

Deep Learning, ICT and 21st Century Skills

Leading for Education Quality

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Abstract

One of the key challenges confronting Catholic Education is improving educational quality. A key indicator of improved educational quality is improving student-learning outcomes so that students acquire the skills needed for 21st century learning. These skills include creativity, communication, collaboration and critical thinking as well as being productive users of technology. The acquisition of 21st century skills requires the development of personalised learning that is broader than simply an acquisition of the basics. Leaders have a crucial role to play in understanding student learning and in facilitating a teaching and learning program which moves from surface to deep learning. The use of information and communications technology (ICT) is fundamental for the kind of personalised learning needed for the development of deep learning but, as the SAMR model makes clear, simply using technology does not guarantee that deep learning will occur. What is crucial is the transformative use of ICT for learning. This paper is designed to link understandings about deep learning with the appropriate use of ICT to enhance learning.

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Introduction

In recent times there has been increasing pressure on school systems, schools and school leaders to ensure continuous improvement. While school leaders are being called upon to undertake a seemingly never-ending list of social responsibilities they are, at the same time, expected to meet increasingly demanding accountability requirements as well as significantly improving student learning outcomes (Dinham, 2007). The expectation is that leaders will transform their schools in ways that are “significant, systematic and sustained, resulting in high levels of achievement for all students in all settings, thus contributing to the well-being of the individual and the nation” (Caldwell, 2005, p. 3). Central to this process of transformation has been an unrelenting focus on student outcomes (Caldwell & Spinks, 1998).

This emphasis on improvement has given rise to, amongst other things, the publication of data in a number of states about how secondary schools have performed in terms of Year 12 results despite concerns that this kind of data is too simplistic and can be too readily used to label schools as ‘failures’ (Gurr, 2002). In addition to Year 12 data, a wealth of other data Australia wide has been gathered since the advent of nation wide NAPLAN tests (Victorian Curriculum and Assessment Authority, 2009). These results have, in turn, formed the centrepiece of the My Schools website (Australian Curriculum Assessment Reporting Authority (ACARA), 2010). Although the provision of education has been a State Government responsibility, the introduction of national testing is part of the growing trend of Australian Government intervention in education policy in the national interest (CSCNEPA, 2008).

Meanwhile, schools and teachers are faced with mounting criticism in the media by politicians, public and social commentators (Starr, 2008) as well as an expectation that student performances will be improved (Duignan, 2006). It is not uncommon to hear of ‘failing schools’ and judgements about ‘good’ and ‘bad’ teachers (Elmore, 2002).

The emphasis on schools transformation is no less real in Catholic schools. The Catholic Education Office Melbourne describes the School Improvement Framework as having two purposes:

1. To satisfy legitimate expectation of government sector authorities about accountability for the outcomes of schooling and
2. To assist schools and teachers to improve student learning outcomes. (Catholic Education Office Melbourne, 2013)

This clearly demonstrates that Catholic schools are subject to the same pressures and are pursuing the same goals as other schools.

Leadership in Schools

The focus on student learning outcomes raises the question as to how these improvements are to take place (Stoll, Fink, & Earl, 2003). While it is widely understood that the individual teacher in the classroom is the most significant school based factor in terms of student achievement (Hattie, 2009), one of the keys to improvement in student learning is effective leadership (Leithwood, Louis, Anderson, & Wahlstrom, 2004; Reeves D.B, 2008). A discussion of leadership needs to acknowledge that leadership is complex and needs to take into consideration the

context in which that leadership takes place (Leithwood Jantzi, 2005; Southworth 2005). Nor should that discussion be limited to the work of the principal whose work, while no doubt important, has only an indirect impact on student learning so that the principal must work with and through others to achieve improvements (Hallinger & Heck, 1996, 1998). Nor should any discussion of leadership become bogged down in a consideration of the different labels sometimes applied to educational leadership:

Different forms of leadership are described in the literature using adjectives such as “instructional,” “participative,” “democratic,” “transformational,” “moral,” “strategic” and the like. But these labels primarily capture different stylistic or methodological approaches to accomplishing the same two essential objectives critical to any organization’s effectiveness: helping the organization set a defensible set of directions and influencing members to move in those directions. Leadership is both this simple and this complex (Leithwood et al., 2004, p. 6).

