CHAPTER 15

LEARNING OBJECTIVES

After reading this chapter, you will be able to:

• understand the potential for ICT to transform learning and teaching;
• appreciate the need for teachers to develop appropriate pedagogical and ICT capabilities;
• identify the challenges to be addressed in realising the potential for ICT to transform learning and teaching;
• identify, propose and justify practical ideas for using ICT to transform learning and teaching.

Information and communication technologies: Transforming learning and teaching

This chapter has been substantially updated by Associate Professor Glenn Finger, Griffith University

This chapter establishes that technological changes offer potential for transforming learning and teaching in the 21st century. While the world is increasingly being characterised as a networked, digital world, this presents challenges for teachers who need to ensure that the educational experiences provided for their students are connected with the ways in which those students go about their daily lives, as well as preparing them for digital futures.

The chapter provides guidance for future teachers on how information and communication technologies (ICT) might be used, and discusses its implications and possibilities.
Learning and teaching in the 21st century: The challenges of technological change

Do you ‘chat’ to people in real time over the Internet while you download a personal selection of music to your MP3 player? Do you use a digital camera that you connect to your home computer in order to print photos? Do you frequently communicate using email, SMS and other functions of mobile phone technologies? Do you use Internet banking, book your accommodation online, and select and watch movies at a time of your choosing? Do you Google™ or use a search engine such as Yahoo!™ when you need to search for information?

Information and communication technologies, which refers to new and emerging technologies such as the Internet, mobile phones, digital cameras, digital video recorders, learning objects, personal digital assistants, interactive whiteboards, wireless and networking technologies, iPods, MP3 players, and virtual reality, have become pervasive as we go about our lives in the 21st century. New and emerging ICT have the potential to transform what, how, when and why we learn and teach. These hopes and promises are reflected in the Australian government’s funding commitment of more than $2 billion for the Digital Education Revolution (DEEWR 2009a, see www.digitaleducationrevolution.gov.au). The Digital Education Revolution aims to achieve a one-to-one computer to student ratio for all Year 9 to 12 students by 2011 (DEEWR 2009b), with a view that this will enable Australia to offer a world-class education system. However, for the revolution to occur, considerably more needs to be done than simply increasing student access to computers. For example, the Programme for International Student Assessment (PISA) 2006 study reported that, while 96 per cent of the Australian students studied had a computer for school use, and 91 per cent had access to the Internet at home, only 23 per cent of students indicated that they used a computer at school ‘almost every day’ (OECD 2007).

Similarly, in the United Kingdom, educators are urged to ‘fully exploit the power of technology to provide a 21st century education that reaches and benefits all learners and enable the UK to compete globally’ (Becta 2007, p. 2). A coalition of leading education, business and technology organisations in the United States formulated the reports Learning for the 21st Century (Partnership for 21st Century Skills 2003) and Assessment of 21st Century Skills: The Current Landscape (Partnership for 21st Century Skills 2007), which ask the question: How can we best prepare
students to succeed in the 21st century? The challenge for teachers in this increasingly networked, digital world is to bridge the ‘profound gap between the knowledge and skills most students acquire in school and those required in today’s 21st century communities and technology-infused workplaces’ (Partnership for 21st Century Skills 2007, p. 4).

How well are schools preparing students for the 21st century? What ICT capabilities do teachers need to meet these challenges? What guidance needs to be provided to teachers to help them deal with the rapid technological changes that are occurring?

Although ICT have the potential to transform learning and teaching, the evidence is not convincing when compared with the changes witnessed in business, government and industry. Indeed, there is evidence that there is an ever-widening divide between the use made of ICT in the home and its use in schools, as illustrated by the PISA study referred to above. In addition, it seems that the infrequent use of ICT is limited to low-level tasks such as developing basic skills, and retrieving information and managing tasks (Elliott 2004). Consequently, students are not being taught the necessary thinking skills to participate in the knowledge culture and economy of today and tomorrow.

The differences go much deeper than access to and frequency of use of ICT, as Prensky argues: ‘[A]s a result of this ubiquitous environment and the sheer volume of their interaction with it, today’s students think and process information fundamentally differently from their predecessors’ (Prensky 2001, p. 1). Prensky describes those born after the Internet became more widely available during the 1990s as ‘Digital Natives’, who are ‘native speakers’ through having grown up and been immersed in the digital language of computers, video games and the Internet. Prensky refers to those born prior to this period as ‘Digital Immigrants’, who may try to assimilate into the new digital world by learning to use digital technology, but still have a foot in the past. Prensky warns that the consequence is that ‘our Digital Immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language’ (Prensky 2001, p. 2). For example, many young people are familiar with multimedia and hypermedia, (e.g. navigating hypertext documents through the use of hyperlinks).

Educators of the future: Technological Pedagogical Content Knowledge (TPACK)

The advent of the Internet has spawned a proliferation of ‘virtual’ schools, classrooms and communities interconnected across the planet. In its wake, a plethora of challenging questions has surfaced:

• What knowledge do educators and parents need to have to make effective choices about how to facilitate their students’ learning through ICT?
• To what extent will the use of home computers and mobile technology by young people affect their cognitive, social, emotional and physical development?
• How much will learning and teaching increasingly take place in cyberspace, removing the necessity to attend formal classrooms?
• How will educational institutions meet the challenges of the new networked, digital world?

Most preservice teacher education programs have been designed by taking into account the need to develop Pedagogical Content Knowledge (PCK), proposed by Schulman as the ‘special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of understanding’ (Schulman 1987, p. 8). Consider other courses and subjects you are studying. In some way, each will be contributing to you developing PCK.

In response to the kinds of questions posed above, there have been growing expectations for preservice and practising teachers to develop ICT capabilities to meet the challenges. This is reflected in standards for teachers, as well as in the expectations by employers, students and parents. For example, the ISTE NETS for Teachers (NETS•T) (ISTE 2008) identifies the fundamental concepts, knowledge, skills and attitudes teachers need in order to apply technology in educational settings, according to the following dimensions:

1. facilitate and inspire student learning and creativity;
2. design and develop Digital-Age learning experiences and assessments;
3. facilitate and inspire student learning and creativity;
3 model Digital-Age work and learning;
4 promote and model digital citizenship and responsibility; and
5 engage in professional growth and leadership.

