Forward thinking
Three forward, two back: What are the next steps?

Gerry White is a Principal Research Fellow at the Australian Council for Educational Research (ACER)

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Abstract

The use of digital technologies and digital media in teaching, learning and leadership in education has gradually gained momentum since the 1980s, when personal computers first became popular. The resultant media hype and educational posturing by technology evangelists were given a boost with the take up of the World Wide Web in the early 1990s. And significant investment followed nationally and internationally. So what have we learnt in that time about using technology for teaching, learning and educational leadership? What will be the challenges for successfully using digital technologies in education in the next five years?

This address will briefly traverse the successes and failures of the past before examining the evidence that may give some clues to the future challenges of using digital technologies and digital media in education. However, is Australian education and training in a position to address these challenges? The capacity of education to meet the future challenges of using technology for teaching and learning will be the focus of this presentation.

Introduction

Education in schools, vocational education and training and tertiary education is about learning. The people who are at those institutions as learners are both students and teachers. Technology has always helped learners when it has been used appropriately. Modern digital technologies and digital media (hereinafter referred to as 'digital technologies') are enablers of learning and learning activities. They enable greater access to information and knowledge than ever before and enable a range of communication capacities both locally and worldwide. Education's record of success in using digital technologies however, remains patchy because attention to learning has been obscured by the combined hype of content and learning management system providers coupled with fears about cyber-safety and online bullying fuelled by news media.

This paper discusses what has happened in Australian education in relation to the use of digital technologies with attention to some of the successes and failures. It then moves to examine the usefulness of digital technologies for teaching and learning before reflecting on a framework and theory for explaining educational practice. The paper then examines recently available research into the use of digital technologies in education before concluding with opportunities that educational

leaders can prioritise so that digital technologies can to be successfully integrated with teaching practice, in order to improve learning engagement and student performance.

Background

The internet was agreed as a communications standard for the exchange of digital data in the early 1970s (Gillies & Cailliau, 2000, p. 40) although personal desktop computers did not appear on the market until the late 1970s (Wikipedia, 2011). The use of automatic word processing systems, financial packages and games became commonplace with personal computers in homes and then with an internet connection users could access news, opinions and software. During the period 1980 until the early-1990s, educators experimented with the uses of stand-alone computers, mainly for creating documents, with the support of small-scale grants from state and national bodies. The result of much of this work with stand-alone computers resulted in the idea and definition of digital literacy (Anderson, 2000).

However, in 1989 the development of the World Wide Web (WWW) by Sir Tim Berners Lee and Robert Cailliau enabled the exchange of media in various information formats such as text, graphic and audio over the internet. Incidentally, the first trial of the WWW occurred between CERN in Switzerland and a high school in Tasmania. Then in 1993, the first internet graphics browser was released with the result that nations globally scrambled to understand the economic impact of such an easy to use mechanism for exchanging multimedia information worldwide. Educators also began to re-examine this new information and communications phenomenon for its potential to improve access to online information and resources. Australia was no exception with its first national efforts in education and training beginning in 1993. Within 20 years, the internet had begun to transform traditional education by replacing restricted access to information and resources with almost universal access to both, progressively throughout the world.

Computer ownership and internet access in Australia has grown rapidly until today, there is at least one computer in almost every home in Australia, 12.2 million internet subscribers, 98% of users connected by broadband and 17.4 million mobile phone subscribers with internet connections (ABS, 2013). Internet access in Australia using a computer is almost ubiquitous, that is, almost everyone uses and relies on the internet and computers, whether they are desktop computers, laptop computers, tablets or smartphones. The uses of digital computers have greatly diversified and the number and range of digital services that are provided on the internet is vast, as is the potential for these uses in education.

Meanwhile, digital literacy has become increasingly complex, as portrayed by Durrant (2012) who describes its complexity as many literacies that have developed throughout the ages: oral, early writing, manuscript, print, video, critical, digital, multimedia, hypertext, and virtual reality (Durrant, 2012, p. xiii). So, how has the large complex adaptive system of education in Australia dealt with such changes and disruption in an environment that has remained almost unchanged for over 100 years (Papert, 1993)?