From this description of leadership it is clear that leaders in schools have the responsibility to set the direction when it comes to improving student learning outcomes.

Directions in 21st Century Learning

The dilemma for school leaders leading transformation for teaching and learning is one of which direction to take: what kind of learning is appropriate for the 21st century? Silva (2008) argues that, “integrating 21st century skills into teaching and assessment, then, is not only an economic imperative, driven by changes in the workforce, but a vital aspect of improving learning” (p. 12). The American Management Association (2010) and AT21CS (2012), (a world wide collaboration amongst information and communications technology (ICT) industry and educational institutions) have both attempted to identify the essential and necessary skills for teachers and students into the 21st century.

The need in Australian education to forge a new learning approach for the 21st Century resulted in the Melbourne Declaration (MCEETYA, 2008). This Declaration, emanating from the combined Commonwealth and State Government body MCEETYA (Ministerial Council for Education, Employment, Training and Youth Affairs) has, in turn, guided the development of the Australian Curriculum (Australian Curriculum Assessment Reporting Authority (ACARA), 2013). The Declaration states that successful learners for the 21st century need:

- To have the essential skills in literacy and numeracy and be creative and productive users of technology, especially ICT, as a foundation for success in all learning areas
- To be able to think deeply and logically, and obtain and evaluate evidence in a disciplined way as the result of studying fundamental disciplines
- To be creative, innovative and resourceful, and be able to solve problems in ways that draw upon a range of learning areas and disciplines
- To be able to plan activities independently, collaborate, work in teams and communicate ideas

As Keane, Keane and Blicblau (2013 (in press)) have highlighted there are strong similarities between the kinds of 21st century skills outlined in the AMA, the AT21CS framework and the Melbourne Declaration. These skills have been identified as the 4Cs:

- **Critical thinking** & problem solving
- Effective **communication**
- **Collaboration** & team building
- **Creativity** & innovation

While basic skills such as numeracy and literacy (often referred to as the 3Rs) are still considered to be the building blocks for learning, the 4Cs are clearly higher order skills. In addition to the 4Cs all three definitions of 21st century skills highlight the importance of ICT for learning. The Melbourne Declaration is especially significant as ICT is seen as foundational for successful learning. It should be noted, though, that it is not just competence in ICT that is seen as a necessary foundation for success but “creative and productive” use which is necessary. This clearly has implications for how ICT is delivered in the classroom.

The significance of ICT for 21st century learning is further highlighted in the European context as shown in a “21st Century Skills Discussion Paper” prepared by the Universiteit of Twente on behalf of Kennisnet, which acknowledged that:

Information and Communication Technology (ICT) is at the core of 21st century skills. Specifically, it is regarded as both (a) an argument for the need of 21st century skills, and (b) a tool that can support the acquisition and assessment of these skills. In addition, the rapid development of ICT requires a whole new set of competences related to ICT and technological literacy. (Voogt & Roblin, 2010, p. i)

Similarly, a later joint EU-US Study, on “Emerging Skills and Competences” identified ICT as crucial in the development of innovative approaches to 21st century education and lifelong learning (Shapiro, Lauritzen, & Irving, 2011).

However, there is a challenge for school leaders in terms of harnessing the potential power of ICT in the terms just discussed. Flanagan and Jacobsen (2003) identified four issues as barriers to implementing Information and Communications Technology in schools:

1. Pedagogical issues;
2. Concerns about equity;
3. Inadequate professional development;
4. Lack of informed leadership.

These four barriers are, in different ways, reflected in the literature on the implementation of ICT in the curriculum. Each of these issues can be understood as being concerned with leadership.