Thus, international standards explicitly expect teachers to have technological knowledge (TK), which enhances the existing expectations for teachers to have developed PCK. The interface between TK and PCK presents new challenges for designing and modelling new approaches to student learning, including challenging traditional models of teaching which were generally confined to pencil and paper. Many of today’s students access information and communicate in a rich multimedia, hypertextual, digital world, requiring new teacher pedagogical and ICT capabilities. Technological Pedagogical Content Knowledge or TPACK (initially known as TPCK) has been proposed to describe this new knowledge set required by teachers to allow them to effectively capitalise on ICT (AACTE Committee on Innovation and Technology 2008).

The stages of teacher development have been conceptualised by Trinidad, Newhouse and Clarkson (2006, p. 8) as inaction, investigation, application, integration and transformation. Importantly, they suggest that there is a critical-use border between application and integration. They describe some indicators of integration and transformation as follows:

**Integration**
- Uses ICT as a tool to address multiple learning outcomes.
- Considers opportunities for students to use ICT to demonstrate learning outcomes.
- Consistently contributes to school communities and planning both in terms of engagement and policy.
- Expects their learning approaches to develop as ICT integration grows.

**Transformation**
- Envisages and uses ICT as a catalyst to appropriately support all learners in a collaborative way.
- Considers the two-way relationship between learning and ICT use.
- Is a leading contributor to school communities and planning in the use of ICT.
- Envisages and can discuss multiple learning roles all of which are changed by ICT integration.

In this chapter we encourage you to consider the ways in which educators can integrate ICT to enhance and transform learning and teaching, and consequently provide access to learning opportunities for a greater range of students than might otherwise be possible.

Imagine that you are a newly graduated teacher applying for a position in an early childhood, school or higher-education setting. During your interview, you are asked to describe both your proficiency in using ICT and the purposes for which you would use it for teaching and learning. What would you say? Before you answer this, consider the definition of ICT literacy adopted by the Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA), which comprises all Australian state, territory and federal Education Ministers. This definition is used to guide the assessment of ICT literacy of Year 6 and Year 10 students in Australia. ICT Literacy is defined as:

> The ability of individuals to use ICT appropriately to access, manage and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society. (MCEETYA 2005, p. 2)

As indicated in the *National Assessment Program—ICT Literacy Years 6 & 10 Report 2005* (MCEETYA 2007), Australia’s young people were assessed as being ICT literate if they could demonstrate proficiency in the following six processes:

1. **Accessing information**: identifying the information needed and knowing how to find and retrieve information.
2. **Managing information**: organising and storing information for retrieval and reuse.
3. **Evaluating**: reflecting on the processes used to design and construct ICT solutions, and making judgments regarding the integrity, relevance and usefulness of information.
4 Developing new understandings: creating information and knowledge by synthesising, adapting, applying, designing, inventing or authoring.

5 Communicating with others: exchanging information by sharing knowledge and creating information products to suit the audience, the context and the medium.

6 Using ICT appropriately: making critical, reflective and strategic ICT decisions, and using ICT responsibly by considering social, legal and ethical issues.

How well would you score on these processes? Could you claim to be ICT literate? In conjunction with these expectations, would you be able to work with students to enable them to become ICT literate? Specifically, the findings of the ICT Literacy Assessment reported that 49 per cent of Year 6 students (MCEETYA 2007, p. xi) reached or exceeded the Year 6 proficient standard by demonstrating the ability to ‘generate simple general search questions and select the best information source to meet a specific purpose, retrieve information from given electronic sources to answer specific, concrete questions, assemble information in a provided simple linear order to create information products, use conventionally recognised software commands to edit and reformat information products’ (MCEETYA 2007, p. xi). In relation to Year 10 students, 61 per cent reached or exceeded the Year 10 proficient standard by demonstrating the ability to ‘generate well targeted searches for electronic information sources and select relevant information from within sources to meet a specific purpose, create information products with simple linear structures and use software commands to edit and reformat information products in ways that demonstrate some consideration of audience and communicative purpose’ (MCEETYA 2007, p. xi).

How might ICT be used? Developing an educational rationale to inform ICT selection and use

The starting point for the selection and use of ICT should be an educational rationale informed by theories of learning, the curriculum demands, and the needs of the learners. In this way, ICT can support many instructional and pedagogical purposes, depending on that educational rationale. You are encouraged to view this decision making as one based upon professional knowledge and practice and determined by your consideration of the relative advantage of selecting and using particular ICT applications, as suggested by Roblyer (2006, pp. 52–53). Furthermore, Roblyer (2006) outlines how instructional uses will vary for directed instructional and constructivist models of teaching and learning. These differences are outlined in the following table, which is adapted from Roblyer at www.prenhall.com/roblyer.

<table>
<thead>
<tr>
<th>Teaching models and their related instructional objectives</th>
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<tbody>
<tr>
<td><strong>Directed instructional models</strong></td>
</tr>
<tr>
<td>1 Teacher transmits a set body of knowledge to all students.</td>
</tr>
<tr>
<td>2 Teacher uses lectures, demonstrations and practice tasks to help students understand, remember, and apply new information and skills.</td>
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<tr>
<td>3 Teacher presents the information and skills that are to be learned in a structured sequence.</td>
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<tr>
<td>4 Teacher gives students individualised work.</td>
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<tr>
<td>5 Students must achieve the same set of specified objectives.</td>
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<tr>
<td>6 Students must master all prerequisites for each new skill.</td>
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<tr>
<td><strong>Constructivist models</strong></td>
</tr>
<tr>
<td>1 Teacher designs complex problem situations for students to explore, discover, and generate understanding.</td>
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<tr>
<td>2 Students actively construct knowledge through their own experiences in real-life contexts.</td>
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<tr>
<td>3 Students explore and discover with no strict structure or sequence.</td>
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<tr>
<td>4 Students work in collaborative or cooperative groups.</td>
</tr>
<tr>
<td>5 Teacher sets open-ended learning goals that may differ for each student (for example, problem solving; higher-order thinking skills).</td>
</tr>
<tr>
<td>6 Students acquire lower-order thinking skills progressively through solving problems that require complex thinking skills.</td>
</tr>
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</table>
Directed instructional and constructivist instructional models

Directed instructional models use tutorial, drill-and-practice, and concept revision game software to:

- correct specific skill deficits and learning weaknesses such as with at-risk students;
- enhance overlearning through practice so that subskills become automatic;
- adapt instruction to individual differences in skill and ability; and
- provide support for self-paced learning for students who need enrichment activities.

