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PART ONE

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International Handbook of Information Technology in Primary and Secondary Education

Part One

Editors

Joke Voogt
University of Twente, the Netherlands

Gerald Knezek
University of North Texas, USA

Springer

Editors
Joke Voogt
University of Twente
Enschede, the Netherlands
J.M.voogt@utwente.nl

Gerald Knezek
University of North Texas
Denton TX, USA
gknezek@jove.acs.unt.edu

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PREFACE

Since the introduction of the computer into education in the 1960s its potential for primary and secondary education has been recognized by many – researchers, policymakers and practitioners. In the International Handbook of Information Technology in Primary and Secondary Education we seek to provide researchers, policymakers and practitioners with an integrated overview of the field.

There is a vast amount of research on Information Technology (IT) in primary and secondary education. In this Handbook we aim to synthesize this research from a broad international perspective. The Handbook has 76 chapters to which 136 authors have contributed. The authors are from 23 different countries spanning five continents.

Consensus on the focus and structure of the Handbook was reached among 15 section editors and the external advisors during a joint meeting at the headquarters of the United Nations Educational Scientific and Cultural Organization (UNESCO) in Paris. The two main themes addressed in the Handbook were determined to be (1) the potential of IT to improve primary and secondary education, and (2) the support that is required to successfully implement IT in educational practice. These two themes are addressed in the 11 sections of the Handbook. Each section addresses the relevant theme(s) from a specific point-of-view.

For each section the editors summarize 5–6 chapters in a two-page overview and introduce their topic in an introductory chapter. In a parallel fashion, in the introductory chapter to this Handbook, the editors-in-chief discuss how the terminology used in the field evolved, explain the focus and structure of the Handbook and discuss intriguing trends that emerged across sections.

The editors-in-chief express their gratitude to the section editors and the authors for their valuable and interesting contributions to the Handbook. External advisors, Prof. Dr. Tjeerd Plomp (the Netherlands), Prof. Dr. Takashi Sakamoto (Japan) and Dr. Fred Litto (Brasil), contributed to the Handbook from the initial stages and helped strengthen the Handbook through critical, but constructive feedback. We particularly thank each of them for their wisdom and support throughout the process.

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Joke Voogt
University of Twente, Enschede, the Netherlands
Gerald Knezek
University of North Texas, Denton, USA

IT IN PRIMARY AND SECONDARY EDUCATION: EMERGING ISSUES

Joke Voogt
University of Twente, Enschede, the Netherlands
Gerald Knezek
University of North Texas, Denton, TX, USA

Introduction

This chapter introduces the main themes addressed in the International Handbook of Information Technology in Primary and Secondary Education. The challenges of information technology (IT) for education have been studied for about 40 years. Due to rapid technological developments the field is continuously changing in intriguing ways. There is a vast amount of research on IT in primary and secondary education, yet most of it is scattered, and a synthesis of the research from a broad international perspective has not yet been achieved. This Handbook aims to provide an overview of major directions of research in the field for researchers, policymakers and practitioners.

Since the beginning of research in this domain the implementation of the potential of IT in educational practice has been a recurring theme. In this Handbook the potential of IT, as well as its implementation in educational practice, is being examined from several perspectives. In this introductory chapter we first address the evolving terminology used in the field. Then we present the focus of the Handbook and finally we discuss common issues emerging across sections.

Evolving Terminology on Computer Use in Education

Since the introduction of the computer into education in the 1960s its potential for primary and secondary education has been recognized by many – researchers, policymakers and practitioners. The development of computer technology from processing information to also supporting communication augmented its potential for education. Owing to the enormous impact of these technologies, our society is in transition towards an information or knowledge society (e.g. Anderson, 2008). The term computer technology has been replaced by information and communication technology (ICT) (mostly used in Europe) or information technology (IT) or technology (in North America). Information and communication technology refers to all technologies

used for processing information and communicating. Because of the integration of computers with communication systems, including audio and video technology, also terms such as multimedia or digital media are being used (Anderson, 2008).