Concerns have been raised about the ability of the principal and other school leaders to exercise effective leadership with respect to ICT. Two studies (Dawson & Rakes, 2003; Gurr, 2000) emphasised that principals are often not experts in the use of Information and Communication Technologies while Schiller (2003) argued that principals have not been prepared for their “role as technology leaders, nor have they had opportunities for meaningful experiences in using computers with children” (p. 172). Schiller (2003) concluded that “Principals need to understand the capacities of the new technologies, to have a personal proficiency in their use, and be able to promote a school culture which encourages exploration of new technologies in teaching, learning and management” (p. 172)

Moyle (2006) contended that “integrating ICT into teaching and learning requires schools to have a ‘whole school’ strategic focus on student learning, teaching and organisational improvement” (p. 52). Both Moyle (2006) and Lee and Gaffney (2008) have argued that few principals are well placed to understand what it means to lead a digital school. Keane (2012) argued that the effective integration of ICT in the curriculum is “fundamentally a question of pedagogical leadership” (p. 52) and that “With significant investment in ICT being made in the belief that the quality of learning will be enhanced, leadership is a critical requirement” (p. 51).

This emphasis on enhancing the quality of learning requires schools leaders to embrace the central role of learners with respect to learning. This responsibility is articulated in the Melbourne Declaration (MCEETYA, 2008) as one of the key goals, “All young Australians become successful learners, confident and creative individuals, and active and informed citizens”(p. 8). This goal is clearly aligned with core values of Catholic Education where, “At the heart of all our endeavours is the student” (Catholic Education Office Melbourne, 2011, p. 3). Given the fundamental role for ICT in terms of contemporary learning and teaching and the issues about the degree to which school leaders are adequately prepared to provide direction in ICT, the challenge is how to best help learners to acquire appropriate 21st century learning. A good place to start is with learning itself.

Understanding Learning

A number of writers have made assertions about the power of ICT to transform learning, partly on the basis that the use of ICT shifts control of learning to the learner (November, 2010; Papert, 1993). This shift of control is important for teaching and learning and it has a direct impact on how we learn (Bransford, 2000).

Early conceptions of learning implied that learning was passive so that “learning was something that *happened* to the learner” (Stoll et al., 2003, p. 23). This understanding of learning led to an emphasis on *filling* the *empty vessel* (the learner) with content. This view of learning tends to result in a *transmission* understanding of teaching in which the teacher explains or tells the learner what to learn and, by extension, what to think.

Set against this view of learning is constructivism which describes learning as being actively constructed by the learner so that the learner is actively engaged in learning rather than passively receiving information (Sjøberg, 2007). This understanding of learning can be traced back to two main theorists who approached

learning from quite different perspectives about how learning is constructed. Piaget's (1953) influential work focussed on the cognitive understanding about how individual learning takes place and he identified four distinct developmental stages from birth to adulthood. In contrast, Vygotsky (1962) was interested in understanding how learning was shaped by the social context and this led to his work on the zone of proximal development which can be understood as the gap between what learners can do by themselves and what they can do with others. Despite their differences, Piaget and Vygotsky can be seen as the forerunners of constructivism, which describes the process whereby learners construct knowledge by developing ways that allow them to add new information to existing knowledge in order to build understanding. While constructivism is a theory of learning, it is sometimes described as if it were a theory of teaching (Loughran, 2010). It is when constructivism is used as a prescription for teaching that it is subject to criticism (Sjøberg, 2007).

The central role of the learner in determining what is learnt is further elaborated by an understanding of *metacognition*, a term first defined by Flavell (1976) as "the individual's awareness, consideration and control of his or her cognitive processes and strategies" (p. 231). Metacognition describes the ability to monitor and control thinking processes and it is a kind of controlling function or voice. Self-talk is the hallmark of metacognition and can be seen most readily in terms of questions we ask ourselves about a task such as: *where do I start? What do I do next? How well did I do?* Understanding that there is this sense of executive control has been very important in terms of explaining our ideas about thinking and learning and it highlights the importance of reflection as a key tool for thinking.