Constructivist instructional models use videos, graphic tools, desktop-publishing, Internet research, simulations and problem-solving software to:

- foster creative problem solving and develop metacognitive strategies;
- build conceptual links though visual models to enhance knowledge transfer to new contexts;
- boost student cooperation through group learning structures; and
- take advantage of different talents and strengths (multiple intelligences) when solving problems.

Having read how the instructional purposes of each model vary, think about the different ways in which ICT could be integrated to suit each purpose. Roblyer (2006, p. 48) suggests some possibilities for both models:

- Integration to generate motivation to learn
- Integration to optimise scarce personnel and material resources
- Integration to remove logistical hurdles to learning
- Integration to develop information literacy and visual literacy skills.

Connectivism—a learning theory for the Digital Age

More recently, in addition to the theorising provided by behaviourism, cognitivism and constructivism, Siemens (2005) presents connectivism, formed through the integration of chaos, network, complexity and self-organisation theories (www.elearnspace.org/Articles/connectivism.htm and www.connectivism.ca). According to Siemens (2005, p. 5), the following are the main principles of connectivism:

1. Learning and knowledge rest in diversity of opinions, not a single source.
2. Learning is a process of connecting specialised nodes or information sources.
3. Learning may reside in non-human appliances.
4. The capacity to know more is more critical than what is currently known.
5. Nurturing and maintaining human networks is needed to facilitate continual learning.
6. The ability to see connections between fields, ideas and concepts is a core skill.
7. Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
8. Decision making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

As Siemens explains, connectivist theory accounts for the new ways in which learners gain and create knowledge through the use of ICT. According to Dede (2005), the learning styles of students have also begun to evolve as a function of the Digital Age (www.educause.edu/pub/eq/eqm05/eqm0511.asp?bhcp=1). What do you consider are the implications of connectivism for learning and teaching? If Siemens is correct, what might schools look like, and what might be the role of teachers, in 2020?
Why use ICT? Research informing practice

Of course, being told as educators to use computers for teaching and learning is one thing, but what does the research tell us that can assist in convincing teachers that this is a good idea?

Roblyer (2006) outlines a number of significant reasons for using ICT in educational settings that have emerged from recent research. They include positive motivational benefits, unique instructional capabilities, new instructional possibilities, increased teacher productivity and possibilities for the development of literacies needed in an Information Age.

1 It is motivating because:
   - learners' interest, attention and enthusiasm can be captured and maintained by the visual appeal and interactivity of programs;
   - learners' perception of control over their learning is increased, especially for at-risk students—intrinsic motivation is consequently fostered;
   - learners can create their own professional-looking products, which boosts confidence and pride in their work.


2 It provides unique instructional capabilities because:
   - learners can obtain rapid access to extensive information resources not possible through traditional means;
   - presentation of information in powerful visual ways, such as through simulations, virtual reality and other 3-D visualisation, allows learners to understand and explore complex topics at deeper levels;
   - electronic monitoring of learners' performance following instruction by teachers can provide formative and summative evaluation of their learning processes and accuracy, as well as immediate feedback.

3 It supports new instructional approaches because:
   - cooperative group projects can be facilitated by computer-based technologies—interdependence and individual accountability within groups can be built into the design of learning activities using multimedia and vast databases;
   - problem solving and higher-order thinking are developed through complex projects facilitated by access to the Internet and multimedia;
   - intellectual resources (‘intelligences’) are distributed between learners and technological tools, thereby expanding the goals of education from individual achievements to those shared by communities of learners. (In this context, read about the use of interactive whiteboards in promoting learner-centred teaching, including the piece entitled ‘Whiteboards Bringing Interactivity in Education’, at this website: www.digitallearning.in/articles/article-details.asp?articleid=1462&typ=COVER%20STORY.)

In the context of the previous two points, Maddux et al. (2001) propose a categorisation of Type I (e.g. usually aimed at the transmission of knowledge, and where the type of interaction between the user and ICT is usually predetermined) and Type II applications (e.g. stimulates active intellectual; engagement by the user, usually aimed at creative tasks, and the user is in charge of what happens). Similarly, Jonassen (2000) refers to ICT used primarily as a productivity tool to accomplish tasks more efficiently. In contrast, Jonassen articulates the concept of ICT used as Mindtools. For Jonassen, ICT can be used for constructivist knowledge construction tools, can engage students as designers, and can scaffold learners into new forms of thinking and reasoning (Jonassen 2000, pp. 11–14). For practical ideas on ICT being used as Mindtools, see Meijers (2008) ICT Mindtools website at www.mindtools.tased.edu.au/default.htm.

4 It increases teacher productivity because:
   - computer-based tools provide efficient means of record keeping and instructional management, as well as preparation and presentation of learning and teaching activities;
weblog (also web log, blog) A webpage consisting of short, frequently entered and updated messages arranged in chronological order, resembling a set of journal entries. A wiki is a collaborative weblog which allows editing of posted contributions; used primarily for collaborative publication and interaction on the World Wide Web.

videoconferencing Involves two or more participants at different venues using video cameras, microphones and speakers to enable an online meeting.

World Wide Web An Internet-based system which connect sites through hypertext links; the term is often used synonymously with Internet, but is in fact a subset of the Internet.

