Foreword

Information and Communication Technologies in Education

In *Learning with Personal Computers* Alfred Bork (1987) promised a revolution in schooling due to the increasing availability of microcomputers. Twenty-five years later, on average, almost every person in economically developed countries is now blessed with one or more computers. However, the revolution that Bork imagined does not yet show definite signs of materializing soon. Upon reflection, we can say that most of us were, in the 1980s, perhaps a bit too optimistic about what information and communications technologies (ICT) could do to promote and improve education. Many are now trying to discern what added value ICT can contribute to the education enterprise, in addition to increasing the convenience of instruction and to motivating students to engage with activities that all too often are trivial. Skeptics have expressed doubts about the utility of technology in the classroom; some argue in favor of maintaining the traditional model of instruction that is exclusively reliant on teachers, print-based textbooks, and blackboards (perhaps a dry-erase whiteboard for the more progressive Luddites).

Increasing numbers of educators and scholars recognize that no technology can automatically benefit education in any significant way. Many realize that it is not about the technology after all—it is about what is done with technology to promote students' learning. When a new technology emerges, what really counts is the educational potential or learning opportunities provided to students, which are often obscured by the novelty of an innovative device. Scholars and teachers have the responsibility to discover and then to reveal those learning opportunities along with the associated potential to transform educational practice.

There is a growing and significant body of research that explores in detail and in depth the impact of new technologies on students' learning. Much of this new research is covered in this *Handbook*, which reviews research about the ways in which technology can significantly impact learning and create profound interactions between and among learners, teachers, and resources. This work is only a small part of a larger picture of ICT in the twenty-first century. The work reviewed in this *Handbook* provides one small glimpse of the revolution that is unfolding (albeit much later than Bork imagined).

There are many kinds of technologies used in present-day schools, some of which were developed specifically for the school context. Examples of commonly used educational technologies include classroom response systems, search engines, word processors, projectors, and interactive whiteboards. All of these and other technologies serve a wide variety of other non-school-based purposes. Most of these technologies were not invented for learning or teaching; however, their application to non-school settings, for which many of them were developed, is different from their use in school settings. For example, consider the word processor. Word processing facilitates the productive work of business by creating the correspondence necessary to conduct affairs. Specific features of the word processor were designed to make such business use both easy and effective. However, when one places a word processor in a classroom context, the use and purpose are not the same at all. Preparing teachers to help primary and secondary school students to make effective use of a word processor is quite different from

training an administrator to help clerks and office assistants make effective use of the word processor in a particular office setting.

How shall we treat different uses of the same technology? How can we realize the educational potential of technologies taken for granted in the workplace? A definition of educational technology might emphasize the significant pedagogical or learning uses that technology serves; such a definition acknowledges the principle that uses and training for use should fit the specific purpose. This *Handbook* focuses on these educational uses and purposes.

Of the millions of teachers, educators, and scholars around the world, only a small number are engaged in research concerning the use of ICT in education. One result of this trend is a contrast between developers and educators who may ultimately use the new technologies. Developers create and laud the features of emerging devices and innovative technologies, while educators who want to teach with those technologies may become confused and frustrated with new technologies. It is rare that the two groups exchange views and experiences, and learn from each other. For many teachers, new educational technologies and facilities can cause some discomfort or even feel threatening due to their lack of adequate preparation in effective pedagogical use and integration into teaching and learning. There has been much research on the application of technology in education, as is evident in this *Handbook*. The chapter on TPACK (technological pedagogical and content knowledge) is a case in point. There is almost always initial resistance to a new technology, and the cost effectiveness of new technologies remains controversial (see Chapter 9 in this *Handbook*). Suggestions by technologists for educational application can be general and too distant from actual classroom use; thus these recommendations all too often fall short of the actual needs of teachers. As a result, too many teachers fail to embrace and use the new technologies in constructive ways with their own students.

An encouraging indication of change is this fourth edition of the *Handbook*, which includes a new section that is subject-specific and explores technologies in different disciplines. The first and last sections of the *Handbook* also offer a range of perspectives on technology integration that are aimed at practical use and widespread application.

