surrounding the use of information; and access and use information ethically and legally (American Library Association, 2000). Though the need for information literacy pre-dates the digital era, its importance has now greatly expanded in a world where vast amounts of unfiltered data are available online. The ability to draw on draw rote answers is inadequate in a world where yesterday's answers are outdated faster than ever. Education must equip students to aim further ahead of a faster target.

Castells' (1996) in-depth analysis of the US and world political economy underscores the crucial value of information literacy in today's world. As his landmark

work demonstrates, the ability to transform information into knowledge using new technologies can be considered the critical factor contributing to wealth and power in today's world at both the individual and national level (see, e.g., Castells, 1996).

Multimedia literacy refers to the ability to interpret, design, and create content that makes use of images, photographs, video, animation, music, sounds, texts, and typography (for overviews, see Daley, 2003; Kress, 2003). Among other things, it includes an understanding of frame composition; color palette; audio, image, and video editing techniques; sound–text–image relations; the effects of typography; transitional effects; navigation and interface construction; and generic conventions in diverse media (Daley, 2003). In the 21st century, multimedia literacy is viewed as important for occupational purposes (with an increasing amount of jobs requiring production of multimodal content), civic purposes (with full participation in society enhanced by the ability to interpret and produce multimedia through blogging, podcasting, Website creation, etc.), and artistic purposes (with digital photography, digital video, and other forms of new media emerging as important forms of art and self-expression).

The predominate position of multimedia in today's world of digital communication has placed such skills in high demand (Lanham, 1993). Indeed, some scholars imagine a digital future in which multimedia literacy or the lack of it brings about a new divide between those who have the knowledge to fully engage with, understand, and create the influential multimedia content of the future, and those whose lack of such ability will render them passive consumers of pre-packaged information (see, for example, Castells, 1996; Warschauer, 1999).

While the rationale behind the need for both information and multimedia literacy is thus clear, what often gets lost in discussions of new literacies is their relationship to more traditional literacies of print-based reading and writing. Two points deserve consideration. First, the same digital media that are fostering the need for new literacies are also making traditional literacies more valuable then ever before. For example, the development of a computer-based informational economy has brought about the loss of millions of manufacturing, mining, and agricultural jobs in the US that demanded little or no literacy, while creating in their place large numbers of office jobs requiring substantial amounts of reading and writing (see discussion in Warschauer, 2006).

Second, competence in traditional literacies is often a gateway to successful entry into the world of new literacies. A particularly vivid illustration of this is seen in a comparative qualitative study by Attewell and Winston (2003) of two groups of 11–14-year-old children in New York City as they make use of computers and the Internet. One group consisted of school children from more affluent families who attend private schools. The group exhibited high degrees of both information and multimedia literacy. For example, a typical fourth grade student posted messages to bulletin boards, read political candidates speeches online, answered online polls to make his opinions heard, and even developed a Website so that his school could carry out its own class president elections online.

The second group consisted of African-American and Hispanic children from poor and working class families who scored below grade level in tests of reading. The limited reading ability of those children virtually eliminated their possibility of exercising information literacy. And multimedia for them became a crutch to avoid use of texts rather than a means of to further expand their knowledge. The authors illustrate through the example of Kadesha, who spends ample time surfing the Web

for pictures of rappers and wrestlers or advertisements for hot new sneakers or Barbie dolls, but ''as image after image flashes by...Kadesha rarely settles on printed text.'' In an after-school enrichment program, Kadesha was encouraged to research a future career, but stopped in frustration after she could not spell ''bakery'' correctly, while her classmates similarly stumbled on ''burger'' and ''pediatrician.''

Conventional wisdom is that students need knowledge of how to search rather than mastery of basic facts. However, for Kadesha and her classmates, ignorance of basic facts restricts their ability to search. One of her classmates, for example, had difficulty searching for the mayor of New York due to lack of understanding as to whether Buffalo was part of New York City or New York state.

My own research (citations temporarily removed for the sake of anonymity) similarly has documented how reading and writing ability and basic cultural literacy strongly mediate students' ability to make use of the Internet to find and use information or create meaningful multimodal content, whether in school or in out-of-school settings. Indeed, the divides allegedly attributed to unequal information literacy or multimedia literacy most frequently have its roots in differential access to basic reading and writing competency and cultural capital (citations temporarily removed for the sake of anonymity).

Unfortunately, many reform advocates have a romantic notion of the empowering potential of learning with new media, without taking into account the crucial role of more foundational forms of literacy and learning for personal and social advancement. In fact, though, the amount of time spent creating multimedia presentations at school has been found to be negatively correlated with students' English Language Arts test scores (O'Dwyer, Russell, Bebell, & Tucker-Seeley, 2005). This is not surprising, given that much multimedia work in US schools consists of producing limited-content PowerPoint presentations (see discussion in Warschauer, Knobel, & Stone, 2004).

