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Beyond traditional literacy: Learning and transformative practices using ICT

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Abstract Educators, government bodies and employers have acknowledged the need for modern learners to acquire 21st century skills using information and communication technologies, to personalise student learning. Students need broader skills than the 3Rs (reading, writing and arithmetic) to operate in the 21st century. These broader skills known as the 4Cs include: creativity, communication, collaboration and critical thinking. The use of information and communication technologies is crucial in developing the 4Cs in conjunction with understanding how learning takes place. However, simply using technology does not guarantee that deep learning will occur. The use of technology needs to align and adapt with our knowledge of learning to be able to operate in a transformative space. This paper is designed to link the understandings of deep learning, 21st century skills and appropriate use of information and communication technologies to provide direction to educators who wish to lead in a technological environment of change.

Keywords 21st century skills · ICT · 4Cs · 3Rs · Personalised learning · Transformative · Deep learning · Surface learning

1 Introduction

The 21st Century has seen education and industry inundated with advances in, and opportunities presented by, information and communication technologies (ICT). Current students belong to a Generation Z world also referred to as the *Technology Generation* (Tucker and Bari 2010). They define this generation as "technically savvy, well adapted at communicating via the Internet, and used to instant action due to the

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Internet technology they have always known" (Tucker and Bari 2010, pp. 37–38). Although these students have demonstrated their enthusiastic use of ICT including the use of the Internet, mobile devices, smart phones and social media (Jacob and Issac 2008), their teachers have been challenged to utilise these technologies for pedagogical application in the classroom. Using these technologies in the classroom matters because students need to be prepared for a 21st century in which they require a skillset that is broader than the traditional foundations of the 3Rs of reading, writing and arithmetic. As Crockett et al. (2012, p. 17) have argued, for students to progress from the foundations of learning, teachers need to expand their thinking outside their "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."

In order to be effective in the information rich, 21st century, teachers/educators need to be able to utilise and ultimately transform the teaching and learning process with the technology their students use on a daily basis. Using ICTs enables the transformation of learning and teaching for both the educators and the learners. ICT provides opportunities for both educators and their students to work towards understanding technological competencies in the 21st century (Back et al. 2009; King 2002; Kitchenham 2006; The Organisation for Economic Co-operation and Development 2010). Moreover, Keane and Blicblau (2012) have suggested that, without an understanding of learning theory, the use of transformative technology may be ineffectual. The present work provides direction to educators who wish to lead in a technological environment of change.

2 The 21st century skills imperative

In a changing technological context, there is a need to focus on more than just the traditional basic skills (Crockett et al. 2012). Students need skills or competences to ensure they are prepared for the modern workforce. The importance of developing appropriate skills for the modern workforce in the US is set out in the report *The new commission on the skills of the American workforce* (2006) which concluded that it is creativity and innovation, along with basic skills, that are essential for future economic and job security. In terms of acquiring these skills, Silva (2008) emphasised the connection between education and employment, argued 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).

A discussion paper prepared for the European Union on 21st century skills, stated 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 and Roblin 2010, p. i)

A joint EU-US Study, on *Emerging Skills and Competences* identified ICT as one of the key developments of 21st century education and lifelong learning skills (Shapiro

et al. 2011). Moreover, the outcomes of the study showed that the key competences and 21st century skills in learning & teaching processes involved closer industry partnerships which emphasised unique opportunities for students to integrate complex problem solving and communication skills whilst working in a global environment.

3 Forming 21st century skills

Three influential organisations associated with education, management and industry developed definitions for 21st century learning. These organisations are:

- MCEETYA (MCEETYA 2008),
- AMA (AMA 2010),
- AT21CS (AT21CS 2012).

They have all attempted to identify the essential and necessary skills for educators, students, workers and graduates into the 21st century. These three organisations have been chosen because they represent critical stakeholders in the discussion about 21st century skills (Government, employers and industry) as well as providing Australian, U.S. and global perspectives.

3.1 MCEETYA

The combined Australian Commonwealth and State Government body, MCEETYA (Ministerial Council for Education, Employment, Training and Youth Affairs) forged a new learning approach for the 21st century resulting in the Melbourne Declaration (MCEETYA 2008) which was the culmination of ten years of discussion and review by the Commonwealth and State Governments. The main findings of the Declaration stated that successful learners for the 21st century needed:

- 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.

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 national Australian Curriculum (Australian Curriculum Assessment Reporting Authority (ACARA) 2013). ACARA was established from one of the key recommendations of MCEETYA with the specific task of establishing a national curriculum. It was set-up as an independent statutory authority responsible for the overall management and development of a national curriculum across all states of Australia.

