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TRADITIONAL AND EMERGING IT APPLICATIONS FOR LEARNING

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Introduction

The introduction of information technologies (ITs) in education has been identified strongly with a variety of applications over the years. Computers, Internet, educational software, laptops and PDAs are concepts largely used in education as technological icons to show to what extent schools are in line with modern life. However, these technologies are often considered fads but also they show the tip of the iceberg in educational issues. In this chapter, the different sides of this iceberg will be analysed to understand more comprehensively, why and how IT applications are used for learning.

"General Background: IT in Education" section presents a general background of the introduction of IT in education, examining the rationale for the introduction of IT in educational systems, particularly in levels K-12. This sets up the scenario in which emerging and traditional technologies are actually being used in schools for learning. "Potential Impacts of IT" section presents the range of possible impacts of IT in students, which helps to understand the expectations that can be drawn on the use of these technologies.

"Factors Affecting the Use of IT for Learning" section presents a range of possible choices of IT applications derived from the combination of the context of use, the possible technologies to select and the instructional moment in which it could be used. Also, it presents examples of emerging applications of IT in schools that

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illustrate some particular choices of these applications and some of the trends of emerging technologies that are being researched. Finally, "Trends in Emerging Technologies and Learning" section discusses the main trends and possible development pathways of the use of IT for teaching and learning.

General Background: IT in Education

The introduction and use of ITs in education are a worldwide phenomenon, including developed and developing countries. The main arguments in which this international trend is sustained at a policy level can be summarized as:

1. IT is an essential "life skill" in the same way as literacy and numeracy.
2. IT is an opportunity for economic development and a requirement for employability.
3. IT is a tool for educational management.
4. IT is a tool that can improve teaching and learning.

(see Organisation for Economic Co-operation and Development – OECD, 2001).

The first two groups of arguments are related to the possible socio-economic benefits of "mastering IT". Although the exact definition/quantification of these impacts is still a matter of debate (see for example, proposals and discussions about the economic benefit of IT in OECD, 2003), there is a generalized consensus that there are benefits and that IT does have an impact on human development. Moreover, one of the UN Millennium Development Goals (http://www.un.org) explicitly asks to "make available the benefits of new technologies – especially information and communications technologies".

Regarding the use of IT as a tool for educational management, there are a growing number of arguments that support the idea of improving education using these tools to improve management-related tasks (see for example, Becta, 2006). Related to this, there is also the concept of using IT as an "instrument" that helps to bring about change and innovation in schools (Fullan, 2007). In fact, this concept has changed through time, first from considering IT as a Trojan Horse (Olson, 2000) then as a catalyst (McDonald and Ingvarson, 1997), and then as a lever – a tool that must be applied purposefully to a task to be of value – (Venezky, 2002), and lately, based on an ecological perspective, as "invasions of exotic species" (Zhao and Frank, 2003). These different categories illustrate the evolution of the role that IT plays in educational innovation, but more importantly show the prevalence of the search for an answer about the role of IT in the process of educational innovation.

Finally, the argument of considering IT as a tool for improving teaching and learning is still an arena for debate (see for example, Balanskat et al., 2006). The main arguments are that:

- The use of IT in teaching and learning can improve students' outcomes. This argument is still used either through explicit reference in policy design documents (McMillan Culp et al., 2003) or implicitly used while reporting the progress of national IT in education policies. For example, the British Educational Communications and

Technology Agency (BECTA) reported in its annual review of the IT in education national strategy that "there is a growing body of evidence indicating that IT use has a positive, if small, impact on learner attainment and other outcomes" (Becta, 2006, p. 44). Several studies have tried to find a positive correlation between high levels of students' achievements and good practice with IT. Among them, some qualitative studies have tried to identify the conditions and definition of good practices with IT (Kozma, 2003b; Venezky, 2002) and other quantitative studies have tried to show a correlation between the use of IT and higher achievement, while some others have combined both methods (Harrison et al., 2002). In general, results of these studies did not show clear evidence that helped to sustain this argument. In this respect, as McFarlane et al. (2000) point out, "the problem is analogous to that of asking whether books are having an impact on learning: books are a medium for transmitting information, they cover a vast range of content, structure and genres, they can be used in an infinite variety of ways. It is therefore extraordinarily difficult to make generalised statements about their impact on learning" (p. 9). Despite the present debate on the actual effectiveness of IT as an aid to improve students' learning achievement, it must be realized that there is widespread interest and a definite need to find evidence of the impact of IT on students' attainment.

