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Knowledge building with ICT in the early years of schooling

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This paper interrogates the concept of knowledge in postmodern times. It is evident that in the 21st century new types of citizens are required: ones who are able to work collaboratively in knowledge-building communities in order to generate the new forms of knowledge that will propel us forward in the century. However, school curricula would seem to remain firmly rooted in the industrial age of previous times. Examples are provided of curricula that embrace the creation of new knowledge in schools that are relevant to the lives of people as well as more detailed descriptions of curriculum applications that enable learners to participate in knowledge-building communities that are vibrant and exciting.

Introduction

This special edition is focused on Knowledge, Learning and ICT in Early Childhood Education. We are concerned about the ways in which our views of knowledge shape curricula and pedagogies in early childhood education. This focus inevitably requires a consideration of the ways in which information and communications technologies (ICT) can be used to support teaching and learning in the early years (birth to 8 years of age) in new and dynamic ways that were not previously possible.

In this paper I consider what it means to be a citizen in postmodern times and how it reflects a shift from an industrial age to a knowledge era. I highlight the need to consider new curriculum and pedagogies that reflect changing views of knowledge and illustrate two ways in which this has been attempted in Australia. The first is at the systemic level in Queensland, where a new basics curriculum, productive pedagogies and rich task assessment underlie a new conceptualisation of learning and knowledge building capacity. The second is a project called Learning by Design, which views pedagogies as knowledge processes.

I then provide three examples of activities incorporated in the early years of compulsory schooling with children aged from 5 to 8 years of age. These tasks exemplify opportunities for learners to build new knowledge, as opposed to traditional activities in which knowledge is simply reproduced. The paper also suggests that moving beyond simple recall of knowledge is essential if we are to engage with meaningful curricula in the 21st century.

Preparing citizens for tomorrow
Postmodern times are characterised by diversity, differentiation and fragmentation (Hall and Jacques, 1989) in contrast to the standardisation, homogeneity and organisations of scale that were prevalent in modernity. Accompanying this shift has been a realisation that new technologies have significantly impacted on the ways in which we think about our world and have changed every aspect of our lives. Yet, while our lives have changed dramatically, schools seem to have remained stubbornly resistant to the fundamental changes that have been manifested in the broader societal context. Despite a broadly based recognition that we need to do things differently, as well as a realisation that it is becoming more difficult to predict the jobs and skills that are needed for the future, we have been slow to realise, and reluctant to operationalise, plans for the future of the children in our schools. Teachers lament the lack of skills in spelling and handwriting, and the ability to recall facts, but are often silent on the range of new skills that students already have, for example, in terms of producing multimedia texts with content derived from a variety of sources and thinking in multimodal formats. Accordingly, there seems to be limited recognition by some educators, business leaders and governments that we need to create new contexts for learning that are relevant and meaningful for preparing students for the knowledge era, as opposed to the industrial one. Scardamalia and Bereiter (2003) have suggested that, "...the health and wealth of societies depends increasingly on their capacity to innovate. People in general, not just a specialised elite, need to work creatively with knowledge" (p. 1370). This has important ramifications for schooling since we have to demonstrate the capacity to ensure that our education system enables students not only to be current in their knowledge but also be able to generate new knowledge as part of their everyday lived experiences. Lyndon B. Johnson recognised this as far back as 1964 when he stated "The Great Society is a place where every child can find knowledge to enrich his mind and to enlarge his talents" (Johnson 1964).

**New curriculum and pedagogies for knowledge building**

To be relevant to the lives of future citizens, education should cater for their diverse lifeworlds and recognise that our lives have become increasingly complex. In this way, the old basics of reading, writing and arithmetic, while remaining functionally relevant in different ways in contemporary times, have been supplanted by the need to be innovative and creative; as well as to work collaboratively and flexibly on authentic tasks that have been generated by the students themselves as well as by teachers. Accordingly, while it is important to know how to add, in fact it is more important to know when to add. New technologies are an integral part of this learning. They permeate every aspect of the lives of the young people that attend our schools, yet within school they tend to remain peripheral to the main work that is done and in many cases their use is tokenistic rather than essential. In 1996, Papert criticised policy makers who were:

... determined to use computers but can only imagine using them in the framework of a school system as they know it; children following a predetermined curriculum mapped out year by year and lesson by lesson. This is quite perverse; new technology being used to strengthen a poor method of education that was invented
only because there were no computers when school was designed (p.25).

