

THE JOSSEY-BASS  
READER ON  
TECHNOLOGY  
AND LEARNING

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*Introduction by*

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## INTRODUCTION

### Beginnings

WHY DOES TECHNOLOGY MATTER for learning? It is worth reflecting on this topic as the reader prepares to launch into a hefty group of chapters on theory and practice concerning key educational issues that relate to learning technologies. In this book, “technologies” refer typically to uses of computing but also Internet telecommunications, in applications as diverse as programming, word processing, games, simulations, multimedia composition, performance assessment, and distance education. But “technologies for learning” has a deeper meaning upon which these more recent historical developments depend.

We may distinguish two senses in which technology and learning are intertwined. The first is thinking *with* technology, the second is thinking *about* technology. The second twist of phrase is crucial for technological literacy and technical education and is the topic of recent standards for student learning. But thinking *with* technology is far more important historically and substantively, for it is in this sense that technology is an instrument of knowing, reason, culture, and humanity itself.

Technologies as instruments of thinking, *cognitive technologies*, are at the heart of the human condition. Before the cognitive revolution in the last half of the 20<sup>th</sup> century, Ernst Cassirer (1944, 1953–1957) and Kenneth Burke (1966), among others, highlighted in influential writings during the first half of the 20<sup>th</sup> century that humans are fundamentally and distinctively symbol-making and symbol-using animals. Fluencies with expressing and interpreting symbolic representations are at the core of what it means to understand subject matter domains, to put knowledge to use in activities. The philosopher Nelson Goodman (1978) talks of humans as “world-making” with their symbol systems, as they create fictional and possible worlds in literature, science, mathematics, and the arts. For example, long before computing, written language and number systems have served as technologies of thinking. By making explicit with inscriptions the traces of verbal and mathematical thinking, written words and numbers preserved cognition for the ages and led to new forms

of activity (such as publishing and commentary) that have had remarkable consequences. The philosopher Ludwig Wittgenstein captured this power of representation aphoristically when he asked, “How do I know what I think until I see what I say?” As Jack Goody (1987), Walter Ong (1982), and David Olson (1996) have highlighted in their accounts of the historical importance of writing systems, an oral argument on paper provides the literate reader with the opportunity to better judge the coherence of that argument than listening to an oration, in which the speaker’s emotive powers may hold sway. Similar arguments apply to the uses of mathematical and logical notation in the formulation and testing of scientific theory. Such systematicity has been taken to new levels by the rigor required in programming computers to execute extraordinarily complex actions, like the tens of millions of lines of code that define today’s computer operating systems, or the circuitry that enables a billion instructions per second in the newest computer chips.

Early in the days of computing, President Roosevelt’s science advisor Vannevar Bush (1945) wrote a seminal essay on imagined future uses of computing to amplify and extend human thinking with new digital renderings of diverse symbolic forms from text to graphics and other media, anticipating the interlinked and globally accessible data records we now know as the World Wide Web. He emphasized how computers could serve to simplify processes for creating documents and other representational forms, invent new means for sharing them with others, and enable powerful search activities. Howard Rheingold’s (1985) book *Tools for Thought* provides an excellent introduction to how computers evolved as cognitive technologies based on the visions of Bush and others, particularly at Douglas Engelbart’s Augmentation Research Center at SRI International in the 1960s with the invention of personal computing, hypermedia, the mouse, real-time text editing, and collaborative computing (Engelbart, 1963; <http://www.bootstrap.org>).

Unlike other waves of technology that were predicted to have important implications for learning and education, such as the radio, the filmstrip, and television, computing provides a *meta-medium*—a representational substrate—in which these previous media forms may be readily assimilated and elaborated in their potential uses and interrelationships (Pea & Gomez, 1992). For example, a digital videoclip of an African savannah can have “hot spots” at key features of interest that, when clicked with a mouse input device, will open up footnote-like expositions of related information. The interactive capabilities of computing make it possible to transform the nature of the relationship between media author and media user, for example, by providing a means for

comes the rule rather than the typical “information delivery” metaphor of previous media. And beyond simply accommodating and extending these previous media, computers have been used to provide fundamentally new representational forms for thinking, including dynamic visualization of large geo-gridded global datasets in the environmental sciences (Edelson, Gordin, & Pea, 1999) and virtual realities for exploring phenomena at nano-level or cosmology-level scales. Children today using LEGO Mindstorm “toys” can program the actions of robots with sensors, which, when first invented in the 1960s, cost millions of dollars, filled a large room, and engaged some of the best minds in artificial intelligence programming.