3.2 AMA

The need to define the kinds of skills necessary for young people in the 21st century is not confined to the education sector. In the United States, the American Management Association (AMA) together with Partnership 21 (P21)—a collaboration between industry, government and education in the United States surveyed over 2000 employers about the critical skills required for a 21st century workforce (AMA 2010). The results of this survey identified skills that employers wanted their employees to have beyond the 3Rs. Moreover, outcomes from the survey highlighted that employers wanted their employees to have specific skills for workforce readiness in the 21st century. These skills were identified as:

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

3.3 AT21CS

AT21CS is a public and private partnership among governments, educators, academics and industries to help educators around the world enable students to succeed by equipping them with 21st century skills (AT21CS 2012). The development of skills incorporating the 4Cs, is complemented by the protocols of AT21CS. They described the essential skills necessary for a knowledge-based economy as being based on learning to collaborate with others and connecting with technology. These essential skills were categorised as:

- Ways of thinking-creativity, critical thinking, problem-solving, decision-making and learning,
- Ways of working-communication and collaboration,
- Tools for working-information and communications technology (ICT) and information literacy,
- Skills for living in the world-citizenship, life and career, and personal and social responsibility.

3.4 Common ground in the search for 21st century skills

As Keane et al. (2013) have highlighted, there are strong similarities amongst the categories of 21st century skills outlined in these three approaches to 21st century skills in education (MCEETYA 2008), employment (AMA 2010; Partnership for 21st Century Skills 2012), and knowledge based skills (AT21CS 2012). These skills have been synthesised as the 4Cs:

- Critical thinking,
- Communication,

- Collaboration,
- Creativity.

The essential features common to the three approaches by MCEETYA, AMA and AT21CS highlight the centrality of the 4Cs. These essential features can be mapped to form a synthesis as shown in Fig. 1. This synthesis of the three approaches highlights thinking, collaboration, and communication using ICT, and creativity, as the necessary skills for working in the 21st century.

3.5 The 4Cs

Critical thinking is vital for problem solving. Often situations that are complex, uncertain and have no precedent require employees to solve problems. Critical thinking is the discipline of actively and skillfully conceptualizing, applying, analysing, synthesizing and/or evaluating information gathered from, or generated by observation, experience, reflection, reasoning or communication.

Whilst students take for granted that they can communicate with others, there are various degrees of communicating effectively. To explain complex ideas, a concise, organized and measured approach is necessary. This provides the necessary social and learning environment to solve problems.

Communication in the 21st century often takes place amongst teams. The emphasis is on communicating in a collaborative context. Collaboration is a process through which a group of people productively explore their ideas to search for a solution that extends into the exploration and generation of new concepts. Current information and communications technologies have facilitated collaboration and have allowed teams to be working globally in both synchronous and asynchronous modes.

Creativity may be defined as pushing the boundaries to develop new ideas, and innovation is the development of these ideas into actuality. Being creative has been

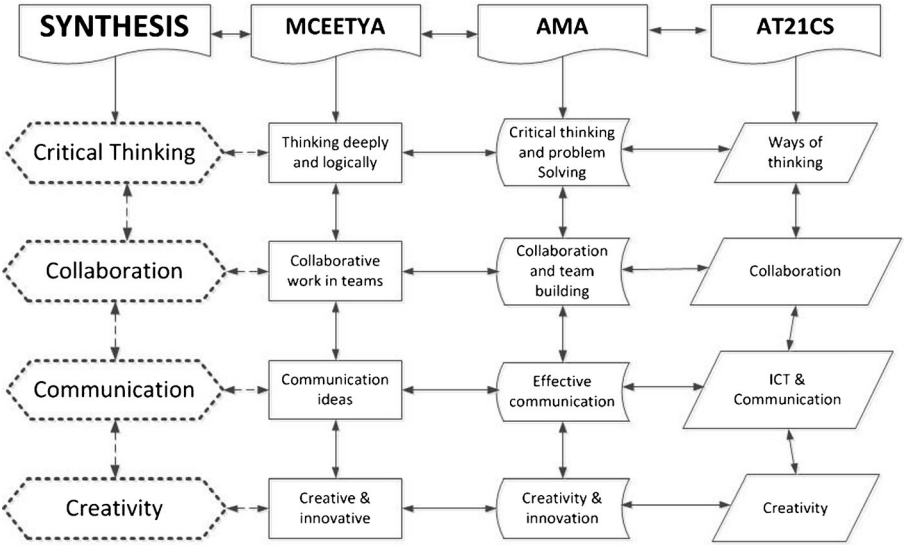

Fig. 1 Synthesis of the common ground amongst MCEETYA, AMA and AT21CS

interpreted as a subconscious act (McGoldrick 2002; Tait 2002). It involves imagining something and then doing something with this imagination (creating something which is new and useful). Creativity is also about utilizing your imagination and assisting others to use their imagination! Dewulf and Baillie (1999) offer a definition of creativity as 'shared imaginations' and identify three characteristics, which may be applied in Information Technology:

- ability to visualize ideas,
- effective use of memory,
- convergent and divergent thinking.