The situation requires that we rethink our practices related to curriculum and pedagogy and consider the ways in which individuals can build knowledge via active exploration in areas or with issues that children have defined themselves, as well as responding to the needs of others in problem-solving and problem-posing contexts. Here, it is relevant to think of children as learners who are engaged in using existing knowledge, extending or innovating current knowledge and creating new knowledge for specific purposes that they have defined. It is also essential that learners be provided with opportunities to share their strategies and to communicate and disseminate their ideas. This is important for the creation of knowledge building communities, and because we can learn a great deal from each other about the varied processes and strategies used, in order to evaluate their effectiveness.

Scardamalia (2003) has stipulated that living in the knowledge society requires:

- Moving beyond brainstorming to bringing ideas into the world
- Producing knowledge that brings value to a community which means going beyond “keeping abreast of the times”
- Developing understandings about knowledge creation
- Playing with ideas so that learners can make meaning and new understandings.

In order to achieve these we need to take a bold approach to new learning scenarios that are characterised by:

- A supportive culture of innovation where risk taking is encouraged
- Providing contexts for collaborative learning
- Encouraging problem posing and strategic thinking
- Enabling autonomous learners
- Promoting higher order thinking that draws from various knowledge basis and perspectives
- Cultivating a capacity for lifelong and lifewide learning
- Creating contexts for learning and sharing of ideas using multimodal forms of communication incorporating new technologies

Adapted from (Kalantzis & Cope, 2005, p. 7).

Knowledge in action

At the systemic level there have been a number of initiatives that address a new way of thinking about curriculum in our schools. In Queensland, Australia, for example, a ‘new basics’ curriculum supported by a productive pedagogies framework and rich task assessments was put in place. The consideration of curriculum, pedagogies and assessment in a simultaneous and complementary way is significant since it recognises that the change process needs to include all aspects of teachers’ professional work as well as promote new learning via a
reorganisation of traditional knowledge and subject matter characteristic of a bygone era.

The new basic curriculum (Department of Education Queensland, 2001) does not consider knowledge as residing in the traditional disciplines and has four organisational features. These are:

- **Life pathways and social futures:** Who am I and where am I going?
- **Multiliteracies and communications media:** How do I make sense and communicate with the world?
- **Active citizenship:** What are my rights and responsibilities in communities, cultures and economies?
- **Environments and technologies:** How do I describe, analyse and shape the world around me?

The investigations and knowledge building that arise from the questions posed in each of the four areas can be initiated by the teacher, or the students. The mode and means of inquiry is discussed, shared and scaffolded by more experienced learners, in order to support optimal learning and knowledge building. For teachers, the new basics curriculum is supported by a productive pedagogies framework that consists of four basic areas: (Department of Education Queensland, 2001 p 7).

- **Intellectual quality:** to ensure that students have opportunities to acquire and manipulate information and ideas in ways which transform their meaning and implications, understand that knowledge is not a fixed body of information, and can coherently communicate ideas, concepts, arguments and explanations with rich detail.
- **Connectedness:** to ensure that students have experiences in which they can engage with real, practical or hypothetical problems which connect to the world beyond the classroom, which are not restricted by subject boundaries and which are linked to their prior knowledge.
- **Supportive classroom environment:** to ensure that students influence the nature of the activities they undertake, engage seriously in their study, regulate their behaviour, and know of the explicit criteria and high expectations of what they are to achieve.
- **Recognition of difference:** to ensure that students know about and value a range of cultures, create positive human relationships, respect individuals, and help to create a sense of community.