In short, while cognitive technologies such as writing and mathematical notation have long been influential for thinking and learning and education, computer technologies have *accelerated* this cultural process of invention and the societal appropriation of new representational tools for thinking. Due to the large and growing installed base of multimedia networked computers and the World Wide Web, the time course of these changes continues to contract as new software programs propagate over the Web in a matter of weeks for use by tens of millions of users through web portals like Yahoo and AOL.

New technological systems of representation and communication make possible new forms of activity, discourse, and reflection. The co-evolution of technology systems and social functions thus has an essential relevance to education and learning. If one takes seriously the reasonable conjecture from sociocultural theory that changing what one does changes what one becomes (Pea, 1985), access to and facility with such new representational tools is not only vital in society, but their universal accessibility becomes an issue of empowerment and identity.

With this preamble, and seeing the large issues at stake, we may now turn to how the chapters of this volume provide a window into contemporary issues in technologies, education, and learning.

## Contents

*The Jossey-Bass Reader on Technology and Learning* is made up of twenty-three chapters on a broad range of topics that are intended to provide useful knowledge about theory and practice of key educational issues involving technologies and learning. The focus is very much on K–12 education, with a repeated and appropriate emphasis on the role of teachers and teacher professional development. The chapters are arrayed in three parts: Reports and Standards; Equity, Access, and Literacy; and

Technology and School Change. Many of the chapters contain classics that are repeatedly cited and debated nationally.

### *Reports and Standards*

During the last half of the 1990s, numerous national commissions were convened and reports were developed on information technologies and education. Chapter One, an excerpt from the 1997 PCAST report to the President on using technology to strengthen K–12 education, is a comprehensive, insightful, and influential document in this vein. The wisdom of the recommendations of the PCAST Panel on Educational Technology has been echoed in many federal programs and state initiatives since that time: (1) focus on learning with technology, not about technology; (2) emphasize content and pedagogy, not just hardware; (3) give special attention to professional development; (4) engage in realistic budgeting; (5) ensure equitable, universal access; and (6) initiate a major program of experimental research.

Parallel with this development was a movement toward greater accountability in K–12 educational systems, which sought to find ways to establish standards for learning and teaching. These trends converged in technology-related standard-setting, with several instructive examples provided by ISTE's creation of technology standards for student learning (Chapter Two) and California's new technology standards for teacher credential candidates (Chapter Three). Chapter Four provides insight into how Texas has grappled with developing a long-range plan for technology in education through the year 2010. A RAND Institute report explores the challenges of financing, teacher professional development, and educational software development that accompany learner-centered, technology-intensive schools (Chapter Five). Hank Becker's comprehensive empirical report on Internet use and valuation by 2,250 teachers (Chapter Six) is my favorite research study in this volume, and bears close scrutiny by educators and policymakers for its many lessons. Chapter Seven provides an accessible report on a complex study by ETS on the conditions under which educational technology is effective for learning mathematics.

### *Equity, Access, and Literacy*

Since computers were first broadly introduced into U.S. schools in the early 1980s, policy issues of equity and access have been fundamental concerns. The development and implementation of state and district

technology plans, as well as the allocation of billions of dollars of Title I funding and E-Rate funding, have turned on policy positions and legislation concerning these issues. These are extraordinarily important, highly charged, and analytically nuanced issues worth careful study, dialogue, and reflection.