- email, electronic bulletin boards, listservs (discussion groups), weblogs and videoconferencing provide opportunities for rapid professional exchange;
- test-generating software reduces the time needed to prepare and assess tests in different formats, from multiple choice and short answer to essays, which are completed on paper or online;
- software exists to facilitate and update the design of Individual Educational Plans (IEPs) for learners with special needs.

It provides opportunities to develop literacies needed for an Information Age because:
- technological literacy will continue to be necessary for vocational opportunities and lifelong learning skills;
- visual literacy is increasingly required to interpret and communicate information presented through instructional technologies;
- critical information literacy is necessary to locate appropriate sources of information on the World Wide Web, and to evaluate their reliability, validity and currency.

What do you think your ICT and pedagogical capabilities are at this stage in relation to those three required literacies for the Information Age: technological, visual and critical information literacies? What do you still need to learn? How do you plan to do this in the short and long term?

Practical ideas for teachers: Possible software applications

In the following sections, practical ideas are provided for the use of a range of software applications. These are designed for you to consider how they might assist in catering for a diverse range of learners and learning styles. Finger et al. (2007, pp. 174–7) suggest that ICT software can be categorised according to the function it serves, such as ICT-assisted instruction for online tutorials, simulation, instructional games, problem solving, integrated learning systems (ILSs), and ICT assistant tools (see also Newby et al. 2006) or support tools (see Roblyer 2006) for word processing, presentation software, spreadsheets, databases, material generators, data collection and analysis tools, graphics tools, planning and organising tools, research and reference tools, and content area tools. The relative advantages of each of the applications discussed in the following sections need to be considered. That is, how do these applications provide learning experiences not available through more traditional approaches and experiences?

Visual learning tools

Visual thinking software, such as Kidspiration and Inspiration, enable teachers and students to generate ideas (for example, the RapidFire tool can be used for brainstorming ideas), organise ideas and concepts, add notes to symbols and text, and develop multimedia, hyperlinked presentations (www.inspiration.com). The instructional effectiveness of graphic organisers for improving student learning and performance has been shown in the following areas:
- reading comprehension;
- thinking and learning skills such as organising and communicating ideas; seeing patterns and relationships; and categorising ideas; and

The use of graphic organisers clearly supports the implementation of cognitive learning theories—dual coding theory, schema theory and cognitive load theory. You can try out the free (for 30 days) downloads of Inspiration and Kidspiration graphic organiser software at www.inspiration.com/freetrial/index.cfm.

Visual learning techniques help students to:
- Clarify thinking: Students see how ideas are connected and realise how information can be grouped or organised. With visual learning, new concepts are more thoroughly and easily understood.
- Reinforce understanding: Students re-create, in their own words, what they have learned. This helps them to absorb and internalise new information, giving them ownership of their ideas.
• **Integrate new knowledge:** Diagrams updated throughout a lesson prompt students to build upon prior knowledge and internalise new information. By reviewing diagrams created previously, students see how facts and ideas fit together.

• **Identify misconceptions:** Just as a concept map or web shows what students know, misdirected links or wrong connections reveal what they don’t understand ([www.inspiration.com/vlearning/index.cfm](http://www.inspiration.com/vlearning/index.cfm)).

### The games people play

The wealth of software available today and its popularity illustrates that learning can emerge from play that is fun and motivating. With many games, learning how to play them comes through immersion in the game. This is an example of the role of *discovery* in learning and the principle of inductive reasoning, where individuals construct hypotheses or rules from examples collected from their experiences.

Many software applications using such an exploratory approach are being specifically designed for very young children. Even before they enter formal schooling, such children learn to ‘use’ a computer mouse and keypad through random exploratory acts with games such as *Sesame Street Baby and Me* ([www.superkids.com/aweb/pages/reviews/multisub/baby/1/babyme/merge.shtml](http://www.superkids.com/aweb/pages/reviews/multisub/baby/1/babyme/merge.shtml)), while children of kindergarten age are also encouraged to engage in exploratory play with specially designed software such as *Paint, Write and Play* ([www.worldvillage.com/wv/school/html/reviews/pwp.htm](http://www.worldvillage.com/wv/school/html/reviews/pwp.htm)) and *Reader Rabbit* ([www.superkids.com/aweb/pages/reviews/multisub/kinderg/2/rrkbball/merge.shtml](http://www.superkids.com/aweb/pages/reviews/multisub/kinderg/2/rrkbball/merge.shtml)).

The challenge clearly exists for both parents and educators to understand the nature of these games and to evaluate the extent to which they engage young children in meaningful learning, rather than being merely entertaining.

Some interactive adventure games, such as *Myst* ([www.justadventure.com/articles/AdventuresInEducation.shtm](http://www.justadventure.com/articles/AdventuresInEducation.shtm)), foster the development of problem-solving skills through totally unguided exploration. *Myst* doesn’t come with a set of rules. It is for the users to discover the secrets of the deserted island from clues they pick up and explore: magical maps, segments of books, and hidden rooms. Simulation programs such as *SimCity* ([www.mediafamily.org/kidscore/games_sim_city_4.shtml](http://www.mediafamily.org/kidscore/games_sim_city_4.shtml)) and *Civilization IV* ([www.gamespot.com/pc/strategy/civilizationiv/index.html?sid=6136659](http://www.gamespot.com/pc/strategy/civilizationiv/index.html?sid=6136659) and [www.commonsensemedia.org/reviews/review.php?id=4793&type=Video%20Game](http://www.commonsensemedia.org/reviews/review.php?id=4793&type=Video%20Game)) are also examples of open-ended, problem-solving games where users construct their cities or civilisations by taking into account a range of complex, interrelated factors (as in the real world), such as population, religion, trade, traffic, disease and climate.

One of the most highly awarded sites designed for young people aged 12 and under to use to engage in ‘playful learning’ and gain ‘technological fluency’ is *MaMaMedia* ([www.mamamedia.com/](http://www.mamamedia.com/)). The site also encourages ‘grown ups’ to explore and participate in the activities of their children, and provides them with guidance on the learning value of these activities ([www.mamamedia.com/areas/grownups/new/home.html?src=sdw](http://www.mamamedia.com/areas/grownups/new/home.html?src=sdw)).