It is generally accepted (Lai, 2008) that IT as such does not support learning. Only when IT is well integrated into a learning environment does the full potential of IT for learning become realized. In the early days of computer use in education these "learning environments" were narrowly defined and referred to the computer software that supports certain types of learning. The term computer-assisted instruction (CAI) was adopted, indicating either a type of software programme for education or a type of instructional process. Steinberg (1991), for example, emphasized CAI as computer-presented instruction that is individualized, interactive and guided.

CAI fits well in a behaviourist approach to education, where students have to learn facts, concepts and theories and be able to apply and illustrate concepts and acquire basic procedural skills (Dede, 2008). CAI was conceptualized as an assistant for teachers by taking over some of their tasks. CAI software has the capacity to provide feedback to the learners and to keep track of their performance. A major benefit of software for education in this category is that it became possible to individualize instruction. The first CAI programmes were introduced in education when large main frame computers were still in use. With the introduction of the personal computer (PC) in the early 1980s in schools (in North America and Western Europe) expectations of CAI to improve teaching and learning were high. The introduction of the PC in schools also triggered the development of a much broader use of IT in education. As a consequence, also other terms in addition to CAI evolved, such as computer-based instruction, computer-based education and computer-assisted learning. These terms were sometimes used in ways similar to CAI, but often also reflected a broader conceptualization of different kinds of computer use in education. Watson (1994), for instance, used the term computer-assisted learning for the whole variety of ways in which the computer is used in education.

The rather confusing terminology is partly due to rapid technological changes. By the twenty-first century, computer technology has become mobile, personal and networked; stand alone desktop PCs are being replaced by laptops, personal digital assistants or mobile phones. These developments also triggered the evolution of new terms, to indicate the use of computers – or more generally Information Technology (IT) – in education.

More recently, new terms evolved to indicate computer use in education, such as E-learning (electronic learning), M-learning (mobile learning), Web-based education or learning, multimedia learning and ubiquitous learning. The term E-learning is used for learning that is facilitated or delivered through the use of computer or communications technologies, Internet, CD-ROM and/or television. Similar to E-learning, the term M-learning emphasizes the facilitation of learning through the use of mobile computer technology, such as mobile phones, personal digital assistants and laptops. If the World Wide Web in particular is used to deliver instruction also the term Web-based instruction or Web-based education or learning is also used. The term multimedia learning is often used when a mix of audio and video technologies is integrated in the learning environment. The most recent term that is emerging for

computer use in education is ubiquitous learning. Ubiquitous learning comes from ubiquitous computing, the ever-presence of computer technology in the environment. Ubiquitous learning refers to the potential of computer technology to make learning possible at any time and at any place. These more recent terms refer to broader conceptualizations of computer uses in education.

IT not only has the potential to enhance teaching and learning processes, it may also change the concept of education. Education is no longer limited to taking place in one physical environment at a certain time during the day. Rather, education can become available at any time and at any place. In this introductory chapter we will use the term information technology. However, based on the backgrounds of the scholars in this Handbook, as well as their perspectives on IT in education, the various terms, briefly introduced here, can be found throughout the Handbook.

Focus of the Handbook

Ten Brummelhuis and Kuiper (2008) in this Handbook distinguish four key elements that affect learning processes directly: the learner, the teacher, the curriculum and the infrastructure. Learners and teachers are the key players in the learning process. The curriculum determines the content and focus of the learning process, and the infrastructure deals with the physical (and/or virtual) learning environment, including the learning materials. Teaching and learning processes take place within an immediate social environment and simultaneously within a wider social context. The school, as the immediate environment, provides the organizational structure for the learning process. In the wider social context, the society, perspectives on education are discussed and educational policies are being developed and implemented, which affect how teaching and learning take place and are organized. Figure 1 presents a graphical representation