Many comparative topics come together in this complex array: socioeconomic level, race, ethnicity, gender, disabilities of different types, geographical region. Furthermore, different assumptions about what specifically is at issue come into play that keep changing the nature of the discourse on these topics. For example, numbers of computers and Internet connections are more readily measurable than equitable access to integral, ongoing, quality uses of computing and telecommunications to improve learning and teaching for all. And yet the effectiveness with which educators use “access” (in the readily measurable sense) turns on the specific conditions of the learning environments—including teacher preparedness, curriculum, assessment, and school climate—in which the technology is available. Even if two schools have equal computer access, they may dramatically vary in the specific applications used (for example, drill-and-practice CAI versus tool use) and in the social context in which they are used (such as labs versus classrooms or solo versus small groups). New measures of “Internet connectivity access” are playing out similarly, with the percentage of schools and classrooms connected as the new quantitative variables of concern. Now more nuanced questions are arising about what activities teachers and students are engaged in once they have such Internet access (Chapter Six). Not all access is created equal for learning.

The chapters in this part of the reader explore these issues in some detail. Tapscott writes that “the most widely feared prediction surrounding the digital revolution is that it will splinter society into a race of information haves and have-nots, knowers and know-nots, doers and do-nots—a digital divide” (Chapter Eight). Tapscott broadens the dialogue beyond access per se to the consequences of inequitable availability of services, technology fluency, and opportunities to learn. Nonetheless, I recommend Cisler’s essay (2000) on the many problems of the phrase “digital divide” for those whose experience is “on the other side” and for whom other issues may be more critical (such as health care, education, and quality of life).

Will there always be computers and connectivity of diverse capabilities, where more money will buy enhanced features, speed, and other perks? Of course, and business or other sectors will be able to afford to pay for it in ways that schools and homes inevitably will not. Will this fact preserve

existing inequities? Or amplify existing inequities? Or create new inequities? These empirical and policy issues deserve ongoing scrutiny and principled action.

Other chapters in this section ask whether there are gender differences in patterns of K–12 technology use (Chapter Nine), and in what ways girl games could more suitably reflect their “technological desires,” which differ from those of boys (Chapter Ten). Several chapters tackle the opportunities of supporting students with learning disabilities in learning science (Chapter Thirteen) and literacy skills (Chapter Fourteen) with computers.

Highlighting the Union City, New Jersey, model of distributed learning, Chris Dede (Chapter Eleven) challenges school administrators to think differently about how to invest in technology-based systemic reform in ways that are affordable, generalizable, and sustainable. Berman and Tinker describe the benefits for hundreds of students from dozens of high schools taking netcourses in a cooperatively organized Virtual High School, such as significant expansion of curricular offerings (Chapter Twelve).

This section closes with Gilster’s helpful portrayal of “digital literacy” (Chapter Fifteen), his account of the new aspects of literacy in an Internet age, including search skills, critical thinking about on-line information sources, and mastery of the rhetoric of hyperlinking in making or critically evaluating an argument.

### *Technology and School Change*

Whenever I have taught courses on learning and technology, I have found it effective to organize readings around controversies. Controversies engage and motivate students, and can help them to understand the sources and consequences of different perspectives on key issues. Controversies also often bring out the best writing from authors. On the topic of technology and school change, I have found that utopian and dystopian writings on the promises (or perils) of technology use for learning provoke the kind of critical reading and reflection I seek in such controversy-centered discussions. And several of the selections in this section light up the extremes of the utopian continuum in my experience: Seymour Papert’s *Mindstorms* chapter on “Computers and Computer Cultures” (Chapter Sixteen) and dystopian selections from Neil Postman’s *End of Education* (Chapter Twenty) and Tyack and Cuban’s *Tinkering Toward Utopia* (Chapter Seventeen). Mapping the claims, counterclaims, and assump-



tions of these works can provide a powerful exercise for thinking deeply about these subjects.

Somewhere in the middle of this utopian continuum are several chapters from the broadly researched Apple Classroom of Tomorrow (ACOT) Project, a ten-year effort that led to many insights about stages relating instruction to technology in technology-rich classrooms (Chapters Eighteen and Nineteen). There will be findings here to delight the utopian, feed the dystopian, and serve the practical reader as ACOT's critical "technoromanticism"—hopeful of powerful results, open to seeing challenges and problems, but empowered to seek improvements through new iterations on design and support—becomes apparent. In a rich description of another technology-intensive school, Gooden's profile of P.S. 125, Ralph Bunche School, in Central Harlem (Chapter Twenty-One) helps us understand why many visitors have been compelled to learn from their experience as a "computer mini-school" integrating technology across the grade-school curriculum.