If you are keen to understand more about the enormous impact of computer-based games on the learning and development of children and young people, refer to Sandford and Williamson’s comprehensive *Games and Learning Handbook* (2005) ([www.nestafuturelab.org/download/pdfs/research/handbooks/games_and_learning.pdf](http://www.nestafuturelab.org/download/pdfs/research/handbooks/games_and_learning.pdf)).

### Freeing the gifted learner

There are many differences in the ways that learners process and retain information. It is vital for educators to assist learners in understanding new information through as many ‘channels’ as they can. Rather than using a hierarchical approach as characterised by ‘command and control’, Husband ([www.wirearchy.com](http://www.wirearchy.com)) refers to this multi-channel approach as a ‘wirearchy’, in which the ‘interconnectivity offered by the Internet enables increasingly horizontal and peer-to-peer based communications and interaction between people, whether they are friends, customers, colleagues, or citizens’ (Husband 2005, p. 1). Husband suggests that this approach enables a shift from ‘command and control’ to ‘coordinate and channel’. In this context, students can engage with rich multimedia and hypertextual learning environments. As demonstrated in the following article, gifted visual spatial learners can ‘suffer’ in a traditional learning environment where material is presented to them through words, whereas they ‘think in pictures’ ([www.nswagtc.org.au/ozgifted/conferences/SwordVisualSpatial.html](http://www.nswagtc.org.au/ozgifted/conferences/SwordVisualSpatial.html)).
Today, we can see evidence of the transformation of ‘art’ by new digital technologies. How exciting it is for those individuals who can now use these alternatives, in addition to paint and paper, as means of expressing and developing their visual intelligence (http://theage.com.au/articles/2006/03/08/1141701518743.html?page=3). Digital video software has similarly opened up many opportunities for learners to collectively research, problem solve and create products that demonstrate their visual literacy and insights into a topic. Digital storytelling has been linked to deep learning, and students can now design, create and share their digital stories (http://electronicportfolios.org/digistory/index.html).

As Microsoft illustrates in the following websites relating to multiple intelligences and learning styles, there are many computer-based tools to support learner preferences for coding information and expressing their understanding (www.microsoft.com/uk/education/learning/multiple-intelligences/ and www.microsoft.com/uk/education/learning/learning-styles). However, because hypermedia lacks explicit cues to provide structure and a sense of control (also important factors for anxious learners), Dillon and Gabbard (2000) reported that the benefits of hypermedia in education are limited to learning tasks reliant on repeated manipulation and searching of information, and are differentially distributed across learners depending on their ability and preferred learning style. On the other hand, those who are ‘deep processors’, have high ability and are willing to explore, do well with information presented as hypermedia. The lack of explicit structure in the information environment supports their developing understanding and transfer of concepts. Spiro’s Cognitive Flexibility Theory (Spiro & Jehng 1990; Spiro et al. 1992) is worth referring to in this regard (http://edutechwiki.unige.ch/en/Cognitive_flexibility_theory).

Just as higher-level thinking skills and metacognition can be fostered through the teacher’s use of higher-order questions and sufficient wait-time (at least three seconds), the same result can be achieved by the use of computer programs that include higher-level questions or prompts (www.ascilite.org.au/ajet/ajet17/hollingworth.html).

It would be beneficial, therefore, to select software that has these features. Many such Mindtools that have been developed and refined over the last 15–20 years to support constructivist pedagogy are described in detail, along with the theory underpinning them, in Jonassen’s (2000) Computers as Mindtools for Schools. In his subsequent book, Modeling with Technology: Mindtools for conceptual change (2006), Jonassen further explains how learning and conceptual change can occur through building, manipulating and experimenting with models through software such as databases, spreadsheets, concept maps, visualisation tools and hypermedia. (See the related resources for Jonassen’s books at the companion website, www.prenhall.com/jonassen/.)

Freedom to write

For many learners who find little appeal in writing, there are significant advantages in providing them with access to word processors. These include:

- freedom from the mechanical concerns of poor handwriting, corrections and spelling, which enables them to concentrate on the flow of ideas. This fosters learners’
- motivation to write because it is fun and physically easier (due to the range of input devices and screens available).

This leads to improvement in the quality of written work, especially for weak writers, and the encouragement to write longer documents.

Clicker 5 is an award-winning program that enables students of all abilities to develop skills in reading and writing English, using words, pictures, sounds and phrases. To see some practical ideas for using Clicker in Your Classroom, visit www.cricksoft.com/us/ideas/using_clicker/index.htm. From a constructivist perspective, using the computer as a writing tool changes the traditional, classroom-based writing instruction to one in which students have greater independence and initiative, with a skilled teacher and peers acting as facilitator, adviser and editor—a Vygotskian (dialectical) approach to learning.
Management and administration of teaching: Effectiveness and efficiency

Many management and administrative functions can be handled effectively and efficiently by ICT, thereby freeing the teacher from numerous non-instructional tasks to concentrate on learning and teaching activities. Examples of these are:

- keeping records of student progress;
- drafting and keeping a record of individualised correspondence to students and parents;
- keeping attendance records;
- maintaining inventories of classroom equipment and materials;
- designing tests, answer sheets, worksheets and individualised learning contracts;
- producing posters, calendars and class awards; and
- generating student reports to parents.

Assessment and ICT

The ways in which ICT might be used for assessment are dependent upon how the role of ICT in teaching and learning is perceived and what types of assessment are required (Bitter & Pierson 2005; Bitter & Legacy 2006). The focus of assessment might be confined to ICT literacy, as described earlier in the discussion of the National ICT Literacy Test in Australian schools (MCEETYA 2007). This form of assessment is limited in its provision of evidence about student learning, particularly in terms of how students are able to use ICT for the development of creative, complex and critical thinking.