Successes and failures

The successes and failures of education in attempting to maximise the benefits of digital technologies are many. The section that follows selects and discusses only a few issues from the national collaborative efforts that began to address the issues associated with introducing and implementing digital technologies for teaching and learning. These efforts included the development of online portals and services, online content and changes in the application of copyright, a focus on the provision of digital devices and finally, mention is made of research into the use of digital technologies in education in order to maximise teaching and learning.

National collaboration

In 1993, the national and state education authorities in Australia came together as a national group to harness the opportunities presented by the new technologies. They established the Open Learning Technology Corporation (OLTC) for the purpose of promoting open learning technologies, developing networks of expertise across the States and to provide a research brokerage (Hesketh et al., 1996). Then, in 1995, Education Network Australia (EdNA) was created and OLTC was replaced in 1998 by a new national education and training technology agency called Education.au Limited that was responsible for the management of EdNA. The role of this new body was to foster collaboration and cooperation between key stakeholders in the use of the Internet as a tool for the delivery of education in Australia (MCEECDYA, 1996). By 2002, with the convening of the first Global Summit of Online Knowledge Networks in Adelaide, EdNA was recognised as a leading example of national collaboration.

Online portals

EdNA was successful in stimulating the development of state, Catholic and Independent school education internet services, as well as state vocational education and training internet services and the development of digital skills among its owners and stakeholders. EdNA provided quality assured linked educational resources, online spaces for professional learning communities and national standards for online educational services. EdNA was decommissioned in 2010 and both the national education technology agency and EdNA were shut down completely in 2012 after 15 successful years. EdNA had achieved its goal to engage the states and to stimulate development of online services in education. However, none of the research, content, policies, reports, papers, conference presentations or guides produced during that 15 year period of rich innovation and research has been preserved or archived and is now no longer available. That's a step backwards.

The states began to develop their own online education services as early as 1998. Victoria developed an online learning resources portal called SofWeb 1998 with a number of schools called Navigator Schools to pilot educational online learning innovation. Other states also developed online services such as New South Wales (NSW) with the Teaching and Learning Exchange (TaLE) resources portal and the Connecting Schools Project for professional learning; Queensland with the Learning Places (closed in 2012) exchange for online communities and sharing of teaching practices; Connected Schools in WA using a standard operating environment; the eSchool project in Tasmania; and the Learning Links project in the Northern Territory.

There may be lessons that can be learnt from these national and State activities. One lesson may be that when an innovation like EdNA becomes a national priority supported by resources, expertise and collaboration, then local State developments follow in time. However, when such a national priority project is withdrawn or ceases then state activities in that field may appear to wane (White & Parker, 2013). The question that then may arise is, 'To what extent do national innovation initiatives stimulate sustainable State activities that are integrated into day-to-day education programs?'

In 2000, a national initiative to develop online resources for schools was funded for the first time. Today the National Digital Learning Resources Network (NDLRN) (http://www.ndlrn.edu.au), known originally as The Learning Federation, hosts more than 16,000 interactive multimedia learning objects (ESA, 2013) available to Australian schools and teacher education faculties via a secure login. These online resources, paid for by Australian taxpayers, are not available to the Australian public, researchers, self-directed learners or students' parents. This situation has occurred at a time when the boundaries between learning at school and learning at home have become blurred, and the relationship between directed learning and self-motivated learning, that is, formal and informal learning has become one of interdependence (OECD, 2009). NDLRN has limited access to resources due to unreasonable copyright restrictions imposed by State education departments as stakeholders and other national government bodies. That's a step backwards.

Content

The proliferation of high quality open content e.g. Wikipedia (http://www.wikipedia.org/) on the Internet is widely known and used, as is open educational content e.g. Curriki (http://www.curriki.org/). There are many more quality educational online services, some of which can be found at the EduTech Wiki (http://edutechwiki.unige.ch/en/Learning_objects_repositories). Open content on the Internet is accessible and it is easily shared. The arguments in support of using quality open online content in education can be seen in the work of David Wiley (Wiley 2012). Its advantages include open access, reduced costs, sharable content and the ability to leverage the internet. However, the focus of Open Education Resources (OERs) is purely on content, whereas learning is a process and so some caution is needed in using OERs in education (Contact North, 2013). Without carefully considering the context for learning, content driven education has the potential to become a step backwards.