Creativity does not mean having to invent something completely new. An example of this is the way that the release of the iPhone© in 2007 captured the public imagination despite the fact that mobile phones were available since the 1980s. Steve Jobs, CEO of Apple convinced the public that a phone combined with a number of other technologies such as a touch screen, a music player, camera, wireless internet connection, Bluetooth and access to an infinite collection of Apps, was now a desirable smartphone (Isaacson 2011). Since the launch of the iPhone, other innovative operating systems and phone competitors have strongly challenged its initial domination of the smartphone field. According to Gartner (2014) the Android platform had 78 % of the worldwide market share in 2013 compared to the iPhone which only had 16 %. This has resulted in the consumer having a selection of highly innovative products to choose from.

Recent develops in smartphones technologies can be understood to be incremental innovation. According to the OECD Statistics Portal (2013), incremental product innovation is described as "an existing product whose performance has been significantly enhanced or upgraded." This can be achieved in one of two ways: enhancement of a product in terms of economic cost or improved performance by selected changes to one or more of the product's components.

Whilst in the past 30 years, new innovations have occurred such as smartphones, Bluetooth enabled devices, wireless technologies, and embedded technologies. Incremental innovations have improved quality, and richness of content, shrunken the size of devices and reduced the costs to make modern technology available to everybody.

Some of the featured incremental innovations highlighted at the 2014 Consumer Electronics Show (CNET 2014) included embedded technology in everyday products (basketball, tennis rackets) which are equipped with Bluetooth technology to collect information about the player's racquet and ball speed and relay it to a smart mobile device. Other incremental innovations included the exchange of commands with stoves, washing machines, vacuums and other household equipment to enable smart homes. The smartphone has become the focus of personal technology and the foundation for these incremental innovations.

While basic skills such as numeracy and literacy remain essential building blocks for learning, higher order skills such as the 4Cs are equally vital for learning and employment in the 21st century. Fundamental to the development of 4Cs is the importance of ICT for learning. This is illustrated in the Melbourne Declaration (MCEETYA 2008) which emphasised that it is not just competence in ICT that is a necessary foundation for success but *creative and productive* use which is essential for contemporary

learning. This clearly has implications for how ICT should be delivered in the classroom.

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).

4 Pedagogy and learning

The use of ICT is central in each of the 21st Century skills frameworks covered above. However, the question remains as to how ICT should be used to advance the 21st Century skills. Far from being straight-forward, the effective use of ICT is dependent on the different ways that teachers make use of the resources available (Webb 2014). Moreover, research has shown that, whatever the benefits, developments in ICT make the work of teachers more complex (Loveless 2011).

It has been argued that ICT use in an educational setting needs to be understood in relation to pedagogy as practised by teachers (Webb 2014; Webb and Cox 2004). The term *pedagogy* can be used in a variety of ways but Loughran (2010, p. 36) provides a useful definition:

> pedagogy is concerned with the relationship between learning and teaching. Understanding this interplay between teaching and learning *and* learning and teaching is an important shift in focus from teaching alone because it really means that the two exist together. The fact that teaching influences learning and learning influences teaching, and the way it that is done, offers insights into the science of educating.

This interplay between teaching and learning is important. One view of learning emphasises the role of the teacher and implies that the process of learning is essentially passive so that "learning was something that happened to the learner" (Stoll et al. 2003, p. 23). In this understanding of learning the teacher explains or tells the learner what to learn and, by extension, what to think.

Set against this view is one which describes learning as the process by which the learner is actively engaged in learning rather than passively receiving information (Sjøberg 2007). This view of learning began with the constructivist movement which had its origins in Piaget's (1953) influential work about how individual learning takes and Vygotsky's (1962) focus on how learning was shaped by the social context of the learner. This, in turn, led to later work which emphasised the decision making of the learner (Flavell 1976; White and Baird 1991), the different intelligences by which people learn (Gardner 1983) and the different dispositions which successful learners utilise (Costa and Kallick 2000).

