Contents

CHAPTER 1

Education and Technology

A person hears only what they understand.
—Johann Wolfgang von Goethe

Why has education failed technology? Why aren't all children being educated to levels of learning that exceed their aptitudes? Moreover, why is this not happening at scale? Overall, the field of education has failed to meet these challenges by inadequately capturing the benefits of Information and Communications Technology (ICT). A series of faulty assumptions and simplified realities has hijacked ICT practices, policies, and product development. These contentions are supported by research, dismantles the foundation on which ICT in education currently rests. We use an A to B paradigm shift metaphor (Weston & Brooks, 2008) to reconceptualize the role of ICT. In it, A is the current educational paradigm and B is an alternate one in which ICT shifts from ancillary and supplementary to indispensable in resolving the essential classroom and school challenge—*genuine learning for all students*. Shifts of thought, theory, and action from the A paradigm to the B alternative frame the new role for ICT. *E*dge is the name we give technology that plays this new role by extending, connecting, and developing the capacities of all educational stakeholders in pursuit of genuine learning for all students. The first letter of *e*dge is italicized to denote the educational focus of the technology. In this book, we present a framework for helping stakeholders take up the challenge, attain scale, and sustain their efforts.

THE PROBLEM OF ICT USE IN EDUCATION

To date, the most stunning feature of the narrative about ICT in education is the minimal overall impact that ICT has exerted on the way teachers teach and students learn (Herrington & Kervin, 2007; Jaillet, 2004). Students and teachers, armed with ICT, were expected by technology advocates to progress along a trajectory of aspiration for profound change in instruction and learning to a genuine widespread transformation of educational practice (Johnstone, 2003, 2006). That trajectory was supposed to lead to dramatic improvements in teaching and learning for all students at scale. What actually happened is a different story, one with many unanswered questions (Lei & Zhao, 2006) and an incomplete (Moje, 2009), often methodologically problematic (Barrow & Rouse, 2005; Heck, 2004), and frequently self-serving literature (Cuban, 2001). How did this happen?

Twenty-five years ago, personal computers (Moreau, 1984) and the Internet (Berners-Lee & Fischetti, 1999) emerged as a distinct advantage for many countries (McChesney, Wood & Foster, 1998), their economies (Bruk, 1961), businesses (Cortada, 2004), and citizenry (Turner, 2006). The unprecedented successes of ICT in those quarters fostered a wide-eyed belief that ICT could improve the way almost everything was done (Cetron & Davies, 1997). A resulting and broadly held view was that since ICT helped transform factories, homes, offices, and stores, it could also help transform schools and classrooms (DiSessa, 2000; Pflaum, 2004). Not surprisingly, the one common element of all recommendations for improving education worldwide during this period was to expand access to ICT (Glennan & Melmad, 1996; Johnson & Maddux, 2003; Shaw, 1998).

Around 1985, the typical classroom did not have a computer (NCES, 2008), Internet access (Becker, 1999), or a teacher who wanted either (Fisher, Dwyer & Yocam, 1996). In the succeeding decade, an unprecedented infusion of ICT in schools and classrooms occurred (Rathbun & West, 2003). For instance, in the United States, one computer for every 125 students was the norm in 1985; 10 years later, the norm was one computer for every nine students. In 2008, the ratio was one computer per three students (NCES, 2008). Similar infusions and drastic changes in ratios have occurred throughout the world (Law, Pelgrum, & Plomp, 2008).

Three circumstances drove the increase in access to ICT in education. One of these was persistent doubt about the efficacy of current educational approaches for educating all students (Clinchy, 1996; Dixon, 1994; Finn, 1991; Lieberman, 1993). In the United States, *A Nation at Risk* epitomized the doubtful-about-education sentiment when it reported, "The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (NCEE, 1983, p. 1). Reports from Australia (Dawkins, 1988), New Zealand (Picot, 1988), and the United Kingdom (Department of Education and Science, 1985) voiced similar sentiments. Fueled by such doubts—yet without any clarity or agreement about how best to resolve those doubts—public support for improving schools skyrocketed (Public Agenda, 1995, 1999, 2003).

A second circumstance that drove increased access to ICT was a perceived need to prepare students for the inevitability of workplaces where ICT skills would be essential for knowledge-economy workers (Marshall & Tucker, 1992). An American report gave voice to this point, saying, "No nation has produced a highly qualified technical workforce without first providing its workers with a strong general education" (CSAW, 1990, p. 3). Reports from other countries made the same point (Dahlman & Aubert, 2001; Kinsella & McBrierty, 1998; Miller, 1996; Sheehan, 1995; Winslow & Bramer, 1994).