Copyright

In Australia, content produced by education departments can be openly licensed using the National Education Access Licence for Schools (NEALS) (http://www.dec.nsw.gov.au/footer/neals). There is a vast quantity of open online content available for use in education licenced using Creative Commons (http://creativecommons.org.au/) licences as well. However, without going into too much detail about copyright licences, there is a need to highlight the importance of students and teachers being aware of copyright restrictions for copying, pasting, quoting and reusing online material in order to avoid potential legal difficulties. This is a good reason for teaching students in educational facilities about copyright and the rules associated with intellectual property without which students and teachers can be at risk.

Devices

The use of digital technologies in learning remains largely concerned with the actual devices that are used. For example, in 1998 the Victorian education department initiated a program to give laptops to teachers (Blyth, 2002) with mixed results for classroom learning. Interestingly, a decade later in 2008 another program of laptops for teachers was announced although this time the laptops were regarded as essential equipment by teachers who were required to lease the laptops from the education department. Teachers are now taking action to recover payments for those laptops because they regard the laptops as essential equipment for teaching (2013, The Age).

In 2007, the Australian Government announced a new program called the Digital Education Revolution (DER), the main thrust of which was the National Secondary School Computer Fund (NSSCF) (http://deewr.gov.au/digital-education-and-technology-schools). Under the NSSCF program students in year 9 to 12 received a computer. The program was very successful and was responsible for delivering nearly one million devices most of which were netbooks. In March, 2010, part way through the DER program, Apple Inc (http://www.apple.com/) released a new device called the iPad. Almost overnight, netbook sales diminished until today netbook sales are minimal (Case, 2012) as they become obsolete. The risk of focussing on technological devices in education is apparent from this event.

Overall the DER invested over $2.4 billion dollars into the supply of computers, some professional development funding for teachers, the development of educational technology standards, funds to improve teacher education using digital technologies and the development of online content for schools. It was a bold and innovative program which established broad acceptance for the use of digital technologies in Australian education. As State education authorities and schools scrambled for their share of the funding and computers rolled into schools, there was little debate about the use of digital technologies for learning and even less research about how to maximise their use for learning. Nor did debates about the sustainability of networked technologies in education dominate the landscape. However, the beneficial use of digital technologies in education was accepted overnight. In the meantime books such as *Bring Your Own Technology* by Mal Lee and Martin Levins (2012) began appearing which suggest that computers able to access the internet could be regarded today as consumable items that are required by all teachers and students involved in education.

The focus on devices for use in education does raise a number of questions. For example, if education is about technological devices then students should be taught how to use them. On the other hand, if technological devices are a means to enable learning then learning using technological devices should be taught in schools. The focus for teaching students how to learn using technological devices should be based on sound qualitative and quantitative research. Yet, where is the research?

Research

In 2005, a comprehensive report on Australia's future using education technology (Spring, 2005) was released by the national department of education. It was based on nation-wide consultations. This thorough and comprehensive report is now very difficult to access due to the fact that the national education department, the Department of Education Employment and Workplace Relations (DEEWR), did not archive content from their earlier websites. The same is also true for the content on EdNA, as previously mentioned. There would appear to be a serious lack of attention to the

preservation and management of digital resources by government authorities. Lost research is a step backwards.

Research into the use of digital technologies and digital media in education is the main feature of the Digital Education Research Network (DERN) (http://dern2.acer.edu.au) which posts weekly reviews of significant education research into the use of digital technologies in learning at all educational levels. DERN also posts weekly news information that highlights the release of significant reports and studies that build on the digital technologies in education knowledge base. It is believed to be the only online service in the world dedicated to online education research about the use of digital technologies in teaching and learning for teachers, lecturers, researchers, educational administrators, policy writers and students.