None of this negates the necessity of promoting multimedia literacy and information literacy in schools, but approaches need to be found that simultaneously develop diverse students' reading, writing, cultural literacy, and academic literacy, rather than relying on basic drills (see, for example, Becker, 2000; Wenglinsky, 1998), haphazard cutting and pasting from the Internet (Warschauer, Knobel, & Stone, 2004), or production of superficial PowerPoint presentations. Cummins's (2001) framework for academic language learning, emphasizing maximum cognitive engagement, maximum identity investment, and a critical focus on linguistic meaning, form, and use, is particularly suitable for combining new and traditional forms of literacy. Recently, he and co-authors (Brown, Cummins, & Sayers, 2007) have provided detailed examples and discussion of how this framework supports innovative forms of technology-enhanced learning for diverse students. My own research in culturally and linguistically diverse laptop schools provides additional examples of how technology use can help students achieve both new and traditional literacies (citations temporarily removed for the sake of anonymity).

The how paradox: autonomous versus mentored learning

A second element of conventional wisdom about digital learning relates to *how* students learn. Simply put, the belief is that the best forms of digital learning involve

autonomous learning, following the mantra that the teacher must become a *guide on the side* rather than a *sage on the stage*.

Digital media undoubtedly provides greater opportunities for youth to learn autonomously. Elementary school students with laptop computers and high-speed Internet connections have greater information and communication resources at their disposal then any scholar in the world of a half-century ago. And the most elite professionals of the 21st century, the *symbolic analysts* described by Reich (1991), including consultants, analysts, professors, executives, and scientists, must exhibit a high level of independence in their own learning and work. Indeed, even at other levels of the workforce, many employees in today's Post-Fordist economy are expected to operate more autonomously than did the typical worker of a generation ago when highly vertical forms of industrial organization were more prevalent (Gee, Hull, & Lankshear, 1996).

Yet the paradox is that people develop the ability to work autonomously, whether in online or offline realms, only through processes of being instructed or mentored by others. A powerful example of this is seen through a 5-year study of Internet-based learning projects known as *network science* (Feldman, Konold, & Coulter, 2000). These science projects involved teams of children in classrooms throughout the US and the world collecting scientific data and sharing it on the Internet, for example, to measure the acidity of local rainfall or track the migration of birds. In these projects, online information developed by the national or international project organizers provided instructions and supplemental material, and online forums enabled opportunities for long-distance interaction. All in all, network science was seen as a perfect educational environment for Internet-based autonomous learning.

However, the study of these projects by Feldman, Konold, & Coulter (who had been instrumental in setting them up) offered a devastating critique of network science practices. Three main trends were identified. First, students tended to upload data to the Internet without even bothering to download others' data. Secondly, when they did download data, they often had no idea about how to analyze or interpret them in any meaningful way. And third, although the students reported that they enjoyed communicating with other students online, it was found that this interaction was usually about personal and social issues and had very little to do with science.

Some network science projects were successful, but only in cases where strong teacher mentoring and instruction were taking place *inside* the classroom. The readings and instructions provided online were in and of themselves shown to be ineffective in teaching children how to do science. Classrooms that depended principally on these online resources offered little benefit. But in classrooms where there was a very strong in-class component, with students learning how to collect, analyze, interpret, and discuss data before they ever went online, then the Internet-based communication and resources added additional value. In other words, the central feature enabling effective use of Internet-based materials and distance communication was a strong local teacher working closely with students in face-to-face communication.

This study of network science, backed up by studies of other online projects (Warschauer, 2003b), strongly calls into question the notion of the teacher being a guide on the side. Rather, the teacher must be centrally involved, actively instructing and mentoring students, especially at the initial stages of work on a project. Unfocused instruction can leave students rudderless, and this is particularly harmful

to at-risk students, such as those with learning disabilities, limited literacy, and language skills, or insufficient background knowledge. Such students are least able to cope with unstructured environments because such environments place too heavy a cognitive load on the learner (Feldon, 2004; Kalyuga, Ayres, Chandler, & Sweller, 2003).

In summary, the ability to learn autonomously will indeed be critical in the digital future. However, paradoxically, strong mentorship is required for students to achieve this autonomy, while an overemphasis on student independence can leave students floundering.

The where paradox: out-of-school versus in-school learning

The *how* paradox is closely related to the *where* paradox. Autonomous learners can learn anywhere. Particularly using digital media, people of all ages can learn in out-of-school settings like never before, through accessing online information, using educational or edutainment software, participating in online communities, or playing individual or multiplayer games. These powerful forms of out-of-school learning are viewed as making formal education less relevant, especially when schools prove less than fully capable of successfully incorporating new media in instruction (see, e.g., Gee, 2003, 2004).

The paradox here is that, at the same time that new opportunities increase for powerful out-of-school learning, formal education is actually rising rather than falling in its impact on people's lives. For example, whereas in 1975, the average person with an advanced degree earned twice as much as a high-school dropout, by 1999 the same ratio was greater than 3.7. Those entering the workforce with a bachelor's, master's, or professional degree today are expected to earn $1.1 million, $1.5 million, or $3.4 million more, respectively, than a high-school dropout over a 40-year career (Day & Newburger, 2002). A total of 49 out of the 50 highest paying jobs in the US now require a bachelor's degree or higher, with the sole exception being that of air traffic controller (Bureau of Labor Statistics, 2005).