Thus, teachers are able to support and facilitate student investigations in specific and productive ways and mentor learners about the ways in which they might organise their work and disseminate their findings from investigations and explorations.

The third dimension of the new basics approach is rich task assessments (Department of Education, 2001) that engage children in authentic activities that may involve the use of new technologies, or not. What distinguishes them from traditional assessment is that they are multifaceted and require an integration of
knowledge and skills well beyond the simplistic type of knowledge and skill use that is assessed in computer marked multiple-choice tests. Additionally, they frequently do not have one right answer in the traditional sense, and might require working and collaborations in groups. For example, a rich task for Years 1 to 3 (Age 6 to 8 years) is to create a multimedia presentation which encapsulates their investigation of an endangered plant or animal. The new basic referents for the rich task are:

- **Life pathways and social futures:** collaborating with peers and others
- **Multilitaracies and communication media:** blending traditional and new communications, mastering literacy and numeracy
- **Active citizenship:** interacting with local and global communities
- **Environments and technologies:** developing a scientific understanding of the world and building and sustaining environments.

The targeted repertoires of practice are:

- Classifying ideas and information
- Collecting and collating data
- Comprehending the concept of ecological interrelatedness
- Comprehending the concept of environmental responsibility
- Dealing in an orderly manner with the parts of a complex whole
- Presenting a persuasive argument
- Respecting the integrity of primary evidence (and reporting data without bias or distortion)
- Setting out information in a cohesive report
- Structuring an argument
- Understanding the potential of media technologies


By outlining criteria and describing the levels of achievement inherent in them, the assessment is specifically focused on the knowledge processes that are utilised during the course of the investigation and allows for a discussion and consideration of the type of knowledge that is generated as a result. Yet, the learner can decide on the broad nature of the project and the ways in which it can be organised to meet the criteria. What is also evident is that during the course of the investigation children are using knowledge across the disciplines and are required to engage with higher-order thinking skills in a rich way. Using new technologies is an essential part of this process and children are afforded the opportunity to decide which media will not only support their inquiry, but also support how they will present their findings to their audience.

When reconceptualising curriculum, pedagogies and assessment in this way, the focus for learning is knowledge building practices that support the communication of ideas in effective ways. Such contexts also recognise the collaborative nature of learning and encourage teams of children to embark on investigations, which are characterised by a desire to solve authentic problems as well as to promote and stimulate creative explorations of the children’s lifeworlds in order to consolidate and build new knowledge. Accordingly, learners are afforded opportunities to see themselves as instigators of
investigations, using the skills that they acquire in school to extend their capabilities in new and dynamic ways.

**Rethinking ways of knowing**

The Learning by Design project (Kalantzis & Cope, 2005) views pedagogies as knowing in action. These are considered as experiencing, conceptualising, analysing, and applying (See Figure 1).

![Figure 1: Learning by Design](image)

*Experiencing* is regarded as immersion in the everyday lifeworlds of the learner and involves the teacher in planning two different kinds of experiences for learners: the *known* and the *new*. In order for learning to be meaningful, there needs to be a link between what is already known and what will be experienced. Teachers afford opportunities for students to make links with their prior knowledge and experiences, (e.g. personal, community) so that they are able to use it to make connections to the new learning that is planned. *Conceptualising* enables learners to make meaning from their experiences and build ideas or concepts about the nature of things and ideas and how the world works. In learning by design, conceptualising occurs through naming when learners are able to label and characterise the ideas that they have encountered; and in theory when concept names are connected to generalisations that may be made.
about the concept. For example, a learner can recognise and name a river and the parts that make up a river, and then build up a theory about what a river is, or build a model or diagram depicting the constituent parts of the whole. The knowledge process of analysing requires that learners are able to examine a context, event or piece of information and able to articulate in a systematic and critical way the underlying assumptions and implications of its application or function. When analysing, learners consider what an idea means and how it might impact on themselves, the community or the world. When critically analysing, learners are required to ask questions about the ramifications of an idea when applied to diverse situations. Finally, in applying what we know in diverse ways, especially in authentic contexts, we are extending learning so that it has a purpose and can add value to our lives and the lives of others. In applying appropriately we often follow traditional ways of doing things, such as using objects for the purpose that they were designed. However, there are always opportunities to extend such applications when people use things in innovative ways and are able to create contexts in which they redesign or transform objects and ideas. If this notion is taken further it represents applying creatively, since the transformation has generated a new idea or product that is original or a hybrid of a combination of ideas.