There is an argument that research into the use of digital technologies in education does need to be more rigorous. Two examples will suffice here. The first is an experiment called the 'hole in the wall' experiment, conducted by a scientist in India. The results of the experiment spread throughout the world very quickly and were often quoted. In the experiment, computers were sealed in a concrete vault so that their touch screens could be manipulated. The experimental results claimed that young uneducated street children learnt how to use the hole in the wall computers, which had instructions in English, intuitively. The claims made on the basis of the experiment were not valid and the research not empirically based, suggests Watters (2013).

The second example, is the notion of 'digital natives and digital immigrants' advanced by Marc Prenksy (2001) in which he argues that young people are able to use digital technologies and digital media effortlessly whereas adults who were born before the invention of the internet struggle to use the internet effectively without significant effort. This pre-determinist view (Oblinger, 2005; Prensky, 2001; Tapscott, 1998) that digital technology skills are determined by the era of one's birth is not supported by research (Thomas, 2011; Kennedy, 2009). However, reference to 'digital natives' by educators and the news-media to illustrate usage of digital devices by young people remains common, contrary to the overwhelming evidence.

Summary

Many efforts have been made to encourage the take up and use of digital technologies in teaching and learning. These have included resource portals and repositories of online curriculum learning objects, email alert services and online discussion groups for teachers with common interests. There has also been an emphasis on increasing the number of computers per child culminating with one computer per child in years 9 to 12. These initiatives came from a limited knowledge base of educational research. Based on the evidence that is now emerging, one can only conclude that education has not taken the restructuring of information and communications in society too seriously but is content to allow digital technologies to shape education instead of placing learning at the heart of education and using digital technologies to improve learning. Some gains have been made with infrastructure and content but a focus on pedagogy and research has been lacking. That may be described as, two steps forward and one backwards.

Is technology successful for learning?

There have been many research reports that have taken a position on the benefits of using digital technologies for teaching and learning. The influential European (European Commission, 2006) and British learning technology impact on learning studies (Condie & Munro, 2007) indicated that there were a range of benefits for teaching and learning. However, there are two studies that stand out: a study by the US Department of Education and a second order meta-analysis of 40 years of technology in education.

The first, a meta-analysis of studies about online learning (Means et al., 2010) concluded that blended learning was superior to face-to-face learning and online learning on their own. That is, blending face-to-face learning with appropriate educational use of online learning was more beneficial than the other two modes. The second study was titled *What Forty Years of Research Says About the Impact of Technology on Learning: A Second-Order Meta-Analysis and Validation Study* (Tamin et al., 2011). This investigation compared the research conclusions of 176 studies although only nine were focussed on K-12 education. It concluded that studies had shown that effective teachers using digital technologies had improved learning by 12% which is statistically a low to moderate increase.

In a more recent study of the take up of digital technologies for teaching (Crook, et al., 2013), the researchers found that 30% of teachers had a highly aligned use of digital technologies with their students, 55% were moderate and 15% were quite misaligned. However, these studies are focussed on how teachers use digital technologies rather than how students use digital technologies for learning.

Assuming that the use of digital technologies are beneficial to teaching and learning especially in blended mode, then the question emerges, 'How do users use the internet?' Research by ACER in 2003 (Lonsdale, 2003) isolated four different types of users of the internet: searchers, explorers, self-improvers and participators (Lonsdale, 2003, p. 43). More recently, as a result of the vast amount of ever increasing information and content for learning available on the internet, a fifth type of user has been identified as curators (Mihailidis, 2013). Given that we now know how people expect to use the internet, especially students, then learning programs can be planned to engage students accordingly. However, what do students say about learning online?

In a recent study in which tertiary students were asked about their preferences for taking either online courses or face to face studies, the findings were clear. Students preferred explanations from the teacher and interaction with the teacher (Jaggars, 2013). This corresponds with research that suggests that when students are engaged in online courses, they value effective and immediate feedback (Hepplestone, 2011). Research by Moyle and Owen (2009) demonstrated clearly that students expected to be able to access the internet for learning purposes because they felt that the internet benefited their studies. However, as pointed out by Kennedy et al. (2009) in a landmark study of the digital competency of university students, student skills for study, collaboration and research using the internet were not well developed.