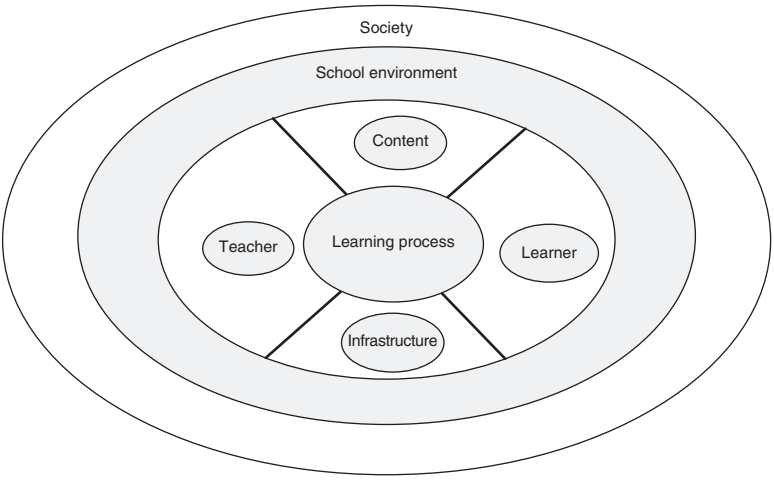

Fig. 1 The learning process: key elements and influencing factors (adapted from Plomp, Ten Brummelhuis and Rapmund, 1996; Voogt and Odenthal, 1997)

of the key elements, as well as the influencing factors affecting the learning process. This figure serves as a conceptual framework to discuss the focus of this Handbook.

The Potential of IT to Improve Education

The first theme of this Handbook addresses the *potential* of IT to improve education. Often two main perspectives are distinguished for IT in primary and secondary education: IT as an object in education, affecting learning content and goals, and IT as a medium to enhance teaching and learning processes (see also Voogt, 2008). The first view affects the curriculum, while the second role primarily affects the physical (and virtual) infrastructure for learning. From the perspective of IT as an object, improving primary and secondary education focuses on how learning content and goals should be attuned to the needs of society. From the perspective of IT as a medium, improving primary and secondary education concentrates on facilitating teaching and learning with IT. Although these perspectives can be distinguished separately, in research and policy debates they are often intertwined.

Within this first theme we aim to synthesize research on the design and impact of IT-based environments for student learning. Much research being carried out in this domain is especially focused on how to design IT-rich learning environments. These environments are based on up-to-date knowledge of fostering learning processes. In the Handbook we address this line of research in Section 3 (IT and the learning process), Section 7 (IT and distance learning in K-12 education) and Section 9 (Emerging technologies for education).

In Section 3 (IT and the learning process), research on some major educational software applications is presented and synthesized from the perspective of how these applications contribute to interactive learning, collaborative learning, inquiry learning and meta-cognitive learning.

Since the use of communication technologies became widespread, education has been attracted by the potential of IT to go beyond classroom walls. In Section 7 (IT and distance learning in K-12 education) the potential of IT for distance learning in primary and secondary education has been explored with particular attention paid to the virtual high school (or open school), the global classroom and the potential of distance learning for teachers.

Technology increasingly becomes part of our daily life. Section 9 (Emerging technologies for education) explores the potential of ubiquitous computing environments. Particularly, mobile technologies and Web 2.0 environments appear to have the potential to enhance education. Issues related to the design of learning environments using these emerging technologies are also addressed.

Infrastructure and Support Required to Implement IT in Education

The second theme addressed in this Handbook focuses on the *support* that needs to be in place to successfully *implement* IT into daily practices in primary and secondary education. This theme deals with the barriers and opportunities for IT implementation. As shown in Figure 1, factors at several levels may affect how IT is being used in learning processes. First, IT use is being influenced by the perceptions, attitudes

and competencies of teachers and learners as the key players in the learning process. Curriculum content and goals may also affect how IT is used, and the available infrastructure either provides opportunities or restricts IT use in educational practice. In the immediate environment school leadership as well the way a school is organized may promote or hinder IT implementation. At the local, state or national level IT-in-education policies guide the way IT is used in teaching and learning.