- The use of IT is only one element in what must be a coordinated approach for improving curriculum, pedagogy, assessment, teacher development and other aspects of the schools' culture. This argument alleviates the expectation of a causal relationship between the use of IT and improvement in learning outcomes, arguing that it enables key conditions for learning (OECD, 2001; Roschelle et al., 2000).
- IT enables a new scenario for teaching and learning. Based on the opportunities offered by IT, authors promoting this argument advocate more radical changes in the way children learn and teachers teach, this is, to move from "traditional" pedagogical practices to more learner-centric, "constructivist" learning models (Dede, 2008), active engagement, frequent interaction and feedback and others (Roschelle et al., 2000). The important issue in this case "is not the availability and affordability of sophisticated IT, but the ways this technology enables powerful learning situations that aid students in extracting meaning out of complexity. New forms of representation (e.g. interactive models that utilize visualization and other means of making abstractions tangible and sensory) make possible a broader, more powerful repertoire of pedagogical strategies" (Dede, 2000, p. 299).
- The proliferation of IT in society calls for a new curriculum. In this case, the argument is based on the assumption that IT both underlines a *need* for curriculum change and affords the *means* whereby the desired change could be achieved (OECD, 2001). In this argument, authors claim that the knowledge society is demanding new skills that are not yet considered in the traditional curriculum, such as knowledge building (Scardamalia and Bereiter, 2006), capacity for change (Roschelle et al., 2000) and lifelong learning skills (Voogt and Pelgrum, 2005). See Anderson (2008) for an extended discussion of this argument.
- IT as a tool for learning. This argument, although not often used, places IT as simple resources that complement students' learning. In doing so, it relieves the pressure on the expected transformational capacity of IT.

The co-existence, and periodic emergence, of different perspectives about the role, benefits and problems of the use of IT in education, generates an almost permanent state of debate around these issues and does not leave enough time to settle down arguments and produce foundational ideas (Dillon, 2004). This special characteristic of this research area can be explained, because:

- Technology evolves/changes too rapidly; therefore, there are always "new technologies" that entail new promises about impact in students' learning, renewing expectations and possibilities. For example, multimedia educational software (1980) was replaced by integrated learning systems (early 1990), that were replaced by Web systems (late 1990), which in turn were replaced by learning objects (2002), which are now being replaced by software to be used in portable devices (2004) and classroom applications, such as smart boards (2005), wearable technologies (2006), etc.
- Technology is very often used as "flag ship" by educational policy makers and politicians. Therefore, newly installed political administrations usually define new IT-related goals and propose the use of "new technologies", which in turn shifts researchers' interest (or funding possibilities) so as to investigate these new proposals.

Given this scenario, it is difficult to keep the focus of the discussion and to elaborate conclusions that can be sustained in time, since once some conclusion is met, the technological scenario has changed, and a new discussion starts. All in all, IT continues producing the expectation that it will transform and revolutionize teaching and learning processes and the idea that this technology better prepares students and teachers for a "knowledge-based" society (Anderson, 2008). These assumptions are directly related to the potential impacts of IT that will be presented in the next section of this chapter.

Potential Impacts of IT

This section describes the current discussion about the possible areas of impact of IT in education reported in the literature. To be able to focus the discussion, from this section onwards, we will focus on the relationship of IT and students' learning. Because of clarity, it does not consider other areas in which IT has shown impact such as teachers' professional development and motivation, school management, schools' enrolment, image, etc.

