PROBLEMS
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TWENTY-FIRST CENTURY LEARNING AND TECHNOLOGY EDUCATION NEXUS

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Abstract

The new Knowledge (or Conceptual) Age of this millennium is creating a globalised economy that requires a much more diverse range of skills and dispositions yet many countries' education systems still promote an outdated Industrial Age model of teaching and learning. In New Zealand, as in many other countries, there has recently been an emphasis on raising the level of qualification and success of students in school. 'No child left behind' philosophies feature in many countries and much money has been spent on trying to raise the levels of achievement of underperforming groups and keeping students in schools longer. Industrial Age schools screened, sorted and disciplined students for work and life in society (Bolstad & Gilbert, 2008). This has been done through traditional learning disciplines where study has been largely content and assessment driven. A 21st century curriculum will develop in students a generic capacity and aspiration to learn (Claxton 2007). Recent research has identified the twenty-first century skills people will require for successful integration into a wider range of communities. The writers will introduce two perspectives developed to address twenty-first century learning and highlight how the Technology Education curriculum and Guided Inquiry are ideally suited for delivering this skill set. Technology Education and Guided Inquiry (Kuhlthau, Maniotes & Caspari 2007) pedagogy engage students in meaningful and successful 21st century learning. The first perspective is the Framework for 21st Century Learning (Partnership for 21st Century Skills 2009) and the other, the New Zealand Curriculum (Ministry of Education 2007).
Key words: *guided inquiry, life-long learning, technology education, twenty first century learning*.

Introduction

Frequently over time events occur that have a profound effect on the world and societies in general. Gladwell (2000) calls these 'tipping points' (as cited in Bellenca & Brandt, 2010). They have occurred when, "a critical mass of circumstances come together and sets a new and unstoppable course" (Bellanca & Brandt, 2010, p. xiii). The technological revolution of the last two decades particularly, has seen a new diverse, globalised, complex and media-saturated society emerge. How well is our existing education system prepared for such change? Typically, this is similar to the factory model which developed following the Industrial Revolution when there was a need for mass education to provide for the human resource needs of the economy (Bolstad & Gilbert, 2008). Gordon (1998) refers to this as a 'graveyard' model where students are, "All in rows and dead." While content knowledge of the subject disciplines is still required, accessing significant knowledge in a timely manner has become considerably easier with fast serving internet search engines. The ways people are required to work, and indeed the way they live, are changing. Knowledge now is more about application of the understanding rather than just having ideas stored for recall (Gilbert, 2005). The skills, attitudes, values and competencies that will be needed have not always been addressed in traditional education programmes. Student's resilience and ability to accept and adapt to change will determine success. Different approaches and methods of teaching are what many educationalists are calling for.

Wagner (2008) in The Global Achievement Gap, has advocated seven survival skills for the twenty-first century:

- Critical thinking and problem solving
- Collaboration across networks and learning by influence
- Agility and adaptability
- Initiative and entrepreneurialism
- Effective oral and written communication
- Accessing and analysing information
- Curiosity and imagination

In considering the requirements for twenty-first century learning, Claxton (2007) identifies the need for a greater and different student learning capacity. He calls for an 'epistemic culture change' in schools to replace stand-alone courses in thinking skills or 'tricks of the trade' type learning. He states, "These approaches are exploring ways in which schools as a whole, and its classrooms in particular, can become settings in which the various constitute elements of learning capacity are acknowledged, discussed, understood and systematically strengthened" (Claxton, p. 121).

Aspects of this epistemic culture will include the ways teachers and learners work together, the range of activities and methods they will engage in, the ways students can transfer thinking and how teachers can role model the attributes, dispositions, and demeanours appropriate for successful participation in future milieux. These aspects will be addressed further in the following pages.

Two curriculum developments in particular have shown willingness for acknowledging that change is necessary. *The New Zealand Curriculum* (Ministry of Education, 2007) was developed to set a clear direction for teaching and learning in the new millennium. Its focus on principles, values and key competencies, as well as learning areas, is an acknowledgement that discipline content alone will not produce the resilience necessary. Secondly *The Framework for 21st Century Learning* (Partnership for 21st Century Skills, 2009) set a multi-faceted direction for successful teaching and learning that included core subjects but also a number of life-long learning skills and dispositions.