A fascinating example of this paradox is seen in a recent paper by Albright, Purohit, and Walsh (in press) on literacy practices by Chinese immigrant youth in New York. The authors involved the immigrant teenagers in documenting their own out-of-school literacy practices and noted resistance from the some of the youth in recognizing the value of literacies involved with playing games, downloading music, or engaging in other non-academic online activity. Specifically, the students distinguished between those literacy practices most directly related to academic success, which they valued, and those not seen as related, which some saw as a waste of time—a bifurcation that the authors found troubling. In reading the paper, I could not help but note the gap in attitudes between the Chinese immigrant students, who are being socialized to value the types of literacy that they, their families, and community believe will contribute to academic success, and the Columbia University authors of the study, who took a more celebratory approach to all out-of-school literacy practices. The authors undoubtedly show insight in recognizing the broad range of unheralded literacy practices that youth engage in, but the youth themselves appear more keenly aware of what literacy practices are likely to enhance their life opportunities.

Another related example is seen in India, where ''Hole-in-the-Wall'' kiosks provide opportunities for impoverished children to play with computers, albeit without keyboards, educational software, adult mentors, formal community involvement, or even a place to sit down. The designers of the initiative have heralded the Hole-in-the-Wall project as a dramatic breakthrough demonstrating how children can teach themselves basic computer skills (see, e.g., Mitra, 2005; Mitra & Rana, 2001), while some parents raise questions about the project for detracting from student's homework time (see discussion in Warschauer, 2003a, b).

Both of these examples raise the question of what youth get from out-of-school computer use. On the one hand, there is certainly a great deal of learning going on when youth play games or otherwise interact online at home (e.g., Gee, 2003; Steinkuehler, in press). Yet research suggests that how at-home computer use contributes to children's academic development is highly variable, with higher socio-economic-status (SES) learners gaining more from such use than their low-SES counterparts (Attewell & Battle, 1999). There are a number of possible reasons for this, but once again the role of mentors is likely key. Simply put, youth in high-SES families and communities are more likely to have people around, whether parents, siblings, or friends, who can help them use computers in ways that promote literacy and learning, through modeling or mentoring. High-SES families are also more likely to provide quality tools to support learning (e.g., computers that are up to date and easier to use, helpful peripherals such as printers, high-speed Internet connections, and productivity, or educational software). These points, too, suggest the value of formal institutions, such as public schools, in promoting the digital learning of the future. Though the human and physical resources of schools in high-SES and low-SES neighborhoods are unequal, the degree of such inequality pales when compared to that found between high- and low-SES homes.

Conclusions

Andrew Feenberg's (1991) book, *Critical Theory of Technology* discusses two common approaches to understanding technology and social change. A *determinist* approach suggests that technology is all-powerful, bringing about change regardless of circumstances. An *instrumental* approach is based on ''the common sense idea that technologies are 'tools' standing ready to serve the purposes of their users,'' whatever they may be (p. 5). Both of these common approaches fail to account for the crucial interaction between social system, agents, and media that shapes the real impact of technology in people's lives. For example, a determinist approach might suggest that digital learning will in and of itself bring about dramatic positive changes for all, regardless of other social and individual factors. An instrumental approach might similarly suggest that digital learning can be used to magically transform learning, if only implemented correctly.

In contrast, a critical perspective situates media use within real-world power structures and inequalities, and thus views technology as neither a neutral tool nor a determined outcome, but rather as a scene of struggle between different social forces. Their own socio-economic standing, the cultural and social capital within their families, and the social structure of American schools, shapes children's access to and use of digital media in the US. New literacies seldom sweep out old ones, but

instead new and old are woven together in a complex web reflecting evolving social, economic, and political relationships. New technologies do not replace the need for strong human mentorship, but, indeed, amplify the role of such mentorship. And the proliferation of new media, while opening up avenues for learning outside of schools, simultaneously strengthens the role of formal schooling in an increasingly competitive society and economy.

Curricular and pedagogical approaches to educational technology exist that can foster improved digital learning for all. Such approaches emphasize scaffolding in reading, writing, and cultural literacy while providing access to new digital-era literacies; involve strong person guidance and mentorship from teachers and peers; and serve to make links between in-school and out-of-school learning, rather than devaluing either (see examples and discussion in Brown, Cummins, & Sayers, 2007; Warschauer, 2006; Warschauer, Grant, Del Real, & Rousseau, 2004). Such approaches will not magically overcome educational inequity; that is a broader challenge involving much more than good use of computers in schools. But simplistic views of digital learning, which pit new literacies against old, autonomy versus mentorship, or home versus school, will only serve to worsen educational divides.

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