Finally, increased access to ICT resulted from the ever-escalating arrival of new technologies: personal computers (Raum, 2008), software applications (Campuzano, Dynarski, Agodini, and Rall, 2009), the Internet (Tuomi, 2002), computer games (Barab, Gresalfi, & Arici, 2009), interactive white boards (Leask & Pachler, 2005), smart phones (Kolb, 2008), and so on. Slick ad campaigns promoted the latest iteration of each technology (King, 1995), along with focus-group-tested messages (Till & Heckler, 2009) and cool imagery (Wedel & Pieters, 2008). For many consumers, the promise of the next "new thing" (Lewis, 2000) and the difference it was expected to make in the lives of its users was seductive (Nusselder, 2009). Students who had the new technological gadgets at home often did not have them at school, leading one report to say, "Today's education system faces irrelevance unless we bridge the gap between how students live and how they learn" (Partnership for 21st Century Skills, 2002, p. 4).

The dominant discourse of the day held that (a) children with access to ICT would learn to use ICT in masterful ways, (b) such access and mastery would change the way children learned other things, and (c) this would serve as a lever for changing education (Negroponte, 1995; Papert, 1993a, 1993b; Tapscott, 1998; Thornburg, 1995). The discourse birthed an agenda for improving education, one that conflated *access* to ICT with *effect* on learning in an unsubstantiated cause-effect relationship.

That agenda claimed that the way to improve education was to increase the amount of access that students and teachers had to ICT (CEO Forum, 1997). Students and teachers having greater access to ICT became a deeply entrenched concept in the educational zeitgeist (Johnson & Maddux, 2003). The responsibilities of ICT professionals often subsumed those of building administrators, curriculum leaders, and classroom instructors (Hall, 2008). The prime metric of success became the amount of access to ICT, as reflected in the number of network ports, network bandwidth, software licenses, and the all-important computer-to-user ratio (Rathbun & West, 2003). Student-to-computer ratios became proxies for educational quality (CEO Forum, 1997). The mantra of technology advocates became how many, how much, and how often (Didsbury, 2003). The battle cry of the true believers became "If only I had the next new thing" (Lewis, 2000).

The combination of persistent circumstances driving the access to ICT agenda and a professional literature that was emerging in the field of education fueled a steady buzz about increasing technology in classrooms and schools. What the buzz sorely lacked, however, were experimental studies showing the broad-based effects of increased access to ICT on teaching and student learning at scale and the sources of those effects. Hoping such effects would be forthcoming, technology advocates moved their access agenda forward without evidence.

In the absence of rigorous research findings, the advent of 1:1 computing initiatives tested the belief that access to ICT would yield instructional, learning, and achievement effects (Lei, Conway, & Zhao, 2008). The 1:1 initiatives—often high-profile, policy-driven, and well-funded—represented a logical extension of the access argument that, for nearly 2 decades, had asserted that ICT would deliver on its promise of educational effects when student-to-computer ratios reached low levels (MacMillan, 2006). The actual attainment of low ratios in the form of 1:1 computing initiatives constituted an endgame for the access to ICT agenda. Problem Example 1.1 describes the advent of the State of Maine Learning Technology Initiative (MLTI) providing every grade 7 and 8 student and teacher with a laptop computer.

Problem Example 1.1: Maine Steps Up

In 2000, due to an unanticipated revenue spike, the state of Maine, despite an economic downturn, had a $70 million surplus to spend (Nemitz, 2000). Angus King, the state's popular second-term governor, seized the opportunity and proposed a program "to ensure a basic level of access to technology, the Internet and training and learning opportunities for all Maine public schools, students and teachers, at the middle and high school levels" (McCarthy & Breen, 2001, p. 39). King believed "giving kids computers will change their future and Maine's" by "putting Maine on the technological map," improving the state's competitiveness with a better technology-rich education system (King, 2000). King said, "There is no question that jobs in the future . . . all will involve computers and Internet literacy . . . and those individuals and societies that are the most competent and at ease with this technology will be the most successful" (King, 2000). King's vision was heavily influenced by the extensive interactions that he had had with Seymour Papert (Muir, 2005), founder of the Media Lab at MIT (www.media.mit.edu). Papert believed that if children were given access to computers, the way they learned would change and subsequently transform teaching, schooling, and society for the better (Curtis, 2003). King used Papert's notions to undergird MLTI (Williams, 2000). As King had hoped, by "being first," MLTI positioned Maine as a world leader for providing students and teachers with access to laptop computers (Curtis, 2003). Such leadership has garnered invitations for state officials to explain their program to a far-ranging audience, including the Organization for Economic Cooperation and Development and the governments of Australia, China, Ireland, and Scotland, among others (Waters, 2009).