It is important, to consider learning in terms of whether the learning is at the basic or conceptual level. In the Taxonomy of Educational Objectives, Bloom (Bloom et al. 1956) outlined a way of categorising instructional objectives and assessment according to increasing levels of cognitive complexity. Further developments of this concept included the work of Marton and Saljo (1976) with their emphasis on "meaningful

learning in the true sense of the term" (p. 11) and later revisions of the original taxonomy (Anderson et al. 2001) reinforced the progression from lower order to higher order thinking.

Whereas Bloom's taxonomy is concerned about thinking processes the SOLO taxonomy focuses on teaching and learning. The distinction between surface and deep learning is a key feature of the SOLO Taxonomy (Biggs and 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 as well as providing guidance to teachers in how to structure questions to achieve learning outcomes. 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.

4.1 Personalised learning for the 21st century

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 et al. 2007). The key features of personalised learning are:

- Learners are central,
- ICT is a key enabler of learning,
- 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. However, as Hattie (2012) has underlined teachers develop theories of practice which "become more convincing to them and sometimes changing them requires a major disruption and high levels of convincing power of the effect of alternative theories of action" (p. 159).

It has become increasingly apparent that the transformative potential of ICT for learning presents a challenge to traditional conceptions of pedagogy (Park and Oliver 2008; Webb 2014). The challenge is to not only ensure the effective use of ICT in an educational setting but also to understand that ICT will change the learning environment itself (Underwood and Dillon 2011).

5 Technology adoption for effective learning

To prepare students for the 21st Century, whether it be work, life and learning, they need to master the 4Cs (Jacobs 2010; Wagner 2008). It is tempting to believe that the simple way to address the development of the 4Cs is by providing students with

computer devices. Certainly there has been a good deal of government policy in education that has been based on the assumption that access to technology is the key to achieving success (Rudd et al. 2007). However, simply providing students with mobile devices such as netbooks, iPads©, tablets, and laptops will not develop these skills and enhance their learning. What the teacher does in the classroom with these devices is important for students adopting ICTs.

The SAMR Model (Fig. 2) developed and enhanced by Puentedura (2011) divides technology usage into four distinct levels; substitution, augmentation, modification and redefinition. 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 (no functional change). For example, a word processor has usurped the need for pen and paper to complete students' assignments. Students can save work and print out the final copy without hand-writing annotations. At the basic level, the word processor is a substitution for handwriting.

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 embedded word processing functions, such as editing features, spelling and grammar checks, insertion of images/graphics and document layout are used at this level. The difference between substitution and augmentation is the use of features to improve the product. However, only minimal learning skills development occurs at each of these levels, which are the enhancement stage (Puentedura 2006).

In the enhancement stage, the task could have been completed satisfactorily—if more laboriously—without technology; at the modification level the use of technology changes the task. At this level, rather than completing a task as a static word-processed document, the writing can be shared electronically through a blog, wiki or social network exchange opening it up to a wider audience. Work on the task can then be done individually or collaboratively, both synchronously in class time, as well as asynchronously out of class.

The final level in the SAMR model is redefinition. Extending from the modification level, the redefinition level gives rise to tasks that were previously inconceivable. For example, using specialised ICTs, students research and share their findings in order to find a common solution. Students transform writing into a range of multimedia where they collect, communicate and disseminate their information. This final level is difficult to precisely describe as we are constantly redefining what is possible using technology

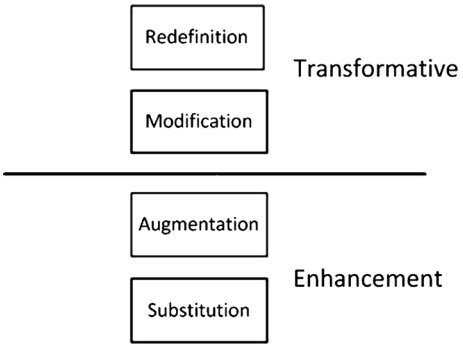

Fig. 2 SAMR model for technology adoption

in advanced forms. These two levels, modification and redefinition are identified as the transformative stage. It is at this stage where deeper learning occurs. To encourage deeper learning, teachers need to work in the higher levels of the SAMR model to improve student outcomes. 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 et al. (2011), "It seems that meaningful learning is far more likely if the new technologies are recognized as providing transformative opportunities" (p. 83).