Students' Achievement

From a general perspective, the research on the impact of IT in student achievement has not been able to provide conclusive statements about positive or negative effects (see discussions in Balanskat et al., 2006; Cuban, 2001; Harrison et al., 2002). The most promising findings found that IT has a positive impact in primary schools in the home language (i.e. English) and science (Balanskat et al., 2006).

Against this backdrop, some authors question the assumption that IT is likely to produce a major identifiable and uniform effect on the performance of learners and therefore we are seeking results in the wrong way (McFarlane, 2001). Underwood and Dillon (2004), in their study about the possible evidence of the effect of IT on learning in national education tests in the UK, state "we were measuring the wrong thing. Perhaps new technologies are delivering new forms of learning for which we have yet to develop adequate assessment techniques" (p. 216). On the other hand, what has prevailed as a consensus is that IT enables key conditions for learning and enriches the school curriculum. Roschelle et al. (2000) provide a good example of these conditions:

- Real-world contexts
- Connections to outside world
- Visualization and analysis tool
- Scaffolds for problem solving
- Opportunities for feedback, reflection and revision

Students' Development of IT Skills

As regards as IT-related skills, there are at least two groups of definitions. The ones aimed at defining skills oriented towards mastering the hardware and software, such as those defined by, for example, the European Computer Driving License (http://www.ecdl.com). The other group of definitions is oriented at characterizing a set of competencies that students can develop while using software, often called "twenty-first century skills" (Anderson, 2008). These competences include "thriving on chaos" that means making rapid decisions based on incomplete information to resolve novel situations; the ability to collaborate with a diverse team – face to face or across distance – to accomplish a task; and creating, sharing and mastering knowledge through filtering a sea of quasi-accurate information.

Regarding the former group, especially in developing countries, research has shown that the introduction of IT does have an impact on students' IT skills (Hinostroza et al., 2005). Concerning the latter, although there is a consensus that students develop certain higher-order skills, its characterization is still a matter of debate (Anderson, 2008). On the other hand, while examining the actual use of IT in schools, the evidence suggests to embed IT literacy within more complex skills such as information handling, communication and collaboration (Voogt and Pelgrum, 2005).

Students' Motivation, Engagement and Self-Esteem

It is a consensus that IT does have an impact on students' motivation and other related variables (OECD, 2005). Complementary, other authors present different theories of enhanced learning through the use of IT developed in the last two decades. Among others, they mention extrinsic reinforcement, intrinsic rewards, challenge and increased self-esteem.

Factors Affecting the Use of IT for Learning

The range of ways in which IT (computers, Internet, PDAs, mobile phones, etc.) can be used in a teaching and learning situation varies enormously, and there are no recipes that can ensure that its use will produce gains in students' learning. This situation has been discussed from several perspectives, including arguments related to the quality of the research in this field (Underwood, 2004), the type of outcomes to expect (McFarlane, 2001), the emphasis given to IT in learning (Cuban, 2001) and others. In this section, we argue that one of the main problems is the complexity of designing specific uses of IT for teaching and learning due to the overwhelming number of options available that result from the combination of four sets of elements: (1) the different contexts in which IT can be used, (2) the variety of pedagogical approaches that can be used, (3) the range of activities that occur during a lesson, and (4) the set of IT options to select from. Additionally, all these elements are permanently evolving and yet, the impact of a given combination is uncertain. Following sections provide a description of these elements.

Context

The first set of elements deals with the large number of contextual variables that act at different levels and that influence education and consequently the use of IT in teaching and learning. Kozma (2003a) describes three levels which may influence IT use in education:

1. *Macro-level* or system factors such as cultural norms, social context, educational policy, curriculum standards, etc.
2. *Meso-level* or school factors such as IT infrastructure available, IT integration plans, school leadership, innovation history, parents, etc.
3. *Micro-level* or individual factors for teachers, such as pedagogical practice, innovation history, educational background, experience with technology, etc; and for pupils, such as experience with technology, social and cultural background, etc.

These variables influence the way in which technology can be used in schools and therefore, the combination of particular values of these factors draws different scenarios that convey particular challenges and possibilities for the use of IT.