MLTI exemplifies the access agenda and the three circumstances that drove it. Explicit in King's arguments for MLTI are doubts about the efficacy of prior efforts in the state and elsewhere to improve education. Equally explicit is an aspiration for the initiative to "transform Maine into the premier state for utilizing technology in kindergarten to grade 12 education in order to prepare students for a future economy that will rely heavily on technology and innovation" (McCarthy & Breen, 2001, p. vi). Further, the initiative coincided with the arrival of affordable laptop computers that provided users with wireless access to the Internet (Raum, 2008).

MLTI and other similar initiatives lacked components for assessing how the increased access to ICT they provided would pay educational dividends (Cuban, 2001). Penuel, Kirn, Michalchik, Lewis, Means, and Murphy (2001) conducted a review of the literature that found few studies of sufficient rigor and quality for determining the effects of 1:1 computing on student learning. Another review found only four studies that met their quasi- or experimental standards of rigor and that addressed achievement effects. Of those four, all studied single schools and three only addressed effects on technological literacy, not on academic learning or achievement (Peneul, 2006). Despite the lack of educational research and demonstration of effect at scale, a number of jurisdictions continued to pursue large-scale high access to ICT deployments (Bain & Weston, 2009).

With no clear picture of how to create genuine educational advantage, initiatives to increase access to ICT played out predictably (Weston & Bain, 2010). For example, an evaluation of MLTI reported that only 60% of participating teachers used their laptop computer weekly to (a) conduct research for lesson plans, (b) develop instructional materials, or (c) provide classroom instruction (Silvernail, 2007). In a study of the Texas Technology Immersion Pilot (TxTIP), a 1:1 initiative comparable to MLTI, Shapley, Sheehan, Sturges, Caranikas-Walker, Huntsberger, and Maloney (2009) reported "students' access to and use of laptops for learning within and outside of school continued to fall short of expectations in the fourth year" (p. 88). As for classes that regularly access computers, what does the data indicate? An evaluation of the 1:1 program at Quaker Valley School District (QVSD) in Leetsdale, Pennsylvania, reported that access and use varied significantly across subjects and grade levels (Kerr, Pane, & Barney, 2003). A study of the Denver School of Science and Technology (DSST) reported that only 38% of the 9th- and 10th-grade teachers and 58% of the 11th- and 12th-grade teachers even asked their students to access laptops daily for academic work in class or at home (Zucker & Hug, 2007).

A 4-year study of the 1:1 laptop program at the Henrico County Public Schools in Henrico, Virginia, found only three-quarters of the students who were eligible to receive a laptop from the school district opted to do so (Mann, 2008). Similarly, when MLTI, which had provided every 7th- and 8th-grader with a laptop computer for 8 years, allowed districts to use funds to provide laptop computers to students in grades 9 through 12, only half of the districts opted to do so (Ash, 2009).

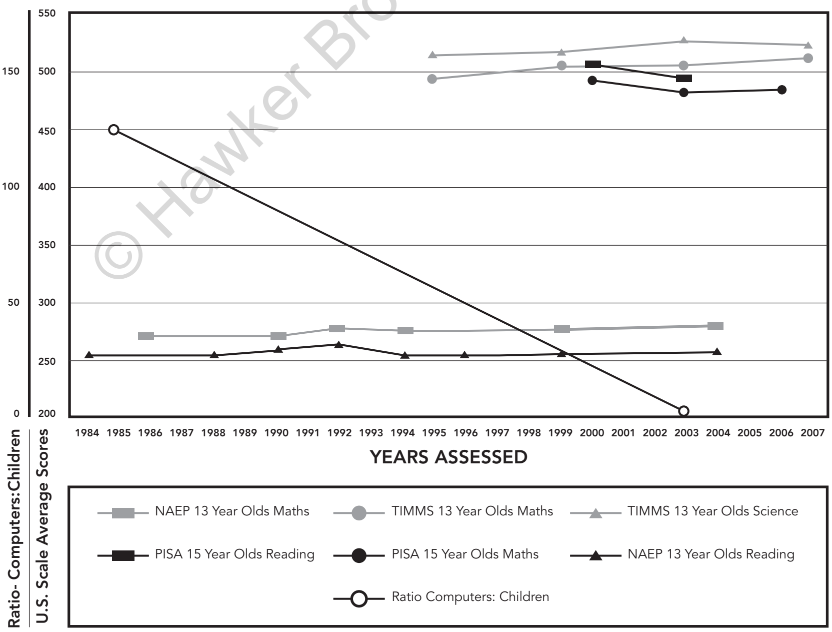
These sorts of findings are the norm, not the exception, and they are not restricted to 1:1 computer initiatives. Studies of educational settings consistently indicate that even when access to ICT is high, the use of ICT is low (Cuban, Kirkpatrick, & Peck, 2001), the type of use varies markedly (Lathouwers, de Moor, &