In this Handbook research, on the implementation of IT in primary and secondary education is discussed from several perspectives. First the perspectives of the learner and the teacher are addressed in Section 4 (IT attitudes and competencies) and Section 5 (Pedagogical innovations, and teacher learning). The curriculum perspective is addressed in Section 2 (IT and curriculum processes), while in Section 6 (IT in schools) research on IT leadership in schools is presented. The influence of educational policy as the wider environment of teaching and learning processes is discussed in Section 8 (IT and the digital divide) and Section 11 (International and regional programmes and policies).

Since the early days of IT use in education, attitudes towards computers and IT competencies of learners (and later teachers and school leaders) have been in the domain of interest of researchers and practitioners, because they appeared to be an important factor in the decision to use IT in educational practice. Section 4 (IT attitudes and competencies) describes research in this domain. Utilizing the potential of IT in educational practice often implies that the role of the teacher has to change. The teacher not only has to learn IT basic knowledge and skills, but more importantly, has to learn appropriate pedagogical skills to be able to integrate IT in a sound way into educational practice. Section 5 (Pedagogical innovations, and teacher learning) addresses the implications of the use of IT in educational practice for the teacher and for teacher professional development.

The intentions for use of IT in the curriculum have not always been realized. Section 2 (IT and curriculum processes) discusses how IT might influence content, aims, organization and assessment of the curriculum. The section discusses these implications of IT in specific domains, and in cross-curricular settings.

An important condition for successful use of IT in schools is the support of school leadership in the implementation of IT. Section 6 (IT in schools) discusses IT leadership in schools and the activities that IT leaders could carry out to facilitate IT integration schoolwide.

Educational policy may also contribute to the implementation of IT in education. In Section 11 (International and regional programmes and policies) international and regional policies for IT in education are analysed, with the intention of identifying the contributions of particular policies to optimizing the impact of IT in education. From a global policy perspective the gap between those who have access to IT and those who have not, often referred to as the "digital divide", is a growing concern. Strategies for realizing digital equity are addressed in Section 8 (IT and the digital divide).

A few additional topics are addressed in the Handbook. First of all the role of education in the information society is addressed (Section 1, Education in the information society). This section offers a rationale for the other sections. Particularly, attention

is paid to new generic competencies that are needed for citizens to be prepared for the information and knowledge society, the role IT could play to acquire those competencies and how these new competencies affect curriculum and teaching and learning processes. Finally, in Section 10 (Researching IT in education) various aims for researching IT in education and the opportunities and limitations of several research approaches are discussed.

In the remaining part of this introduction chapter we briefly address major themes that emerged across the different sections of the Handbook.

Emerging Issues Across Sections

Different Views on the Role of IT in Education

The potential of IT to improve primary and secondary education can be discussed from several – sometimes competing – perspectives. In this Handbook two major rationales for the integration of IT can be found. First is the generally accepted belief that the society is changing from an industrial towards an information or knowledge society. This change implies that students need to be prepared for jobs that might not yet exist. Being able to use IT is seen as one of the core competencies for the twenty-first century. Anderson (2008) and Mioduser, Nachmias and Forkosh-Baruch (2008) elaborate on twenty-first century competencies. The second rationale is the belief that IT has the potential to enhance teaching and learning processes. Dede (2008) in this Handbook shows that IT applications have been developed on many different theories of learning. Although it is believed that IT applications particularly have great potential to facilitate the realization of constructivist approaches to teaching and learning, Dede argues that for some learning tasks simple CAI can be very effective.

Ten Brummelhuis and Kuiper (2008) offer a slightly different perspective. They distinguish between two instructional paradigms driving the integration of IT in education: the belief that IT has the potential to change education (see, for instance, Sections 7 and 9) vs. the belief that IT may contribute to addressing educational needs. Ten Brummelhuis and Kuiper position these two perspectives as opposing each other. For the belief that IT is considered a catalyst for educational change they use the term "technology push". For the belief that IT has to follow educational needs they introduce the term "educational pull". Table 1 is an effort to summarize what these different perspectives imply for the focus of technology use in education, as well as the kind of technology used.