Consideration needs to be given not just to learning but also to the quality of learning. From their research, White and Baird (1991) reached five conclusions about learning which are summarised below:

1. Learning outcomes are determined by decisions made by the learner
2. Poor learning is due to poor decision making
3. Learners are often unaware of their learning problems
4. It takes effort to learn with understanding or change a conception
5. Increased awareness of learning changes attitudes and procedures

The centrality of the learner in the learning process has focussed attention on how learners learn and what factors enable better learning. This has, in turn, led to various ways of understanding how thinking takes place. For example, Gardner's (1983) theory of multiple intelligences described eight intelligences which usually operate interdependently. Gardner's work described learning in different kinds of ways: spatial, linguistic, kinaesthetic, musical, interpersonal, intrapersonal, naturalistic and existential. Because of this mix of learning styles, learners learn in ways that are essentially unique to them and this clearly has important implications for the construction of learning activities. Costa and Kallick (2000) also looked at how individuals learned and they identified 16 *Habits of Mind* which lead to successful learning. These *Habits* are best described as psychological dispositions, which the learner brings to the task as important precursors to learning.

Just as ideas about learners have been subject to change, distinctions can be made between different kinds of learning. In developing the Taxonomy of

Educational Objectives, Bloom (Bloom, Engelart, Furst, Hill, & Krathwohl, 1956) outlined a way of categorising instructional objectives and assessment according to increasing levels of cognitive complexity. His classification system was based on the idea that different learning objectives are the result of different skills and abilities and that some objectives are easier or harder than others. Bloom's Taxonomy classified thinking skills into six categories (using nouns), each of which was dependent upon the previous one: knowledge, comprehension, application, analysis, synthesis, and evaluation. Because each thinking skill was dependent on the one before it Bloom's Taxonomy is a hierarchical structure. Partly to take into account the use of technology as a mode of instruction as well as objections to the use of nouns for some of the skills, Bloom's Taxonomy was later revised to reflect the changes in the educational landscape (Anderson et al., 2001). The revised taxonomy replaced the nouns with verbs to form the following categories: remembering, understanding, applying, analysing, evaluating and creating. One of the issues with the Taxonomy (in whatever form) is that its use can lead to the belief that it is necessary to completely master the lower level thinking skills before moving onto the higher order ones. The obvious danger is that too little time and attention is devoted to the higher order skills. Nevertheless, Bloom's work had a major impact on education as it introduced the concept of higher-order thinking skills. The recognition that there is a hierarchy of skills has led to the distinction being made between surface learning and deep learning.

Understanding the difference between surface learning and deep learning is important. Marton and Saljo (1976) focussed their research on what they described as "meaningful learning in the true sense of the term" (p. 11). When they scrutinised students' approaches to reading texts they found that there were significant qualitative differences between what students learned and this was determined by whether they adopted a largely rote learning strategy to remember the text itself (surface learning) or whether they were using strategies which focussed more on the author's meaning (deep learning).

This distinction between surface and deep learning is a key feature of the SOLO Taxonomy (Biggs & Collis, 1982). SOLO, which stands for the Structure of the Observed Learning Outcome, is a means of classifying learning outcomes in terms of their complexity, enabling students' work to be assessed in terms of its *quality*. The SOLO Taxonomy describes how, once students move beyond unfamiliarity with the material (pre-structural), surface learning responses require one idea (uni-structural) or many ideas (multi-structural). Deep learning responses require students to relate ideas (relational) or extend ideas (extended abstract). Surface learning is typically *quantitative* in nature where students recall facts or lists to put together. In this form, assessment is often a matter of seeing how many facts are recalled. In contrast, deep learning is essentially *qualitative* where students are required to form judgements and think conceptually and these tasks are often longer and more complex.

Many of these conceptual understandings of learning including the importance of the learner in the learning process, the focus on deep learning for understanding and the transformative power of ICT has led to the development of the concept of personalised learning (Keamy, Nicholas, Mahar, & Herrick, 2007). The key features of personalised learning are:

- Learners are central

- ICT is a key enabler
- Learning is lifelong
- Communities of collaboration are created.