Pedagogy

The second set of elements corresponds to the type of pedagogy that the teacher implements. For example, Table 1 presents two pedagogical approaches, one fitting in the industrial society and one that suits the information society (Voogt and Pelgrum, 2005).

Despite of the particular approach in use, Table 1 illustrates the variety of activities available for teachers to develop during their lessons. Additionally, although there is a tendency to associate the use of IT to the more innovative type of activities

Table 1 Overview of pedagogical approaches that fit the industrial vs. the information society

Aspect	Pedagogy in an industrial society	Pedagogy in the information society
Active	Activities prescribed by teacher	Activities determined by learners
	Whole class instruction	Small groups
	Little variation in activities	Many different activities
	Pace determined by the program	Pace determined by learners
Collaborative	Individual	Working in teams
	Homogeneous groups	Heterogeneous groups
	Everyone for him/herself	Supporting each other
Creative	Reproductive learning	Productive learning
	Apply known solutions to problems	Find new solutions to problems
Integrative	No link between theory and practice	Integrating theory and practice
	Separate subjects	Relations between subjects
	Discipline-based	Thematic
	Individual teachers	Teams of teachers
Evaluative	Teacher-directed	Student-directed
	Summative	Diagnostic

Voogt and Pelgrum (2005, p. 158)

(i.e. the ones associated to the information society), particularly among teachers that use IT as an instrument to express how they want to be seen as teachers (Olson, 2000), there is enough research to illustrate how IT can be used in activities corresponding to both pedagogical approaches, thereby expanding the possible types of activities to implement.

Range of Activities: The Instructional Instances

The third dimension corresponds to the design of the instructional instances of the lesson. Regarding this dimension, there are several "traditional" proposals for structuring a lesson, such as the ones proposed by Gagné (1987) or others that are more related to particular pedagogic roles. In this last vein, Leinhardt et al. (1987) define routines as systems of exchange that are set up to accomplish tasks and included three types: (a) management routines that include housekeeping, discipline maintenance and people moving tasks; (b) support routines, i.e. specific behaviours and actions necessary for a learning–teaching exchange to take place, for example "how to pass in papers", and (c) exchange routines, i.e. the interactive behaviours that permit the teaching and learning exchanges to occur. They govern the language contacts between teachers and students – for example, routines for choral responses.

For instance, a teacher can structure the lesson, considering that the initial activity of a lesson can be designed to motivate students (management routine), a second part for demonstrating concepts or ideas, after that the teacher can trigger discussions (exchange routine), and finally illustrate how to perform an experiment (support routine), etc.

Regarding this dimension, there is not much research that focuses on the use of IT only for specific activities or routine activities during the lesson (see discussions in Hinostroza and Mellar, 2001). On the other hand, there are a growing number of

proposals that relate IT applications to activities during the lesson. It highlights the principles for designing effective learning activities proposed by Boettcher (2007). Some principles include scaffold learning on students' prior knowledge, teach children how to learn, apply concepts in multiple ways and varied contexts, and so on. These principles provide thoughtful rules that prescribe how to design activities for a lesson, but they do not clarify what to do in a lesson (i.e. activities and its sequence).

Technologies

The fourth set of elements corresponds to the technologies. In fact, for each configuration of the previous elements, there are a variety of technologies that have different characteristics and affordances. Table 2 presents a classification of different IT applications and its possible educational use (OECD, 2001).

All these IT applications can be used to enhance learning, but as it has been argued before, the question is what is the best technology to support a teaching and learning activity in a particular context?

The sets of elements presented above define a space of opportunities from which teachers, in a given context, need to select a pedagogical approach, design a set of activities that will be developed during the lesson (instructional instances) and choose the best IT applications that support these activities. As it can be imagined, the variety of options is large, for example, what particular piece of software would be recommended in the following:

> A sixth grade mathematics teacher of a semi-rural school has 6 computers. There are 30 students in her class. These students are from a low-income socio-economic background. They only have access to computers at school. The teacher's vision on education is to value and respect the environment. She wants to implement problem-based learning in geometry (properties of geometric corpus) and is in the phase of starting to present some background information to state the problem.