ICT can be used for assessment purposes as a data collection tool, a recording, analysis and communication tool, and a plagiarism detector (Bitter & Pierson 2005). It offers advantages in efficiency, particularly in terms of assessment of many students and where the focus is on ‘basing student learning on mastery of content rather than technology use’ (Bitter & Pierson 2005, p. 300). ICT for assessment can also be used where the content is the focus, and it can be used for ePortfolio purposes.

A recent study of existing practices by Busuttil-Reynaud et al. (2006) identified four types of ePortfolio being used in schools in the United Kingdom, namely:

- Transition ePortfolios: where relevant administrative and educational information about the learner is transferred from one institution to another as a learner progresses.
- Assessment ePortfolios: where information about and evidence of work undertaken by learners, and achievements in assessing or matching against specified criteria, are collected and managed.
- Presentation ePortfolios: where learners select and present evidence of personal information or achievements.
- Learning ePortfolios: where the learner develops a broader, more general resource which can support whatever the individual wants to do and could form the basis of any of the previous portfolios if desired.

(Busuttil-Reynaud et al. 2006, cited in Becta 2007, p. 31)

For excellent ideas on ePortfolio approaches and resources, visit www.electronicportfolios.org.

eLearning and blended learning possibilities

Traditional instruction was timetabled and took place in physical spaces such as classrooms and schools. More recently, eLearning, characterised by web-based and Internet-enabled systems, enables both the instructors and students to access information, to study, and to communicate irrespective of their location. The term blended learning is used to refer to the use of ICT to engage students and to enrich the quality of the student experience through interactive learning activities, particularly with the aim of achieving learning experiences not able to be realised through only face-to-face learning. Blending technologies is now possible, whereby schools adopt infrastructure to support intranets, Learning Management Systems (LMS), Local Area Networks (LAN), Learning Management Content Systems (LMCS) and Virtual Learning Environments (VLE). The limitations of those digital
systems is leading to the next phase with the development of Digital Ecosystems conceptualised as learning platforms, which keeps learning central, enables interoperability, and forms a base for building upon through the use of new technologies and the increased capabilities of educators to use ICT for curriculum, pedagogy and assessment (Ingvarson & Gaffney 2008).

eLearning design decisions need to be informed by research, as the assumption that ‘going online’ ensures success is problematic. Six dimensions which impact upon eLearner satisfaction were identified by Sun et al. (2008): student dimension, instructor dimension, course dimension, technology dimension, environment dimension, and design dimension. Furthermore, they reported that these six dimensions encompass 13 factors that should be considered to enable eLearner satisfaction, as follows:

1 **Student dimension**
   (i) learner attitude towards computers,
   (ii) learner computer anxiety, and
   (iii) learner Internet self-efficacy.

2 **Instructor dimension**
   (iv) response timeliness, and
   (v) instructor attitude towards eLearning.

3 **Course dimension**
   (vi) eLearning course flexibility, and
   (vii) eLearning course quality.

4 **Technology dimension**
   (viii) technology quality, and
   (ix) Internet quality.

5 **Environmental dimension**
   (x) diversity in assessment, and
   (xi) learner-perceived interaction with others.

6 **Design dimension**
   (xii) perceived usefulness, and
   (xiii) perceived ease of use.

**Getting connected to online projects and communities**

Education Network Australia—Australia’s free online network for educators (at www.edna.edu.au/edna/go)—provides a wealth of excellent resources, email discussion lists, information about events and conferences, education RSS feeds, and edna groups. Edna groups are a free service enabling communication and collaboration among Australian educators and members of the training community.

A range of online collaborative projects is available. For example, an exciting and successful initiative made possible through the Internet is the Better World Project (www.betterworld.net), part of which has emanated from the United Nations’ declaration of the first International Day of Peace on 21 September 2006 (www.betterworldcalendar.com/peaceday.htm). The site not only represents an opportunity for schools to participate through collaborative peace projects, but is also an opportunity for all nations to communicate as one global ‘voice’.

A further outstanding example of how educational communities around the world can connect via the Internet for their mutual enrichment can be found at the site of iEARN, the International Education and Resource Network (www.iearn.org) which has been operating since 1988. For links to some excellent Australian, New Zealand and Asia-Pacific schools collaborating for educational purposes on the Internet, investigate the site for Aussie SchoolHouse at www.ash.org.au/projects/default.asp, and the main Global SchoolNet site at www.globalschoolnet.org/index.cfm which provides a directory for finding international partners wishing to participate in collaborative Internet projects.
CHAPTER FIFTEEN INFORMATION AND COMMUNICATION TECHNOLOGIES: TRANSFORMING LEARNING AND TEACHING

Electronic journals as learning spaces

Students in many educational settings, especially adult learners, have long been encouraged to keep reflective learning logs or diaries. Now that the technology exists, they can create ‘authentic’ electronic learning journals in the form of weblogs—a diary kept on the web. An effective example of such a dynamic weblog about learning journals themselves can be found at www.binaryblue.com.au/elj.

Excellent sources of links to ideas on the educational value of weblogs, as well as to the important issues of Internet access, privacy and security, are available at the following Education Department site: www.eddept.wa.edu.au/cmis/eval/curriculum/ict/weblogs.

One-to-one computing: Computers as a personal learning resource

A markedly different model is exemplified in schools where the goal is for every student to have a computer as a personal learning resource. This is the philosophy underlying school initiatives in which parents are asked to purchase laptop computers for their children to use both at home and at school. The justification given is that portable computers should be seen as resources for enhancing the processes of learning and teaching in the same way as pencil and paper. Rather than being seen as tools for enabling the learner to be more productive and efficient (a business metaphor often used for the computer), the personal laptop computer can enable learners to develop their own idiosyncratic knowledge. The following site provides access to research that supports the learning value of portable ICT devices: www.eddept.wa.edu.au/cmis/eval/curriculum/ict/notebooks/.

Digital divide as knowledge gap

Until now, the term digital divide has referred to the lack of access to hardware by those who cannot afford it, or are denied access to it. As digital technology has become increasingly affordable and available, however, the term has come to refer to the knowledge gap caused by limited ICT literacy, and the absence of the range of cognitive skills that optimise technology use which many would argue are vital to function in a global community increasingly dependent on ICT.