Personalised learning requires the connective power of ICT to develop ways of thinking and learning which liberate and empower the learner. While many traditional elements of education such as basic literacy and numeracy skills (3Rs) remain important, “We need to move our thinking beyond our primary focus and fixation on the Three Rs (3Rs) – beyond traditional literacy to an additional set of 21st century fluencies, skills that reflect the times we live in” (Crockett, Jukes, & Churches, 2012, p. 17).

It is within this context of learning that school leaders should focus their attention on the use of ICT in the classroom. To be effective learners, students need to be able to integrate the 4Cs in an online world. It is tempting, then, for leaders to believe that the main focus of their efforts should be to provide students with computer devices. Much government policy has been based on the assumption that access to technology is the key to achieving success and school leaders have, often of necessity, focussed their attention on the provision of computers for staff and students. Leaders need to do more than simply providing students with mobile devices such as netbooks, iPads[®], tablets, and laptops as these devices will not, of themselves, develop these skills and enhance their learning. What the teacher does in the classroom with these devices is important for developing a personalized student-learning scheme for technology adoption and school leaders have a key role in providing the vision to achieve this. As principals and other school leaders often lack skills and expertise when it comes to the provision of ICT for teaching and learning providing the necessary vision is a challenge.

The way forward for school leaders is to make use of their grasp of learning as a way to understand how best to utilise ICT for improving student learning outcomes. Crucial to understanding learning is the distinction between surface learning and deep learning which is usefully described using the SOLO Taxonomy. In a similar way, but with a focus on ICT, the SAMR Model developed and enhanced by Puentedura (2011) divides technology usage into four distinct levels as depicted in Figure 1. In this model, *substitution* is the lowest level of technology usage where it is used to simply replace whatever was being done without that technology. For example, a word processor – without the use of enhanced features for editing - is used as a substitute for pen and paper. At the next level, *augmentation* is where the technology acts as a direct tool with some functional improvement, following on from the previous example, the use of sophisticated editing functions are used in this level. For example, the difference between *substitution* and *augmentation* is the use of features to improve the product. However, only basic learning skills take place. These two levels of technology use are defined as the *enhancement* stage.

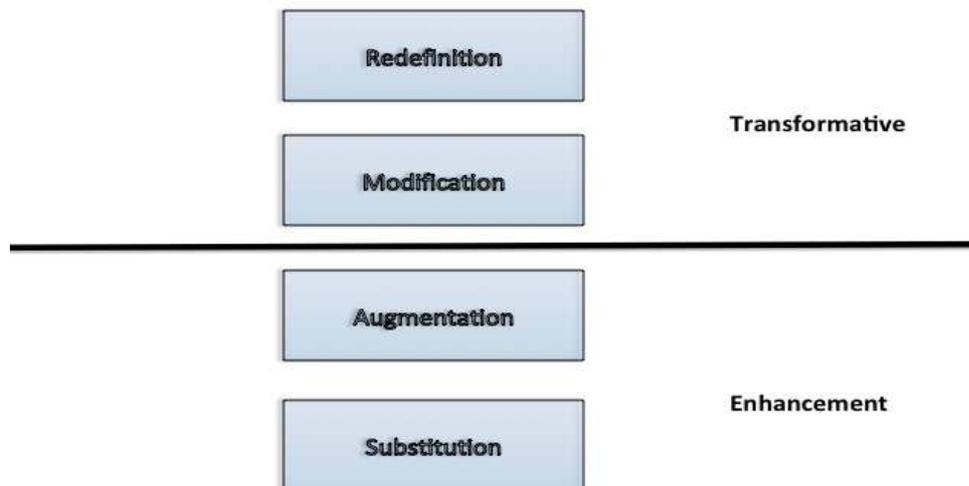


Figure 1: SAMR Model for Technology Adoption

Whereas, in the *enhancement* stage, the task could have been completed satisfactorily without using technology, at the *modification* level the task becomes something quite different. So that rather than complete a word-processed piece to be printed out, the writing becomes part of a blog, wiki or social network exchange. The final level of *redefinition* is where the technology allows for the creation of new tasks previously inconceivable. This final level is difficult to describe as we are constantly redefining what is possible using technology in advance forms. These two levels, *modification* and *redefinition* are identified as the *transformative* stage.