The curriculum that best supports this new direction is interdisciplinary, integrated, inquiry, problem or project-based, values and competency driven, and one that engages and excites student learning. Learners will see that this new student-centred paradigm will prepare them for life in the real world, generate curiosity and excitement, and promote life-long learning. While there are many teaching and learning approaches that promote this authentic learning (Snape & Fox-Turnbull, 2011), the authors believe that the Guided Inquiry (Kuhlthau, Maniotes & Caspari, 2007) strategy encapsulates an approach that integrates content, process, skills, values and understanding.

The authors postulate that the curriculum learning area, Technology Education, exemplifies this direction into authentic and effective teaching and learning practices more than any other curriculum learning area.

Technology in *The New Zealand Curriculum* (Ministry of Education, 2007), is defined as:

> Technology is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 34, 2011

> expand human possibilities by addressing needs and realizing opportunities. Adaptation and innovation are at the heart of technological practice. Quality Outcomes result from thinking and practices that are informed, critical, and creative (p. 32).

In technology students should work in a variety of collaborative and cooperative ways, engaging with the wider community and frequently incorporating service learning as an added component. Students engage in higher-order thinking skills, multiple literacies, technology and multimedia, and complete authentic assessments. The multi-disciplinary nature of technology is ideal to integrate diverse knowledge and understanding that is rich in meaningful and purposeful content and engagement.

In this paper the authors will introduce the themes and demonstrate how technological practice and process provide the ideal vehicle for a fully integrated learning programme matched to the requirements of life-long learning in the twenty-first century.

Two Newly Emerging Perspectives

In the United States over the last decade the Partnership for 21st Century Skills organisation has developed the *Framework for 21st Century Learning* (Partnership for 21st Century Skills, 2009) to meet the educational needs and support systems required to radically refocus the education system. This framework identifies the wide range of considerations necessary to meet the new demands. The group's website (www.p21.org) identifies that sixteen states, representing 26% of the country's prek-12 enrolment, are now members of the initiative. This framework includes:

- Core subjects
- 21st century themes – global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy and environmental literacy
- Learning and innovation skills – creativity and innovation, critical thinking and problem-solving, communication and collaboration
- Information and communication, media and technology literacy
- Life and career skills – flexibility, adaptability, initiative, self-direction, social and cross-cultural skills, productivity, accountability, leadership, and responsibility
- 21st century education support systems – assessment, instruction, professional development, and learning environments.

The framework has many clear connections with the second perspective, *The New Zealand Curriculum* (Ministry of Education, 2007). Many connections can be seen in the Vision, Principles, Values and Key Competencies in the 'front end' of the *New Zealand Curriculum*. Curriculum 'front end' learning includes the:

- Vision – young people who are: confident, connected, and actively involved, life-long learners
- Principles – high expectations, cultural diversity, inclusion, learning to learn, community engagement, coherence, future focus and Treaty of Waitangi awareness
- Values – excellence; innovation, inquiry and curiosity; diversity; equity; community and participation; ecological sustainability; and integrity

- Key Competencies – thinking; using language, symbols and texts; managing self; relating to others; and participating and contributing.

Together these two perspectives identify what our school teaching and student learning programmes need to promote. They include the significant and meaningful content of a modern curriculum but will need a radical change to the very structure and organisation of primary and post-primary schooling.

Bellanca and Brandt (2010) suggest that no generation can escape the responsibility of deciding what students should learn and that for learning in the 21st century teachers face a daunting challenge of equipping students with skills and knowledge necessary to survive in the information age. New knowledges and skills are needed to enable students success in the 21st Century and to become life-long learners (Gilbert, 2005). Many new ideas challenge current educational assumptions and schools will need to change significantly to meet new and emerging needs of today's students (Gilbert, 2005). Many systems are out of step with student lives and programmes seem irrelevant to their future lives (Hennessy, 1993; Turnbull, 2002). It is skills supporting innovation, creativity, critical thinking, and problem solving that are needed to fulfill the expectations of the new economy (Bellanca & Brandt, 2010). In many countries, existing educational systems continue to expand the gap between rich and poor, and exacerbate the divide between different ethnicities and students of differing ability.