Studying the Impact of IT on Student Learning

The ever-changing technology environment makes effective research into IT in education difficult, complex and challenging. This is particularly true for studying the impact for IT on student learning (Cox, 2008). The high expectations about the potential of IT for student learning could not easily be confirmed by convincing evidence

Table 1 Perspectives for technology use in education

	Information society	Enhancing teaching and learning processes
Technology push		
Focus	Creation of learning environments to encourage flexible learning	Enhancing existing (behaviourist/cognitivist) teaching and learning practices
Examples of IT applications	Content management systems, online learning environments, virtual high schools, mobile technologies	Commercially available IT-enhanced curriculum materials (e-books, websites added to textbooks)
Educational pull		
Focus	The use of technology to master twenty-first-century skills	Enhancing in-depth learning; in constructivist learning environments
Examples of IT applications	General application software; GPS systems, Internet; e-mail	Specific IT applications for education (simulations, games), knowledge-sharing environments, augmented reality

from research. Problems related to studying the impact of IT on student learning can be summarized as follows.

The kind of student outcomes. Initially it was expected that IT could enhance student achievement in traditional learning goals, as could be established by standardized tests. However, many IT applications also aimed at contributing to conceptual understanding of difficult concepts and the mastery of higher order cognitive skills such as problem-solving, which are different from traditional learning goals and could not easily be determined with standardized achievement tests. In addition, room was asked to pay attention in primary and secondary education to twenty-first century competencies next to traditional learning goals.

New indicators are needed. From the perspective of policymakers, higher scores on standardized tests attributed to the use of IT are a relatively easy and reliable way of determining the success of IT in education. However, more sophisticated IT applications contribute to other learning goals. From this perspective, standardized tests are not always a valid measure of the impact of IT on student learning. Small-scale studies about the impact of specific IT applications have developed their own tests and assessments for determining effects, but those findings could hardly be generalized. Increasingly, evidence about the impact of IT on student performance in the so-called twenty-first-century competencies becomes available in the form of self-report data. Although these data are considered an important source of information, they are not accepted as clear evidence of student performance. To be able to study the effect of IT on performance in more complex cognitive skills, efforts are needed in the development of "standardized" performance assessments.

Nature of research. To study the impact of IT on student learning is not an easy job. Experimental (or quasi-experimental) research designs are appropriate for studying the potential of specific IT applications under controlled conditions. However, it is not easy to transfer findings from experimental research designs to the reality of the classroom. Other research designs and methodologies are needed to take into account the complexity of the classroom, such as mixed methods approaches and design research. In addition, studies researching the impact of IT on student learning also require a careful specification of the IT application involved. In many large-scale studies IT is used as a container concept, which in reality consists of many different IT applications.

Despite the complex nature of studying the impact of IT in education, evidence on the impact of IT on student learning is slowly growing. Several contributions in the Handbook report about the major findings so far. Liao and Hao (2008) provide a comprehensive overview of findings from meta-analysis carried out between 1986 and 2006 in which they reviewed studies that compared IT-enhanced instruction and IT-enhanced distance education with traditional classroom instruction. The overall effect sizes on cognitive achievement, not taking into account specific IT application(s), domains or target groups, appeared small but in favor of computer use in education. A more detailed analysis of studies included in their review showed that IT-enhanced instruction has positive effects on achievement of language-disordered and cognitively disabled students. Liao and Hao also found that IT-enhanced instruction designed by research groups have greater effects on student achievement than commercial IT products.

Results on student achievement are reported for language arts, mathematics, science and twenty-first-century skills. Most convincing evidence for the effects of IT is related to student learning in Language arts (see also Voogt, 2008). The evidence with regard to student learning in math and science education seems less convincing (Voogt, 2008; Webb, 2008). Research focusing on student learning of twenty-first-century skills is scarce, and partly based on self-report measures. However, results so far indicate that more research is needed to be able to better understand how specific IT applications contribute to student achievement in these domains.