We understand then that students expect to be able to use the internet for their studies at their learning institutions; they also expect to be engaged and to be able to interact with their teachers and receive feedback with a preference for immediate feedback but that their competence for study, research, collaboration, curation and presentation using the internet is still limited. These are skills that need to be taught. A study in 2008 by Burgad of the use of laptops for learning found that 'students, teachers, and parents all perceived increased student engagement, motivation, and organization, along with improved research, writing, and editing skills' (Burgad, 2008). In fact, these laptop students also made learning improvements in mathematics and language arts although they decreased in reading, reported the researcher. Based on the above information, there is a clear need for educational leaders and lecturers/teachers to understand how digital technologies can be used successfully for learning as well as for teaching. A place to start would be agreement on a framework of the knowledge and skills domains that may be necessary.

Thinking about digital technologies in education

The use of a framework for thinking about teacher knowledge to integrate digital technologies in teaching and learning is particularly useful. Koehler and Mishra (2009) argued that teachers needed to have (T) technological knowledge, (P) pedagogical knowledge (A) and (C) content (K) knowledge. This framework for thinking about the teacher knowledge that is necessary has come to be known as TPACK. Koehler and Mishra (2009) advanced the thinking that teachers required this base of knowledge for effective teaching with digital technologies. As mentioned above, Australia has focussed on the content and the technological components but research and good teaching practices based on sound pedagogical thinking would appear to be scarce.

The simplistic TPACK model is useful for thinking about teacher's knowledge and the implementation of technology with teaching and learning. However, a more nuanced way of thinking about the future of digital technologies in education was advocated by Pegrum (2009). Pegrum (2009) recognised that the rise and use of digital technologies, especially in education, was a global phenomenon. He argued that there were a number of perspectives that needed to be taken into account through five different lenses: a technological lens, a pedagogical lens, a social lens, a socio-political lens and an ecological lens. Using these perspectives for planning the use of digital technologies in teaching and learning is particularly useful because there is consciousness of a blurring of the boundaries between learning at school and learning at home using a system that is global in nature. This is important because we have learnt that students who use computers both at home and at school do better than students who use technology only at school (OECD, 2009). In fact, there would appear to be a negative effect on learning for students who only use computers at school (OECD, 2009).

The issue of equity emerges from this discussion especially for students from low-socioeconomic backgrounds, from indigenous backgrounds, those with low English language proficiency, students in remote locations and those with a disability (Australian Government, 2011). A theory for explaining teaching and learning practice, in such a complex and adaptive system such as education with so many variables, would also be helpful.

Do we have a theory?

Discussions and thinking about a theory for using digital technologies in education began largely with the proliferation of personal computers. Taylor (1980) suggested that there were three categories of computer use at a time when personal computers were used as stand-alone devices. They were the computer as a tool, as a tutee, and as a tutor. That is, the computer could be used as a device to achieve a task, the computer could be taught and the computer could teach the student. However, these categories were soon disregarded as other education technology thinkers such as Rushby (1984) described computers as enablers. Rushby (1984) argued that computers enabled instruction, they enabled new information to be revealed, they could enable conjectural thinking such as the testing and modelling of new ideas, and they could reduce the workload of students. However, the connectivity of computers with the internet advanced the development of theory in a different direction.

In 2004, George Siemens first proposed his theory of Connectivism (Siemens, 2005) as a learning theory for the digital age. This radical departure from traditional learning theories such as behaviourism, cognitivism and constructivism where the individual was the focus for learning provoked considerable ferment about the use of digital technologies for teaching and learning. Siemens (2005) argued that knowledge was diverse and changeable, and that being connected on the internet meant that knowledge resided in the networks which needed to be maintained. He argued further that the capacity to learn more was more important than what was currently known. Such a fundamental departure from theorising learning as part of an individual to thinking about learning as part of a network, spawned international controversy and discussion. Connectivism also stimulated online experiments in education and new forms of being connected for learning such as massive open online courses or MOOCs. MOOCs based on the open connectivist approach became known as cMOOCs and the more traditional distance mass learning courses known as xMOOCs (Clark, 2013).