Educational Communication Technology (ICT for Education)

Educational communication technology is a very dynamic area of research and application; new products can become out of date within a matter of months. The popular press often disseminates stories that dwell on the novelty rather than on the practicality of a new technology. Decision makers and those responsible for procurement are presented with a dilemma regarding acquisition of newer, forward-looking but riskier technologies as opposed to the reliable, older but more mature technologies. As is shown by the many chapters pertaining to emerging technologies, innovations ranging from cloud-based technologies to tablet applications are undoubtedly worthy of our attention due to their educational potential. However, the maturity of a technology and its connection and compatibility with existing technologies and expertise present significant challenges. When venturing to deploy a new technology, there are usually many unknown factors and some risk (Spector, 2012). When a new technology is profoundly different from previous technologies, or when the application of the technology dramatically changes practices, there are bound to be a multitude of unexpected problems.

In addition to the constant change of educational technologies, there is another challenge—namely differences between theory and practice, along with differences between the natural sciences and the humanities. A new educational technology that works well in support of learning physics may not work as well in support of learning philosophy, and vice versa. Moreover, the relevant learning theories and paradigms might be quite different in different areas of application. Effective technology integration requires sensitivity to the potential of various technologies as well as a profound understanding of specific disciplines and associated pedagogical practices. In too many cases, educators adopt without hesitation a new technology

only to see it fail in practical use. As a community of professional practitioners, we are slowly coming to the realization that new tools need to be tested in the real and somewhat uncontrolled and chaotic circumstances in which everyday learning and instruction occur. Educational technology researchers and developers should carefully observe, assess, and identify the adaptability and success of the new technologies in light of actual teaching and learning; furthermore, all must keep in mind the opportunities, the benefits, the constraints, and the risks. Compulsive and hasty adoption of a new technology will very likely result in another cycle of sweet expectation followed by bitter disappointment.

Another important issue is the boundary between the two academic disciplines of educational technology and computer science. They are distinct from each other; however, a typical program of educational technology often offers many courses that are also found in a computer science curriculum. A closer scrutiny, however, reveals that educational technology courses are quite different from apparently similar courses in a computer science department. A recent IEEE-sponsored report recommends a very specific, cross-disciplinary curriculum for advanced learning technologists that could, if adopted, reduce the tensions between computer science and educational technology as separate and competing disciplines (Hartley, Kinshuk, Koper, Okamoto, & Spector, 2010). As things now stand, educational technology graduates find themselves at a disadvantage in the job market in comparison with a computer science graduate who appears equally well qualified. This state of affairs affects the growth of the discipline adversely. To avoid this waste of resources and dashed expectations, the discipline of educational technology needs to enhance its own reputation as a separate and credible area of expertise, which is what Hartley and colleagues (2010) encourage. That is to say, advanced learning technology graduates need to command abilities and skills that neither computer scientists nor education degree holders possess. However, they should be able to communicate and collaborate with both computer scientists and professional educators. In short, there is a need for a careful scrutiny of the field and a re-delineation of its academic scope and theoretical systems, along the lines of the Hartley et al. (2010) report, which identified the following domains of competence for educational technologists:

1. Knowledge competence—includes those competences concerned with demonstrating knowledge and understanding of learning theories, of different types of advanced learning technologies, technology-based pedagogies, and associated research and development.
2. Process competence—focuses on skills in making effective use of tools and technologies to promote learning in the twenty-first century; a variety of tools ranging from those which support virtual learning environments to those which pertain to simulation and gaming are mentioned.
3. Application process—concerns the application of advanced learning technologies in practice and actual educational settings, including the full range of life-cycle issues from analysis and planning to implementation and evaluation.
4. Personal and social competence—emphasizes the need to support and develop social and collaboration skills while developing autonomous and independent learning skills vital to lifelong learning in the information age.
5. Innovative and creative competence—recognizes that technologies will continue to change and that there is a need to be flexible and creative in making effective use of new technologies; becoming effective change agents within the education system is an important competence domain for instructional technologists and information scientists.

Growth of the Discipline

Since its establishment, the discipline of educational technology has been through several paradigm shifts and grown remarkably. Informed by theories and concepts from many other disciplines, including education, computer science, psychology, cognitive science, and communications, educational technology has acquired academic respectability. However, some

have expressed doubts about the field, raising the issue of educational technology borrowing from other disciplines without creating a coherent and unique discipline of its own. In rebuttal, educational technologists argue that adoption and integration are not merely effortless borrowing tasks; rather, technology integration is a dynamic, innovative, and productive process—a *transdisciplinary* process, as Hideaki Koizumi (2004) put it. According to that Japanese scholar, educational neuroscience is a product of such a transdisciplinary process. The growth of the discipline of educational technology has been a product of a similar transdisciplinary process (see Richey, Klein, & Tracey, 2010). It is through this transdisciplinary process that the discipline of educational technology has made many unique contributions to both theory and practice. The work on cognitive load theory is a recent example of the transdisciplinary nature of educational technology (see, for example, van Merriënboer & Ayres, 2005).