5.1 Building the 21st century digital learning (21CDL) model

Ensuring there is powerful lifelong learning and teaching which is flexible and personalised is one of great challenge for leaders and educators 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 SAMR model for technology adoption results in our proposed 21CDL model, as depicted in Fig. 3:

This model synthesises the three frameworks for 21st century learning discussed in this paper, surface and deep learning and technology adoption. A central contention of this model is that the 21st Century skills described here are higher order skills and require deep rather than surface learning while still requiring the acquisition of basic skills as a necessary precondition to their development. As a framework for learning,

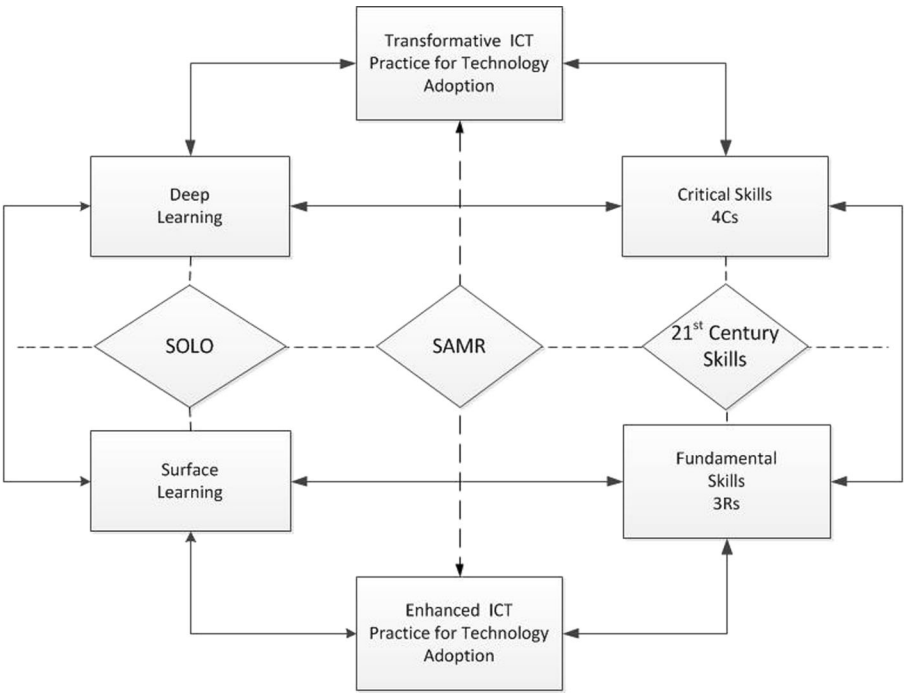

Fig. 3 The 21CDL model for enhancing learning

the SOLO Taxonomy describes the interdependent relationship between deep learning and surface learning while also providing a framework for moving from surface to deep learning. In a similar way the SAMR model identifies the difference between enhanced and transformative ICT practice and illustrates which practices need to be adopted to achieve the desired ends.

The 21CDL model describes the elements of the frameworks in relational rather than hierarchical terms. One way in which this can be understood is to realize that, in the 21st Century framework, the acquisition of the critical skills of the 4Cs are dependent on the learner possessing the fundamental skills. This is not the only way in which this model is relational. If the higher order skills illustrated here are dependent on the lower order skills, it is also true that there is no requirement to fully master the lower order skills in order to move to the higher order ones. This is true not only of the SOLO Taxonomy, where both surface and deep learning can occur more or less simultaneously, but even more so with respect to the SAMR framework where students can undertake transformative ICT tasks at the beginning of learning about a topic. However, ICT practice at the enhanced phase will only be of benefit for surface learning and the reinforcement of fundamental skills. For the development of deep learning and the 4Cs, ICT practice needs to be transformative.

6 Concluding comments

What happens in the classroom with technology usage in schools too often occurs at the enhancement rather than the transformative stage and is therefore more aligned with surface rather than deep learning. Therefore we need to provide the appropriate situations that will allow students to develop a mastery of the 4Cs. ICT is often touted as a key enabler for learning but in accordance with the 21CDL model, using ICT in the enhancement phase will be ineffective in promoting deep learning and the 4Cs. Therefore, using ICT in the transformative stage develops deep learning and encourages students to be flexible in their critical thinking and problem solving methodology, be effective communicators, work collaboratively in teams and develop their creativity.

Now and into the future students need the combination of the 3Rs and the 4Cs to operate in the 21st century. The 3Rs alone are not sufficient to provide students with the appropriate skills required to function in the 21st century. Instead, there needs to be a fusion of the 3Rs with the 4Cs.

Future work needs to focus on developing the 4Cs for teacher professional development and evaluating student outcomes in a technological transformative environment. Employing appropriate ICTs enables the transformation of learning and teaching for both educators and learners to function effectively in the 21st century.

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