Although a large number of students report having access to a computer at home, they seem to use it mainly for entertainment, chatting, and to access the Internet for information. There are still too few computers for individual use in most classrooms. Increasingly, projects around the world are being set up to determine the learning value of providing all students with a handheld computer for use at school and home. It is becoming more feasible for students to have access to their own computer due to the reduction in purchase costs of computers. This increasing ease of availability can result in digital inclusion, which overcomes the situation where the use of ICT and the Internet for educational purposes is available mainly to the privileged few who can afford the hardware and software, and pay the Internet access fees. Most recently, collaborative research efforts have begun to extend the opportunities provided by the Internet to societies that are unable to afford the newest technology.

The One Laptop per Child (OLPC) initiative (http://laptop.org/en/) was initiated after Negroponte, founder of the MIT Media Lab, had witnessed how connected laptops transformed the lives of children and their families in a remote Cambodian village. The OLPC vision is for children in developing countries to be provided with a laptop, enabled through the invention and provision of
low-cost hardware. (To view a video on this project, visit http://laptop.org/en/vision/index.shtml.) Loaded with Skype (software enabling free international telephone calls through the Internet—www.skype.com), the laptops have been distributed with the help of the United Nations to tens of millions of children in developing countries, free of any costs. (For current information on deployments, see http://wiki.laptop.org/go/Deployments.) Children and their families in the poorest parts of the world will now have an invaluable educational tool that will connect them to each other and to the rest of the world (www.theregister.co.uk/2006/04/05/negroponte_defends_laptop/).

Projects of this nature have raised many questions. Specifically, while access to laptops will certainly assist many students in poor communities to acquire skills needed for local and global communication in a Digital Age, the key problem remains that the digital divide will continue to widen as a function of wealth. Many valuable sites relating to international efforts to provide digital inclusion for disadvantaged communities can be found at http://lanic.utexas.edu/la/region/digitaldivide/. Most importantly, we know that access alone doesn’t result in improved learning outcomes. Although having access to technology is the starting point, the key to student learning will lie in providing high quality, up-to-date training and professional development for teachers in those countries, to enable meaningful use of ICT for effective student-centred learning.

**Special learning needs and technology**

Consider the case of a university student who has severely injured her preferred hand. On her first day at university, she begins to ‘teach’ a computer equipped with voice recognition software to recognise her speech so that she can learn how to ‘write’ her assignments. Excruciatingly slow—90 minutes of dictation and correction to produce an accurate paragraph—it is nonetheless miraculous to see what would otherwise have been a tragedy turned into a situation where a young person will have a chance, albeit a slower one, to learn and to achieve success.

Much research has shown that computer-assisted instruction can raise the academic achievement of students with mild and moderate learning disabilities in mathematics, spelling, reading and other subject areas. There are many additional ways, however, in which ICT can help to overcome educational disadvantages for students with special learning needs. Computer-based assistive devices for learners who cannot speak or write, for example, can provide an enormous range of communication possibilities.

Individuals with special needs can learn so much more through assistive technologies, such as ‘switches’ that interface with keyboards that can be activated by a blink, joystick alternatives to a mouse, speech-to-text and text-to-speech software, and Braille converters.

Visually impaired students can access information from computers linked to speech synthesers and Braille printers, use speech output devices that can ‘explain’ what a computer program does, or ‘read’ with their hands vibrating tactile displays that have been converted from a printed page. In this context, see the Job Access with Speech (JAWS) site (www.nanopac.com/JAWS.htm) to learn more about the capabilities of this amazing screen reader that enables text on screen to be read out loud from to the visually impaired user, or converted to Braille.

Johnson’s Write: Outloud SOLO (www.spectronicsinoz.com/product.asp?product=18688) is a talking word processor that can be used to motivate any users who have difficulty with writing, not only those with specific disabilities. Produced by the same company, the NoteTaker, a Portable Electronic Highlighter, is another tool that can be of great assistance for those who have difficulty in reading and comprehending written text. It enables the user to quickly highlight and scan printed text to later re-read and study using the auditory feedback of a speech-supported application such as Read:Outloud. Students can also use such an electronic highlighter to do research and collect information for written assignments, which can be uploaded to Draft:Builder where further structured assistance is provided for moving from an initial outline of their ideas to the final written product (visit www.spectronicsinoz.com/product.asp?product=19381).

A comprehensive overview of the range of assistive technologies available for learning is provided at www.futureofchildren.org/usr_doc/vol10no2Art5.pdf. Two websites that provide useful information on assistive technologies are www.assistivetechnologies.com/ and http://en.wikipedia.org/wiki/Assistive_technology.

There is a serious responsibility for teachers as professionals to diagnose students’ individual learning needs and to accommodate these through a range of instructional strategies and tools. This will require professional knowledge,
time and careful consideration to select carefully, review thoroughly, and monitor fastidiously any educational hardware and software that is used. There are no short cuts to effective instruction for any learner. In this context, it would be worth looking at Chapter 9 in the text, where we consider the many special needs of learners and the teaching implications of these.

**Conclusion**

From reading this chapter and investigating the links to the many websites provided, you should be better equipped in your understanding of both the challenges and the possibilities that ICT enables for enhancing and transforming learning and teaching in the 21st century. It is important for you to consider the metaphor of an ICT journey on which you are embarking and to consider how you are moving through the stages of developing your ICT capabilities as a teacher—from inaction, to investigation, to application, through the critical use border—to effectively integrate ICT and produce transformations in learning and teaching.

**QUESTION POINTS**

1. **You have been asked to outline to staff at your school the relative advantage of two software applications for use in a range of curriculum areas. Provide:**
   - the names and brief description of the two software applications;
   - the age and year levels for which the software is most appropriate;
   - the curriculum areas; and
   - for each software application, a practical idea for how the teachers might use the software to engage students in complex, creative and critical thinking.

   Ensure that you make a case in terms of the *relative advantage* of these applications when compared with more traditional approaches.