The two remaining chapters depict some important developments from the learning sciences research community on how school change for deeper learning can build on appropriate uses of technology. Scardamalia and Bereiter (Chapter Twenty-Two) convey a vision of a knowledge-building society comprising interlinked networks from different communities, including schools, universities, businesses, and cultural institutions. They seek to involve "people in the actual work of a society engaged in constructing, using, and improving knowledge." As part of Canada's Tele-Learning Research Network, they are pursuing this dream using their Computer Supported Intentional Learning Environment (CSILE) software, and they distinguish the Knowledge Society model from other models for educational networking.

Finally, Sheingold and Frederiksen (Chapter Twenty-Three) describe how technology is being used to support innovative performance assessments that model challenging learning activities for students instead of the traditional closed-response or short-answer paper-and-pencil test. Such assessments employ student work portfolios, can require collaborative work among students, and seek to provide what they call "transparency" in making clear what good work looks like and by what criteria it will be judged. Technologies can serve the multiple roles in this vision of supporting students' project work, creating replayable copies of their performances, providing libraries of examples and interpretive tools, expanding the community of judges, and publishing best works for recognizing learner accomplishments.

## Looking to the Future

As one of the primary generative functions of a society, education is an exceptionally vital enterprise. The goals of education—what a society seeks to achieve through its activities—essentially involve *renewal*. In this sense, education is both a conserving enterprise, looking to the past and learning from it, and a futuristic enterprise, second-guessing the needs of the possible worlds ahead and readying learners to adapt to them creatively and successfully. No wonder the issues around technology and education evoke such vital passions in advocates and detractors, educators and policymakers.

Defined by both Moore's Law on processor speed and cost and Metcalfe's Law on the power of network effects, technology change is proceeding at an exponential pace, and outstripping the capacity of society and social institutions, including schools, to deal with its ramifications. What is education to make of these transformations under way? How should educators, education policymakers, parents, and the related marketplace of publishers engage with these changes?

This volume provides an indispensable resource for learning about many of the key issues, lively concerns, and recurrent controversies in K-12 education using learning technologies. These readings are fertile with materials for making sense of these changes, in providing "concepts and controversies to think with." Nonetheless, this volume provides a snapshot of learning technologies and education that is inevitably several years old.

But beyond this book, and on the World Wide Web itself, educators, policymakers, researchers, parents, and others need to become more connected in an ongoing way with the pulse of transformations in technologies as they bear on learning and education. How is this achievable? There is unfortunately no good central resource today for keeping apace of developments. A reasonable place to begin is the regularly updated Web site of the U.S. Department of Education, which seeks to provide a service to these audiences with regular analyses of new developments in learning and technology. But for imagining the future of education, nothing substitutes for personal experience and observations of new learning environments in action, so when you have the opportunity to see something new, take advantage of it. Seek out vivid examples that are held up as models of innovation, and ask hard questions about the issues this book has helped you think about.

What will we be looking back to when the next volume like this appears? I see several likely new dimensions of major change. One is toward

itous or pervasive access to Web-based computing. For many global citizens, their first access to the Internet will be via smart cell phones, information appliances like e-books, and interactive cable television services. The growing convergence of the industries of computing, telecommunications, publishing, video, and entertainment will assure new opportunities for learning and education, and new dilemmas and challenges around equity, access, and digital literacies. Another issue will be the dot.com'ing of education, as virtual universities and virtual schools take shape and new public-private partnerships are tried out and found to be working or wanting.

I also expect a next edition will document a real and growing erosion of boundaries in the contexts for learning with computer and communications technologies. Schools are changing too, but the nodes of distributed learning networks are lighting up throughout other settings and institutions. Over half of U.S. homes have multimedia computers that are connected to the Internet, and nearly all public libraries are now connected. TV time is being supplanted by Internet use time among our youth. Community centers, clubhouses, and churches are also increasingly common places of computer-based learning, and as computers like the Palm Pilot become more commonplace, children are learning with computers in the streets and neighborhoods, in cars and buses. What we do not know is whether and how these pervasive technologies for learning will make new forms of education, and what new problems they will raise. But the adventures are in the making. Participate!

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