The focus of learning by design is on meaning and action as ways of knowing, and the four knowledge processes described are the constituent parts. The ways of knowing are sensitive to cultures, learners, knowledge domains and pedagogies, so that they will have different emphases depending on the context that they are planned for. Making the knowledge processes explicit enables teachers to consider which facets they regard as being most effective, depending on their context and content, and enables them to support or scaffold the deep learning of students in their classes. It is generally regarded that there is a link between pedagogical knowledge and learning outcomes (Darling-Hammond 2001). When working with teachers using the learning by design schema for their planning, we have noted that the essential conditions of learning—that is, belonging and transformation (Kalantzis & Cope, 2005)—are usually met. Additionally, making knowledge processes more explicit ensures that teachers and learners are fluent in their use and this has a profound impact not only on learning outcomes but also on creating a positive classroom climate and becoming confident about being a lifelong learner.

Rethinking learning in knowledge building communities

I have previously stated (Yelland, 2007) that we need to move beyond mapping new technologies onto old curriculum but rather should be rethinking the ways in which curriculum need to change to support new learning. I will now describe and explain the rationale behind three specific tasks designed to assist young children in the early years participate in knowledge building.

We have known for some time (Clements, 1999; Yelland, 2003) that the teaching of fundamental concepts in the mathematics curriculum needed to be redesigned in light of the use of ICT. Rather than simply use ICT tasks to practice and reinforce basic skills and concepts, we knew that new ways of teaching and learning were possible that encapsulated deeper understandings of concepts and represented an opportunity to provide knowledge building concepts. Yet we ignored this data and continued to create mathematical
learning scenarios that were not authentic but were designed to perpetuate a view of mathematics as fixed and skill driven.

For example, in a curriculum called *Investigations in Number, Data and Space* (Clements et al., 1995) that included ICT, children were able to acquire new knowledge and skills much earlier than in traditional curricula. Furthermore, their understanding about basic geometric concepts was much more sophisticated and deeper than children who had not experienced the same learning tasks. For example, we had learning scenarios in which 6 year old children ‘discovered’ decimals (not introduced until the Year 6 mathematics curriculum) and used their new knowledge to build new geometric figures incorporating innovative design and precision in measurement. They created project designs (Figure 2) in which they demonstrated their ability to:

- **analyse** geometric figures in order to determine their role/place in the final product
- **understand** that shapes can be moved to new locations, and flipped and turned without losing their essential properties, that is, the angles in a square were always 90° even when the square was tilted.
- **apply** their mathematical knowledge, especially related to number and operating on them to produce length and turns for different functions.

![Figure 2: Geometry Projects](image)

Results indicated that in this *new* type of curriculum model, attention was paid to rethinking the essence of teaching geometry and measurement in light of the opportunities afforded by technology, rather than just using the technology to
‘glitz’ up the traditional way of doing things. It fundamentally changed how we thought about children’s knowledge and the ways in which they could use it in a variety of applications. By the end of the study these (then) 7 year olds were creating procedures with variables; using these to make patterns and pictures; using coordinates to position the turtle; and incorporating the use of negative numbers. They were playing around with ideas that were well in advance of those expected in traditional educational settings and the technological setting enabled them to do so in a non-threatening and playful manner.

More recently, as part of a project investigating numeracies with ICT (Yelland, 2007), I worked with teachers on authentic tasks which required that they design and plant a patch of vegetation as part of a new building development on the school site. The students measured, mapped and drew the gardens to scale using rulers, protractors, measuring tapes and orienteering compasses to ensure their measurements were accurate. The maps were designed on a computer and featured such gardens as the “Grasses Garden”, the “Entrance Garden”, the “Pea Garden” and a “Bird Garden” (see Figure 3).