2. **Debate the advantages and disadvantages of implementing one-to-one computing; e.g. making a Netbook or laptop computer compulsory for each student and for every teacher in a school. In your response, indicate the advantages and disadvantages for the students, for the teachers, and for the parents/caregivers. Consider and suggest:** Who should pay for their purchase? How would repairs and maintenance be managed? Should the students be able to use them at home as well as at school? Should they have wireless Internet connection?

3. **Considerable professional development of teachers aimed at improving their students’ use of ICT for learning has tended to be ineffective in changing classroom practice. Often, this has been characterised by what might be described as ‘one shot inoculation’ or a ‘scorched earth’ approach, whereby the teachers attend a seminar or conference, are given ideas and have professional development ‘done to them’, but nothing changes in terms of what their students engage in when they return to their classes. We know that the roles played by teachers to transform learning using ICT are critical.**

   Develop a proposal for implementing an effective model of professional development that will result in improved student use of ICT to enhance and transform their learning.
1 Software can be categorised according to a range of possible learning and teaching uses. For example, software applications might be used with the instructional intention being drill and practice, tutorials, simulation, instructional games, and instructional learning systems. Consider how your selection and use of these might be primarily as a productivity tool (e.g. spreadsheets to make accurate calculations quickly and efficiently) or as a Mindtool, defined by Jonassen (2000) as an intellectual partner to enhance a learner’s ability to think (e.g. spreadsheets used to support higher-order quantitative thinking such as analysing data, mathematics comprehension and simulation modelling). Select two software applications that your students will be using and indicate how they are used as a productivity tool and/or as a Mindtool.

2 As an aspiring educator you should be aware of high-quality and relevant resources available on the Internet. In learning and teaching in a networked, digital world, you and your students should be familiar with Internet tools for communication (e.g. email, chat, videoconferencing), Internet tools for inquiry (e.g. web browsers, bookmarks, favourites, understanding URLs, online tutorials, WebQuests), and Internet tools for construction focusing on design processes (e.g. web design, graphic design, text presentation and writing style).

   Undertake a search of the Internet and develop a compilation of links to quality educational resources for teacher and student use. Develop and use a system for enabling this to be shared and built upon by other teachers and by your students; for example, use bookmarks and favourites, and/or use social bookmarking such as Delicious (http://delicious.com). Try starting with the following:

   • WebQuests: http://webquest.org/index.php. At Webquest.org find, create and share WebQuests.

   • Mrs Mac’s Library Site: http://smclibrary.shaz.googlepages.com/home. This site redefines the stereotype of librarians, providing tools for Teacher Librarians and Teachers. Follow the link and join Mrs Mac’s del.icio.us site—sharonmccg’s Bookmarks—at http://delicious.com/sharonmccg/.

   • Project Gutenberg of Australia: http://gutenberg.net.au/. This site provides access to free electronic books that are in the public domain.

DEFINITIONS FOR ACTION STATIONS

- bookmark Term used in Netscape web browser for an internet location ‘marker’ which enables a user to return to that location easily
- favourites Term used in Internet Explorer browser for an Internet location ‘bookmark’ which enables a user to return to that location easily
- URL Uniform Resource Locator specifies where an identified resource is available and the mechanism for retrieving it
- WebQuest A project for students using web resources; has a generic structure, usually involving introduction, task, processes, resources, evaluation and credits

KEY TERMS
To make learning these definitions easier, let the glossary flashcards in MyEducationLab help you. Visit www.pearson.com.au/myeducationlab.

The sources for explanations of the following key terms are acknowledged:


assistive technologies (p. 14)
Becta (p. 2–3)
bookmark (p. 16)
DEEWR (p. 2–3)
digital divide (p. 13)
edna (p. 12)
eLearning (p. 11)
email (p. 2)
ePortfolio (p. 11)
favourites (p. 16)
Google™ (p. 2)
hyperlinks (p. 3)
hypermedia (p. 3)
hypertext document (p. 3)
integrated (p. 4)
Internet (p. 2)
intranet (p. 11)
iPod (p. 2–3)
ISTE (p. 3)
LAN (p. 11)
MP3 (p. 2–3)
multimedia (p. 3)
NETS (p. 3)
search engine (p. 2)
simulations (p. 6)
Skype (p. 14)
SMS (p. 2)
software (p. 5)
transformation (p. 4)
URL (p. 16)
videoconferencing (p. 8)
virtual reality (p. 2–3)
VLE (p. 11)
weblog (p. 8)
website (p. 7)
WebQuest (p. 16)
World Wide Web (p. 8)
Yahoo!™ (p. 2–3)

For direct hot links to online learning sites and useful web destinations, as well as an extended recommended reading list, go to MyEducationLab at www.pearson.com.au/myeducationlab

WEB DESTINATIONS

- Better World: www.betterworld.net
- Global School Net: www.globalschoolnet.org/index.cfm
- Helen Barrett’s ePortfolio website: www.electronicportfolios.org
- Iearn, the International Education and Resource Network: www.iearn.org/
- Inclusive Learning Technologies: Spectronics: www.spectronicsinoz.com/
- Inspiration and Kidspiration: www.inspiration.com
- International Society for Technology in Education (ISTE): www.iste.org/
- Job Access With Speech (JAWS): www.nanopac.com/JAWS.htm
- Margaret Meijers, ICT Mindtools: www.mindtools.tased.edu.au/default.htm
National Educational Technology Standards (NETS•T) and Performance Indicators for Teachers: www.iste.org/Content/NavigationMenu/NETS/ForTeachers/2008Standards/NETS_T_Standards_Final.pdf


One Laptop per Child (OLPC) initiative: http://laptop.org/en/


Partnership for 21st Century Skills—Home: www.21stcenturyskills.org/

RECOMMENDED READING

AACTE Committee on Innovation and Technology (2008) The Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators. Lawrence Erlbaum Associates.


REFERENCES

AACTE Committee on Innovation and Technology (2008) The Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators. Lawrence Erlbaum Associates.