The main problem is that there is not enough evidence available to produce responsible recommendations for technology choices for a given pedagogical approach and instructional instance that has to be implemented in a particular context. One explanation for this is that the availability of choices is permanently changing either because of new pedagogical approaches and new curriculum demands, or due to opportunities arising from new technologies that are being introduced in schools (e.g. interactive whiteboards – IWB) or that are being adopted by the learners (e.g. mobile phones, PDAs). This sets a highly dynamic and uncertain scenario in which arguments about best technology option change before they can be proved to be right or wrong.

In this vein, some authors argue that the design of pedagogical uses of technology requires the development of a new type of knowledge that they call technological pedagogical content knowledge (TPCK). Particularly, they argue that, "in practical terms, this means that apart from looking at each of these components in isolation, we also need to look at them in pairs: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and

Table 2 Classification of different IT applications

Type of application	Examples	Educational use
General tools	Word processing, presentation, spreadsheet, multimedia authoring, including Web publishing	Becoming more and more important; require innovative and creative thinking from the teacher; quality is in the application, not the tool itself, since such tools are not dependent on particular content
Teacher tools	On-line lesson outlines; computer-projector systems; interactive whiteboards	Lesson preparation; whole class teaching with shared view of screen; interaction managed by teacher
Communications	E-mail, e-learning; video-conferencing, Internet browsers	Require a view of education as reaching beyond school, for which they offer huge potential; familiar in the out-of-school context
Resources	Especially Web-based, whether general or specifically educational	Used according to availability, in whatever way wished; for resource-based, skills-oriented learning
Computer-assisted instruction (CAI)	Drill-and-practice, related to a certain kind of content and relatively unsophisticated	Offers individual learning opportunities without expensive development; appears to fit well with transmission models of teaching and learning
Integrated learning systems (ILS)	Individualized task assignment, assessment and progression, including CAI, with recording and reporting of achievement	These appear to sit outside teacher-led instruction and learning, but are only truly effective as an integrated part of the learning process, which may have to be re-thought
Computer-based assessment tools	Examination boards are developing computer-based examinations, which attempt to mimic paper-based tests	Components give advantage to the computer literate; teachers will need to incorporate some elements of similar tasks in their teaching, to prepare students adequately
Management tools[a]	Classroom procedures	Students' progress, deficiency analysis, etc.
	School administration	Financial, personnel and educational resources
	Publication of results	Parents, governors, inspectorate, general public
	Communication	e.g. school to home and vice versa

OECD (2001, pp. 38–39)

[a]Little is known about the effects of these four kinds of management tools on the quality of teaching and learning

all three taken together as technological pedagogical content knowledge (TPCK)" (Mishra and Koehler, 2006, p. 1026). In fact, we would argue that TPCK is the type of knowledge needed to design a lesson.

On the other hand, despite this large set of options, international evidence shows that the most commonly used IT applications in schools are general tools, e-mail and the Web (Kozma, 2003b; Pelgrum and Anderson, 1999; Venezky, 2002). Although one could argue that these technologies are the most "traditional" ones, this research also shows a quite innovative pedagogical practices using technology. Moreover, Anderson (2003) reported that diversity is the outstanding characteristic of these cases and that "any given innovation was likely to utilize diverse pedagogies concurrently" (p. 215).

The fact that these practices used a variety of technologies to support different pedagogical approaches supports the claim that the space of IT choices is much more complex than it appears to be and that teachers in schools are already making this type of decisions, probably using rules based on intuition and experience. In this vein, teachers look for ways to fit new technologies into classroom "business as usual" or as Lankshear and Knobel (2003) called it, the "old wine in new bottles" syndrome.

Bearing this in mind, we argue that to reduce this complexity, there is a need to recognize the different elements that interact in this decision and develop understanding of the role of IT in specific situations defined by a particular context, pedagogy and activities during the lesson.