There is a need to reconstruct the theoretical framework for educational technology, and there is an associated need to reconceptualize its academic scope and purpose. Supporting learners and the learning process with appropriate technologies is the fundamental belief of educational technology. Therefore, the design, development and application of technologies capable of such a role should be within the sphere of this discipline, where learning and technology intersect, and numerous other disciplines mingle in creative ways. In this theater of interaction and hybridization, there is both chemistry and synergy, and participants from diverse academic backgrounds and researchers of various segments of educational technology cooperate productively. However, due to their differences in training, skills, and values, these experts view technologies with different lens and may study problems from different perspectives and interest themselves in different dimensions of the same problem. How can they work together optimally?

No doubt, their cooperation needs to be based on the common ground designated by the shared ultimate goal of assisting learning. More is needed; however, mechanisms should be created and deployed to merge horizons and promote synergy among experts from different disciplines, thus removing academic biases, increasing their appreciation of each other's paradigms and interests, and locating the possible points for connection and cooperation. The fourth edition of this AECT (Association for Educational Communications and Technology) *Handbook* represents a creative realization of such an effort.

Global Differences

In addition to overcoming the aforementioned problems, we, as professional practitioners, need to do more if we want the desired educational technology revolution to unfold on a large, global scale. We have yet to scale the formidable barriers created by global differences, which are seen in both economic development as well as in social-cultural interests and habits.

First, economic inequalities have caused disparities in educational investment between countries and regions. Even within one country, especially some large and diverse ones, there can also be seen the full spectrum of differences in educational investment and accrued educational benefits. Underdeveloped countries and regions may acquire educational equipment and facilities by virtue of inter-governmental assistance, NGO (non-governmental organizations) donations and aid, and so on, addressing part of the significant physical digital divide. Nevertheless, these facilities are not usually updated and upgraded in a regular and timely manner as they would be in developed economies. More disconcerting is the gap in human resources and expertise—the non-physical digital divide. Technical expertise that is pedagogically informed is in short supply, making the Hartley et al. (2010) report even more pertinent.

Second, schools and their administration are often constrained as much as enabled by their particular social and cultural settings, which can differ radically because of racial, ethnic, or religious distinctions. Differences in local traditions, community characteristics, and special academic/educational interest can also be determining factors in enabling or inhibiting effective use of educational technology. Consequently there exists a wide range of teaching beliefs;

major disagreements about pedagogy and educational technology may even be found among teachers employed by the same school. Such discrepancies in culture and values can result in conflicting attitudes towards technology. In extreme cases, an educational technology may become an object of distrust or even ridicule. Compared with the hardware gap and infrastructure challenges, social and cultural inequalities are more subtle and difficult to manage.

In spite of those global differences, multinational organizations, especially network technology businesses and other information technology leaders are promoting their new educational technologies and relevant products. One result of this trend is that new technologies are confronted with a huge array of economic, social, cultural, and educational settings. As a result, the performance of the same educational technology can vary from one context to another; we have such failures to replicate findings in the research literature. This phenomenon is not unlike the legendary orange in an old Chinese saying: Grown south of the Huai River, it is sweet; grown north of the river, it tastes bitter and sour. If educational technology researchers and practitioners do not take into account local situations and customize technologies and educational practices accordingly, the promised revolution in schooling due to emerging educational technologies will never take place.

To sum up, there are significant challenges to the effective pedagogical use of technologies and development of new educational technologies based on the following four conclusions:

1. Technological advancement is an endless enterprise, but technological improvement does not necessarily translate into proportionate improvements in educational effect and impact on students' learning.
2. In different economic, social, and cultural environments, the same technology may perform differently.
3. The accelerated development in technology makes more acute the shortage of instructor knowledge about the effective use of technologies; good teachers who are well prepared are always in short supply.
4. Extensive and intensive involvement of teachers and pedagogically knowledgeable instructional designers is essential for progress in educational technology. There is little that educational technology can contribute to improve formal or informal student learning without this critical involvement.

We look forward to the day when a large number of elementary and secondary school teachers become readers and/or authors of the future editions of this *Handbook*; that will be a positive sign that educational technology is penetrating deep into classrooms and adding the synergy to launch the long-awaited revolution. Therefore, let us focus our efforts and work collaboratively across multiple disciplines so that this day may come sooner rather than later. Together we can make a difference.

Shanghai, China — Youqun Ren

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