More recently, leading researchers and thinkers in the area of teaching and learning using digital technologies have advanced theories that have gained some traction. Harasim (2012) has cogently put the case for online collaboration as a theory to explain the educational use of digital technologies for teaching and learning. Harasim's (2012) theory of online collaboration harnesses one of the main benefits of using digital technologies for learning and is consistent with other learning theories. Online collaboration is particularly appropriate for application in higher education in an age when participation is expected and rewarded (Bull, 2008). The focus on a theory for learning is important in order to explain how learning best takes place but what about good teaching practices that can stimulate learning?

In a most lucid treatise on teaching using digital technologies, Laurillard (2012) has built on the notion that the skill of teachers is about designing appropriate learning experiences for students. Laurillard (2012) argues that teaching is a design science that builds pedagogical patterns for learning using digital technologies. Her argument advances the strengths of learning using inquiry methods, discussion, practice and collaboration that can be enabled further than before using digital technologies.

Siemens (2005), Harasim (2012) and Laurillard (2012) have made significant contributions to advance thinking about a theory for integrating digital technologies with teaching and learning. They have provided a sound basis for planning teaching and learning. In addition, they have provided a guide for the professional development of lecturers, teachers and Principals. The development of pedagogical knowledge is as important as the technological knowledge and the content knowledge, if not more so, because teaching and learning are at the centre of education.

Research

Research into the use of digital technologies for teaching and learning has been included throughout this paper. However, there are three further issues that are worth mentioning in the context of using digital technologies for teaching and learning: distractability, social networking, and gender.

Distractability and social networking

Digital technologies are commonplace in Australia with most people having access to and using them, particularly mobile devices. Research has consistently pointed out that distractability (Cha, 2010; Jennings, 2010; Gasser, 2012) can be an issue using digital technologies for learning. Cha (2010) has also pointed to a significant finding in relation to social networking in that it can be used for personal organisation, for playing games, for entertainment and for keeping in touch with friends on the one hand or social networking can be used for productivity, learning and research on the other. That is, social networking can be used for social purposes or productive purposes. There is considerable evidence that using social networking for productive purposes is beneficial (Harasim, 2012; Laurillard, 2012) and there is also evidence that a high use of social networking for personal purposes is counter-productive. For example, Kirschner and Karpinski (2010) found that the prolific use of Facebook by students had a negative effect on student performance. Pea et al. (2012) have gone further and showed how media multitasking, online communication, messaging, talking and listening to music are interchangeable but online reading and online communication are not interchangeable. That is, reading and communicating online are uninterruptable activities that require single task focussed concentration.

Gender

There has also been some research that has indicated that females perform better at online searching and digital literacy than males (Tsai, 2012), that females are better at playing computer games although males play more often (Roberston, 2012) and that females outperform males in digital reading although males outperform females on navigation tasks (OECD, 2012). Although these issues may seem inconsequential initially, they do indicate that when using digital technologies for teaching and learning that the different approaches of females and males to the use of technology is worthy of consideration.

Pedagogy

Research and trials in education have shown that there is a raft of suitable pedagogies to choose from for using digital technologies that have distinct advantages in terms of engagement and student performance. A selection for further discussion includes:

- Project based learning (Skillen et al., 2012)

- Inquiry based learning (Laurillard, 2012; Pow, 2012)
- Research based learning (Skillen et al., 2012)
- Project based learning (Gurell, 2010)
- Self-directed learning (Siemens, 2005)
- Personalised and customised learning (Project Tomorrow, 2012)
- Online collaboration (Hasrasim, 2012).

There is an indication in these pedagogies that a shift is taking place in education towards more student-centred learning and participatory learning programs. If this is the case then teaching and learning have moved considerably away from traditional passive receptive learning to more interactive and engaged learning. This provides a sound argument for the need for systematic and continuing professional learning for educational leaders, lecturers and teachers throughout education without which beneficial change in education is unlikely to happen.

Sustainability

These changes in education come at a financial cost in terms of the infrastructure, technical support and the availability of internet accessible devices for use by teachers and students. Although high-speed broadband is being rolled out across Australia, the provision of fibre optic backbones with wireless nodes remains necessary in educational institutions in order to achieve mobile connectivity to the internet for students and teachers. Evidence would suggest that across the nation this is happening progressively which could be considered as a step forward.