The Bird Garden was designed to attract a number of small native birds that live in our area, into our school. A variety of smaller, bushier species were planted here, to create a good nesting environment for the birds. Plants include varieties of ground covers, wildflowers, small shrubs and medium shrubs. It is hoped that this garden bed, along with the Grasses Bed which is located nearby, will attract the smaller birds back into this area, as opposed to the crows we currently have.

In considering the ‘Design a Garden’ project, it was apparent that it constituted a multi-dimensional task (Yelland, 2005) in that it afforded opportunities for the children to apply various mathematical concepts and processes to create and design a functional garden based on a theme of their choice. When creating their gardens, the groups had time and resources to investigate the problem of how to create a new garden and were able to conduct research to find out more about native birds and the plants that they needed to consider in each context. They represented their ideas using new technologies and were then able to share this with a wide audience beyond the classroom on the school’s website. The learning outcomes were varied and provided the students with multiple opportunities for learning not only about gardens but also about how to plan for building one and then implementing their plan in a practical way. Of course, this
task was not completed within one mathematics class, but rather in a series of classes, allowing ample time to achieve such worthwhile outcomes and satisfying results.

I have previously stated that it is important for children to represent their ideas and the outcomes of their knowledge building experiences in a variety of modalities (see also Yelland, 2011; Yelland, 2007; Yelland & Kilderry, 2010). Collecting information about children’s knowledge and skills is a fundamental component of portfolio assessment that documents how they have grown over a particular period of time. Figure 4 illustrates one way in which an innovative teacher documented the learning of her reception class over the course of their first year at school. It was multimodal in its format with a sound track in the child’s voice; it contained digital pictures and video and was constructed with the 5 year-old reception child working with a Year 6 (11 year old) ‘buddy’. I have yet to see a better example. The way in which the teacher discussed and incorporated the children’s ideas in the structure of the portfolio was exemplary and a wonderful example of child-centred and knowledge-focused learning. The headings, organised around statements such as, “I am a... mathematician, a reader, an artist”, enabled a focus on positive learning experiences. Additionally, the type of knowledge building that each child had acquired, and the examples chosen by the children, exemplified the sophisticated level of learning that they had achieved as well as the articulate ways in which they were able to explain this to their audience.

Figure 4: My portfolio by Sean

Where next?

As previously stated, we know that new technologies have transformed all aspects of our lives, and in the sphere of work a shift from industrial labour-intensive industries to a ‘knowledge’ economy increasingly requires workers who are creative, innovative and have high levels of specialist knowledge (Robinson, 2001). It is readily apparent that globally, governments and businesses have
recognised that the key element to a successful economic transition lies in education producing students who work well in collaborative contexts and are creative, innovative and flexible. Social and economic imperatives underpin the international push for educators to teach students to be creative thinkers. Increasingly, a competitive edge is based on knowledge, creativity and innovation rather than land, labour and capital (Amabile, 1988; Beeman, 1990; Florida, 2003). Innovation accounts for more than half the economic growth in America and Britain (McCreedy, 2004). Initiatives in education related to knowledge creation, creativity and creative partnerships (e.g. Partnerships for the 21st century, 2008) have proved that focusing on creativity and imaginative processes has positive learning outcomes for all students.

The rapid pace of new technological initiatives has presented challenges to educators. There have been many calls to rethink pedagogical practices and re-examine the traditional classroom environment (Chadler-Olcott & Mahar, 2003; Yelland, 2005). The ways in which ICT are embedded into pedagogies and learning are essential to the process of knowledge building (Yelland, 2007; 2010) and creativity (Loveless, 2003; Yelland, 1999; 2007; Yelland & Leung, 2009). It is apparent that teachers need to understand the implications of all these issues for their classroom practice and pedagogies so that they are able to make effective decisions about curriculum, process and assessment so that students are able to live productive lives in the knowledge era.

References