Trends in Emerging Technologies and Learning

We have focused on previous sections in the more known or "traditional" use of IT and we have argued that this use struggles with a number of variables which gives the bases of some use patterns. In this section, we describe, from the technology standpoint, what new or "emerging technologies" are being explored so as to improve existing teaching–learning processes or to create new ones. In particular, we suggest that emerging technologies can be grouped, based on its intention, as belonging to one of these three groups:

1. Expanding learning opportunities (learn anywhere and anytime)
2. Creating new learning scenarios in traditional contexts (tools for students focused on improving learning in schools)
3. Improving teaching and learning process (tools for teachers focused on improving teachers' classroom teaching)

Expanding Learning Opportunities

Attempts to create new learning opportunities are largely based on the use of mobile technologies. In fact, its use in education is evolving rapidly and there are high expectations on its potential. For example, Chan et al. (2006) argue that "three factors – (1) ubiquitous access to mobile, connected, and personal, handhelds, (2) the relentless pace of technological developments in one-to-one computing, and (3) the evolution of new innovative uses of these handhelds – will create the potential for a new phase

in the evolution of technology-enhanced learning, characterized by seamless learning spaces" (p. 23). Some projects that use mobile technology to expand learning opportunities use e-mail and voice communication to support students' learning and to promote their participation in Web communities. Other projects are looking at the provision materials, including multimedia games, SMS text messages and context-aware content and services for the learners (Lonsdale et al., 2004).

Based on these types of experiences, Stead (2006) argues that now it is known that mobile learning can empower and engage and that the engagement and motivation can continue beyond the initial "gadget honeymoon". Also, he reports that learners are more comfortable engaging in personal or private subject areas using a mobile device than doing so using traditional methods and that these devices can be powerful tools for self-evaluation and reflection.

Digital television, due to its interactivity, is emerging as a technology that can expand learning opportunities since it is slowly moving from a mass to a more personalized medium. In this vein, Bates (2003) argues that t-learning (TV-based learning) can be an alternative solution to utilizing an Internet-enabled computer, but research is still limited in this arena.

From a different perspective, *Wikis* – i.e. Web sites that allow several users to easily add, edit and remove content in collaborative way (Cych, 2006; Engstrom and Jewett, 2005) – are another emerging technology that are expanding the learning opportunities. In this regard, Cych (2006) argues that the main learning opportunity of *Wikis* is that "each person shares a part of what they know to construct a whole – in effect another form of peer-to-peer constructivist learning" (p. 35).

Examples of ways in which *Wikis* are used include creating encyclopaedias (Wikipedia), brainstorming sessions, project development, practicing language and promote creative writing (Cych, 2006). Additionally, there are authors that confer upon *Wikis* an important opportunity for knowledge democracy.

Creating New Learning Scenarios in Traditional Contexts

Due to its (potential) wide availability, mobile devices are being used in classroom scenarios, for example to support collaborative activities in the classroom (Zurita et al., 2005), using PDAs to create simulated scenarios or landscapes in which students assume the role of animals in a Savannah (Facer et al., 2004), and others in which students develop behaviourist, constructivist, situated, collaborative, informal and lifelong learning activities for computers, for example, in schools serving disadvantaged communities in which the installation and maintenance of computers are not feasible (Leach et al., 2005).

Classroom communication systems (CCS) are also new technologies that show an accelerated penetration in schools. CCS – also known as classroom response systems (CRS), personal response systems (PRS), electronic voting systems (EVS), classroom network and audience response systems (ARS) – are basically receivers that input on-line signals from 30 or more remote devices used by students. In general terms, research results show that these technologies are used to enhance questioning and feedback, to motivate and monitor the participation of all students, to

foster discussions of important concepts, to promote collaboration and competition, to energize and activate students' thinking and to enable to collect data for further analysis of the lessons or evaluations (Roschelle et al., 2004). Also, when used in conjunction with interactive teaching strategies, such as peer discussion, it has been shown that they produce gains in conceptual understanding in subjects such as science (Crouch and Mazur, 2001). Additionally, some current research in this field is looking toward expanding the theoretical basis of its application, based on a sociocultural perspective (Penuel et al., 2006).