IT as Core or Complementary Technology

Collis and Moonen (2001) introduced the terms core and complementary technology. For IT to become a core technology the major activities of the teaching and learning process need to be based on it. To date, this particularly seemed to be realized in online learning contexts, but not in the dominant way of schooling in classrooms around the world. Complementary technologies in schools are often more specific than IT applications that offer a technology-based solution for a pedagogical problem. Collis and Moonen argue that IT can only become successfully integrated when IT has become a core technology for education, comparable to what the blackboard and the text book used to be. The use of complementary technologies in education is strongly connected to pedagogical approaches adopted (see also Dede, 2008); that is why, according to Moonen (2008), it is much easier

to have policies for IT integration accepted for core technologies than for complementary technologies.

IT as Core Technology: The Success of the Virtual High School

Since the use of communication technologies has become widespread, education has been attracted by the potential of IT to go beyond classroom walls to provide learning opportunities at any time and at any place. A relatively new phenomenon in secondary education is the virtual high school or open school. Contrary to the relatively pessimistic views about the time needed to transform education and the role of IT in such transformation (e.g. Moonen, 2008; Voogt, 2008), the rapid increase of virtual high schools, particularly in the USA, is a success story in the history of IT in education (Roblyer, 2008). The goal of the virtual high school is to contribute to digital equity by providing learning possibilities for those in remote areas. Research has shown that the most successful students in the virtual high school in the USA are those who most capable of regulating their own learning. These students are successful in any learning environment. The discussion remains whether education in the virtual high school also will transform pedagogical practices. Some researchers (Nikolov and Nikolova, 2008; Butcher and Wilson-Strydom, 2008) argue that virtual schooling might consolidate behaviourist approaches to teaching and learning. Roblyer (2008), on the contrary, foresees a change because the virtual high school provides learning opportunities at any time and at any place.

IT as Complementary Technology: IT-Supported Learning Environments

To realize the potential of IT for learning, IT needs to be well embedded in a learning environment. The term "learning environment" is no longer narrowly defined, as in the early days of CAI, but covers a broader concept. It comprises people (teacher, students), technology, materials, classroom layout (or the virtual classroom) and the environment (Lai, 2008). In the domain of IT-supported learning environments, some environments have been well designed and studied for more than 15 years. Knowledge Forum (Scardamalia and Bereiter, 2003) is a well-known example of an IT-supported learning environment in which students are supported in knowledge creation in many domains. The work of Linn and colleagues (e.g. Linn, Clark and Slotta, 2003) in the domain of science education (e.g. The Web-Integrated Science Environment) focuses on concept learning through inquiry and collaboration. Both examples provide an infrastructure for collaboration between students and between students and their teacher and provide a variety of scaffolds to facilitate collaboration (Arvaja, Häkkinen and Kankarantaara, 2008), knowledge building (Chan and van Aalst, 2008) and meta-cognition (Lin and Sullivan, 2008). These are typical examples of complementary technology. The design and research of these "classics" demonstrate the added values of IT for enhancing teaching and learning processes, and also contributed to a better understanding of teaching and learning. It is unfortunate that despite their long history, they have only found their way to a very limited number of innovative teachers and did not become part of main stream education.

Core and Complementary Technology: Best Practices on IT Use

In comparison to the well-designed and researched IT-supported learning environments described earlier, schools and teachers themselves develop educational practices in which they make use of IT.

Increasingly, these educational practices are studied as innovative or best practices. Many best practice studies on IT use in primary and secondary education have been conducted with the aim of understanding the practice and its implementation conditions. In this Handbook several authors (see e.g. Voogt, 2008; Nachmias, Mioduser and Forkosh-Baruch, 2008) refer to the Second Information Technology in Education Studies (SITES) as a worldwide series of studies (Pelgrum and Anderson, 1999; Kozma, 2003; Law, Pelgrum and Plomp, 2008), paying attention to innovative pedagogical use of IT in education. The SITES studies indicate that increasingly schools and teachers use the basic possibilities of IT in innovative pedagogical contexts to be able to pay attention to the so-called twenty-first-century competencies. Compared to the classics described earlier, these examples do not exploit the full potential of IT. Instead they make particular use of the basic features of technology: communication and information handling. The use of IT in these best practices can often be typified as core (e.g. used as major information resource) and complementary (addressing pedagogical needs) educational resources.