What the SAMR model shows us is, when technology is only used in the *enhancement* stage, there is a minimal effect on learning (Herrington, Herrington, Mantei, Olney, & Ferry, 2009). As mastery of the 4Cs requires deep learning, ICT use needs to be *transformative* to provide the ideal conditions for powerful learning. According to Oostveen, Muirhead & Goodman (2011), “It seems that meaningful learning is far more likely if the new technologies are recognized as providing transformative opportunities” (p. 83).

Ensuring there is powerful lifelong learning and teaching which is flexible and personalised is one of great challenge for leaders in schools. The development of a suitable framework for learning and teaching which emphasises higher order thinking of the kind embedded in the Melbourne Declaration (MCEETYA, 2008) and in which ICT is a central enabler is important if school leaders are not to be overwhelmed by the task at hand. Taking elements from the work on 21st century skills, the SOLO Taxonomy for surface and deep learning and the SMAR model for technology adoption produces Figure 2:

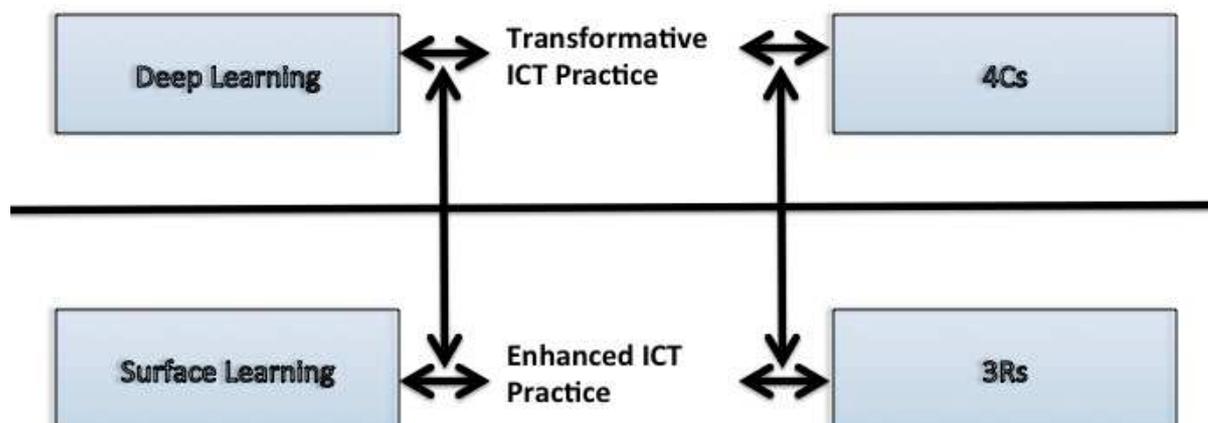


Figure 2 – A model for enhancing 21st learning

This model highlights that learning contains both lower level or basic skills and higher level or more complex skills and that these skills are in relationship with each other. The horizontal arrows illustrate the relationship between three elements of the model both the lower and higher order thinking, while the vertical arrows highlight the relationship between the two levels. While there is a distinction between the two levels, in one important respect this is not a hierarchical model as it is not necessary to demonstrate complete mastery of the lower order skills before attempting the higher order skills.

Conclusion

There is a good deal of agreement about what is commonly thought of as 21st century skills. Most definitions of these skills include critical thinking, communication, collaboration and creativity. These are clearly higher order skills, which build on more basic skills. Acquisition of these skills requires the development of personalised learning in which the use of ICT is fundamental. School leaders have a crucial role to play in setting directions for the use of ICT but they do not always have the necessary skills to ensure the transformative use of ICT for learning. The way forward for school leaders is for them to consider ICT use in the broader context of learning generally. The use of a model such as the one described in this paper could be useful for leaders seeking to facilitate the use of ICT to enhance learning.

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