Finally, learning objects (LO) have also created new learning scenarios. In fact, they are becoming very popular, especially among the computer-based instruction researchers. In general terms, a learning object can be defined as any digital resource that can be re-used to support learning and in this sense is a new type of computer-based instruction, grounded in the object-oriented paradigm of computer science (Wiley et al., 2004). Although the concept is attractive for education, there is much debate about the real possibility of re-using LO (Collis and Strijker, 2001; McKenney et al., 2008), particularly because the conditions for its re-use are based on technical considerations, rather than on pedagogical ones. Actually, many studies report that the main difficulty while re-using LO is that students' learning needs are very particular and therefore each class needs a new set of instructional conditions and strategies (Collis and Strijker, 2001; Wiley et al., 2004).

Improving Teaching and Learning Process

The teaching activity has not always been considered as an opportunity to use technology for improving learning; only recently, new initiatives are focusing in the use of digital technologies to improve what teachers do in the classroom, hence to improve learning.

In this vein, the first of these technologies are the IWB. Although IWB are relatively old technologies, its massive introduction to schools started with the millennium and its use is expanding rapidly. The main potential of this technology is that the software developed for its use in the classroom can expand the resources available for the teacher and its manipulation resembles the use of a traditional blackboard.

Research has shown that the main benefits to use IWB for teaching and learning are:

- Versatility with applications for all ages; increases teaching time; more opportunity for interaction and discussions in the classroom; increases enjoyment of lessons for students and teachers.
- Enables teachers to integrate IT into the lessons; encourages spontaneity and flexibility; enables teachers to save and print what is on the board; allows teachers to share and re-use materials; widely reported to be easy to use; inspire teachers to change their pedagogy and use more IT.
- Increases enjoyment and motivation of students; provides more opportunities for participation and collaboration; reduces the need to note taking; students are able to cope more complex concepts; different learning styles can be accommodated;

enables students to be more creative in presentations to their classmate; students do not have to use a keyboard to engage with the technology (good for younger children).

(see Smith et al., 2006).

On the other hand, there is evidence that IWB bring about learning improvements within more traditional pedagogical approaches rather than learning transformations.

Conclusions

The reviews and discussions presented in the previous sections of this chapter represent a good sample of the issues being discussed today regarding the introduction of IT in K-12 education.

Regarding the role of IT in education, it was argued that IT can be considered to facilitate student learning, may change the curriculum and may improve teaching and learning. It was showed that IT might have a variety of impacts on learning, which includes achievement, IT competencies and student behaviour. Several factors affecting the selection and use of IT applications in teaching and learning situations were discussed, such as context, pedagogical approach and instructional instance. Finally, emerging IT applications were explored for their potential to expand learning opportunities, create new learning scenarios and improve the process of teaching.

All these perspectives on IT provide a complex tapestry, in which it is becoming increasingly difficult to keep positions and/or opinions at such a level of generality. However, the analysis of this information allows extracting some general tendencies in the field:

- Despite the increasing social- and economic-related benefits of the introduction of IT in education, there is still an ambition to impact student achievement, particularly achievement measured through national-level tests. This has been the "Holly Grail" for IT in education researchers and policy makers, and apparently it will continue to be for some time. On the other hand, there are a growing number of researchers that argue for "changing the target", this is, to define and measure the set of learning aims that are in fact affected by the use of IT. However, there is also a discussion about the definition of these "new" learning aims.
- Research has shown that the introduction and use of these technologies depend on a large set of interrelated variables including the context of use, the pedagogical approach and the instructional instance, in which particular pieces of hardware and software can play particular roles. The combination of these elements forms a large set of options which are difficult to characterize and therefore to research and test. In this context, we claim that there is a need for research that systematically defines and explores combinations of these dimensions.
- There is a rapidly growing availability of new types of digital technologies that are challenging research to look for their potential impact on education. This situation widens substantially the concept of "IT" and expands the "IT in education research field" since now it includes all sort of digital devices.

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