Teacher Learning and IT Leadership

It is widely recognized that using IT for education also implies that teacher's pedagogical practices need to change. Teacher learning, in preservice and inservice settings, is needed to support teachers in changing their pedagogical approach and to learn how IT can be used to facilitate the new pedagogical approach. Research from Knezek and Christensen (2008) has shown that teachers' use of IT is affected by will (attitudes towards IT), skill (IT competencies) and access to IT tools. Teacher IT competency is not limited to basic IT knowledge and skills. A competent teacher is able to blend subject matter knowledge with appropriate pedagogy and IT knowledge and skills. The term technological pedagogical content knowledge (TPCK) (Hinostroza, Labbé, López and Post, 2008; Law, 2008) is used to emphasize the interaction between these three domains. To guide teacher learning in IT integration, standards for teachers (e.g. Thomas and Knezek, 2008), as well as benchmarks for teacher education programmes (Kirschner, Wubbels and Brekelmans, 2008), have been formulated. Law (2008) argues that TPCK is not enough for IT integration, but that teachers' disposition towards educational change is also important.

It is not only teachers who need to adopt IT and integrate it into a new pedagogical approach. Rather, organizational structures and contexts need to be in place to allow teachers to apply new pedagogical approaches. Davis (2008) argues that a shared school perspective on the integration of IT is needed in order to allow teachers to integrate IT in their educational practice. The importance of IT leadership is recognized by many. IT leadership needs to focus on vision building for IT integration, providing facilities for teachers to develop a vision on why and how to integrate IT into

education, and in organizing support. According to Dexter (2008), a team approach is needed to arrange for IT leadership in schools. Riel and Becker (2008) argue that leadership should be a focus of attention in the preparation of every teacher. IT leadership from this perspective is not only an organizational issue, but also a challenge for the individual teacher. According to Riel and Becker, schools need to develop forms of distributed expertise of teacher leadership to be able to cope with the integration that technology requires.

Towards Digital Equity in IT for Education: The Potential of One-to-One Access

In less than a decade (between 1997 and 2006), the access to computers in schools has improved markedly (Law, Pelgrum and Plomp, 2008). The findings from PISA 2003 (Ainley, Enger and Searle, 2008) also show that the majority of students across countries participating in the PISA study have access to a computer at school, and a slightly smaller percentage of these students have access to computer at home. Hence, in developed countries access to IT does not seem to be an issue in discussions about computer uses in education. However, general figures about access to computers are only partially informative with respect to how computers are used in educational practice. As Ainley, Enger and Searle (2008) make clear, contexts for IT access and use differ among countries. Norris and Soloway (2008) argue that, despite the improved IT infrastructure, computers are still scarce resources. They show that even in many US classrooms teachers have limited access to computer laboratories or have only very few computers available in their classrooms. In such circumstances, one may not expect teachers to integrate IT into teaching and learning activities. Norris and Soloway (2008) argue that to make use of the full potential of technology in education, one-to-one access to technology is a condition sine qua non. The rapid development of low-cost mobile computing devices makes it possible that one-to-one access can indeed be realized in education.

The emergence of low-cost mobile computing devices also contributes to access to technology on a global scale. With the widespread use of cell phones throughout the world (Brown, 2008), as well as initiatives such as the One Laptop per Child Project (OLPC) from MIT, there is a real possibility that access will no longer be a problem for countries with fewer resources (Norris and Soloway, 2008). Although important, increased access to hardware and connectivity is only one of the strategies needed to increase digital equity. Resta and Laferrière (2008) propose five strategies that contribute to digital equity: (1) access to hardware, software and connectivity; (2) provision of content in local languages; (3) qualified educators; (4) quality research to enhance learning with IT and (5) access to content creation. Particularly, the availability of content in local languages and access to content creation seem to be of paramount importance to strengthen designated groups with technology. The importance of content is described by Roy Chen, Cherian and Tuiono (2008), who show how IT can be used to document cultural and historical artefacts of native Americans. In this way, IT may even strengthen minority groups in their struggle to survive within the majority society.

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