Didden, 2009), and its effect on student achievement remains, at best, inconclusive (Barton & Coley, 2009; Wainer, Dwyer, Dutra, Covic, Magalhaes, Ferreira, et al., 2008). Moreover, if exceptional findings are claimed by researchers, the design and methodology of the studies do not possess the control over key variables to confidently attribute found positive effects to the ICT (Fouts, 2000).

These disconcerting findings stimulated research and practice on getting to scale with ICT (Dede, Honan, & Peters, 2005). However, at this time, and when viewed summatively, research and evaluation reports of 1:1 indicate quite clearly that at scale, the ever-increasing access to ICT does not co-vary with higher scores on standardized achievement tests at local, state, national, and international levels. Figure 1.1 presents student computer ratios and performance on key international tests from1984 through 2007, showing that there was no bump in student performance (Gonzalez, 2004; Martin, 2004; Martin, Mullis, & Chrostowski, 2004) to correspond with students and teachers having much greater access to ICT in their classrooms, schools, districts, and homes (NCES, 2008; OECD, 2008; UNESCO, 2008).

The lack of covariance between increased access to ICT and test scores should have raised pedagogical concerns about possible conceptual flaws in the access to ICT agenda. Technology advocates, however, did not take up the tough ques-

Figure 1.1. NAEP, PISA, TIMSS, and Computers Per Student



tions that the lack of covariance raised. In part, because the three circumstances—doubts about the prevailing education system, the need for technologically literate workers, and the continual arrival of new technology—that originally fueled the access to ICT agenda in education remained firmly in place. Worldwide, the annual expenditure for educational technology is now over $19 billion, of which $8.9 billion annually goes toward providing ICT in American classrooms (NCES, 2008; OECD, 2008; UNESCO, 2008).

In sum, the findings of limited use and weak outcomes run counter to the lofty aspirations of ICT having a transformative scalable effects on teaching, learning, and achievement. The ascent of 1:1 computing in Maine and elsewhere provide practical examples of what happens when access to ICT is conflated with effects on learning at scale. Clearly, giving every child and teacher a computer will not produce the expected transformational and wide-scale effects that supporters of the access agenda expected.

FAULTY ASSUMPTIONS ABOUT ICT AND SCHOOLS

Why has the access to ICT agenda failed to demonstrate attributable, scalable, and sustainable learning effects in education? The answer is embarrassingly simple. It involves five faulty assumptions that underlie the access to ICT agenda: (a) children with access to ICT learn to use ICT in masterful ways, then apply that masterful use to their other learning; (b) teachers spontaneously change their teaching practices when they gain access to ICT; (c) teaching teachers how to use ICT redresses poor learning results of students; (d) improved access to ICT improves the quality of ICT use; and (e) improved access and use increases student achievement. In the following section, we contest each assumption, using the available empirical and evaluative evidence.

Assumption 1: Children with access to ICT learn to use it in masterful ways, then apply that masterful use to their other learning. Despite rhetoric among ICT advocates about a digital generation (Tapscott, 1998) of students forever altered by technology, it is clear that children lead parallel lives in relation to their use of ICT. Although ICT use (e.g., Facebook, MySpace, Twitter, YouTube) has dramatically and often spontaneously changed the social lives of children, accounts of ICT use in schools show no comparable sweeping change in the ways students use ICT for education. Moreover, ICT mastery has not dramatically and spontaneously transferred from the broader home-use dimension of children's lives to the education dimension (Clotfelter, Ladd, & Vigdor, 2008). With some exceptions, most students simply use educational technology in ways that automate the traditional forms and function of schooling such as taking attendance, reporting grades, and managing course materials (Golon, 2008).