However, the ongoing provision of internet accessible devices for students remains an issue following the provision of laptops for students in year 9 to 12 as part of the DER. One solution that has been advanced is the 'bring your own technology' (BYOT) strategy. This strategy is explored in some detail in the book of the same name by Lee and Blevins (2012) where the authors liken ownership of internet accessible devices to that of consumables. They argue further that such devices are personal items and allow students to engage in personalised learning and productive collaboration at both home and at school. However, the issue of equity remains when this strategy is considered.

Whereas infrastructure and technical support will incur additional costs, the provision of online content could reduce costs for schools and universities, students and teachers. In the US, the Obama administration, the US Department of Education and the Federal Communications Commission (FCC) together with a number of US states such as Maine, Texas and California, have mandated that electronic open texts be used in schools within five years (Cummins,, 2012; Lederman, 2012). Electronic texts are cheaper to produce, reuse, copy, share, store and manage. Furthermore, they are more functional in terms of multimedia use such as embedding audio, graphics, animations and video, as well as text analysis such annotating, searching, noting, linking and copying. The proliferation of open online content suggests that there is no shortage of suitable content online although questions of quality, suitability for education, relevance and currency remain. In order to use appropriate online content, students need to be taught digital literacy skills to discern the following attributes of online content: authority, accuracy, coverage, objectivity, date and

significance (Tyndall, 2008). How can these infrastructure/technical support sustainability needs and the transition to online texts be achieved?

Next steps

The need for digital educational leadership at senior levels in education is urgent. A leadership that understands where the changes are occurring as a result of the application of a new global digital infrastructure together with the impact it is having on teaching and learning is fundamental, if education is to move successfully into the digital era. Many areas of service, such as medicine, health and news media, have begun to understand the changes in information and communications that are occurring, and to adapting and directing how the changes will occur in their domains. Education also needs to begin to drive digital use for education in an appropriate teaching and learning focussed direction.

The author would contend that funds spent on digital educational infrastructure, technical support and the development of content should be equalled by funds allocated to the professional development of teachers and lecturers. Professional development that explores, trials and shares good pedagogical practices across the disciplines in order to develop knowledge sets of best educational practices using digital technologies is essential, if teaching and learning is to be maximised (Aubusson, 2005; Pegg, 2007; Timperley, 2007; Hadfield, 2009; Hammond, 2009; Gerrard, 2011).

However, using digital technologies in education also needs to be taught. If students are to learn to use digital technologies appropriately then use of digital technologies needs to be modelled by teachers (Crook, 2013). The knowledge and skills that are needed include:

- Acceptable behaviour
- Collaboration, communication, problem and research skills
- Digital commons
- Community involvement
- Copyright and intellectual property
- Critical thinking
- Design skills
- Digital fluency
- Ethics
- History of the internet
- Identity
- Project management
- Safety
- Technology terms (White, 2012).

Leaving the use of the internet for teaching and learning to serendipity is counter-productive given that the use of digital technologies today and the opportunities it affords are as important as reading and writing.

What are the challenges and opportunities?

Education has spent considerable sums of money on the development of infrastructure (NBN, wireless, devices) including technical standards and also on online content (portals, learning objects) but minimal on research into using digital technologies for learning and good pedagogical practices. In saying 'three steps forward and two back' there is recognition that something continues to be overlooked. In fact, what is missing is research into the uses of digital technologies for learning and sharing good pedagogical practices that can maximise learning.

The challenges that education faces in coming to terms with the new digital age and shaping it appropriately for teaching and learning are not new. Each of the challenges has been mentioned, in different places, above. They also equate to opportunities to focus on learning in education and include:

- Research into the use of digital technologies for learning,
- How to build and sustain online learning communities to advance good pedagogical practices,
- How to assess online learning, that is, learning analytics,
- Educational leadership in research and good teaching practices using digital technologies, and
- Professional learning for lecturers and teachers in designing learning experiences based on research.

Is education in Australia up to the challenge? Educational leaders will be judged by their efforts and the resources that are deployed to grasp these opportunities. The alternative is for economists and politicians to drive education and continue missing the many opportunities that digital technologies enable for learning.

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