Epistemic Culture Change

It has generally been accepted that educational achievement in the twenty-first century will focus on less discipline content knowledge and more on the development of appreciative dispositions that enable people to react to situations they face for which they may not be specifically prepared. However, often these are mere good intentions (Claxton, 2007) and the long-time emphases on knowledge recall and test performances still remain the essential measure of success at school. In recent times more has been learnt about how to "expand the capacity to learn beyond the school gates" (Claxton). The conceptual framework of what this involves is now much clearer.

Claxton (2007, p. 117) has identified that effective learners are thought to be capable of being:

- Curious, adventurous and questioning
- Resilient, determined and focused
- Open-minded, flexible, imaginative and creative
- Critical, skeptical and analytical
- Both methodical and opportunistic
- Reflective, thoughtful and self-evaluative
- Keen to build on their products and performances
- Collaborative but also independent.

It is essential that a climate is established that will encourage and foster these dispositions. Claxton (2007) describes this climate as: "… students' questions are welcomed, discussed and refined, so the disposition to question becomes stronger – more and more robust; broader – more and more evident across different domains; and deeper – more and more flexible and sophisticated" (p. 120).

So what does epistemic culture change mean in the twenty-first century classroom? Schools and classrooms need to change so that students' capacity for learning is more robust, broad, skilled and flexible. Claxton (2007) has summarised the change in eight themes.

Language – teachers will need to encourage students to think and talk about their

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 34, 2011

learning processes. These conversations will require collaborative discussion and reflective thinking. Portfolios and reflective journals would make an ideal ways of recording this focus on expanding learning capacity.

Potentiating activities – student engagement needs to develop a sense of challenge where thinking is hard and frustration or confusion may result.

Split-screen thinking – as well as teachers looking to extend students' grasp of content, they need to be considering how they challenge their capacity to learn

Wild topics – the topics selected as contexts for learning need to be meaningful, real, relevant and rich. Students will be challenged through taking greater responsibility and control over their learning and processes. These topics will raise high quality questions and require substantive discussion and inquiry. It is here particularly that the Technology learning area offers so much potential.

Transparency and involvement – greater success will come when students are encouraged to be part of the change process. They need to understand their role in the change process and appreciate the knowledge-creating that is happening. At a micro level it is essential that students understand the nature of the learning whether it is about skills and content, or the process, values, competencies, etc that expand their learning capacity. Students need to be made aware of the learning that is involved in contexts being used to address curriculum. 'Learning intentions' (Clarke, Hattie, & Timperley, 2003) when made clear to students, will sharpen their focus and separate the importance of the learning from the context or activity.

Transfer thinking – students should be helped to see how they can transfer their learning to wider real-life contexts in order better understand their world beyond the school. Where else might they use it? What else might it be good for?

Progression – it is essential that learning is scaffolded to develop understanding in a progressive way, building on previous learning and allowing for students to realize why rather than just be told how to complete a task.

Modeling – students need to see learning and capacity to learn modeled by those around them. The adults and peers they work with will model approaches of learning rather than just be the knowledge providers. Students should experience learning in a cooperative way with a variety of others who can share in the learning journey in a number of ways as expert, mentor, co-learner or teacher.

If these aspects form the critical nature of twenty-first century learning as Claxton prescribes, then what elements of curriculum can teachers use to engage students in successful achievement? Technology Education with its emphasis on design, innovation, creativity, entrepreneurialism, cooperation and societal integration, often through practical involvement seems well placed. The multi-disciplinary nature and holistic approach of this learning area allows students to make meaningful connections to significant learning.

Technology Education

Technology is intervention by design (Ministry of Education, 2007), the 'know how' and creative process that may utilise tools, resources and systems to solve technological problems and enhance control over the natural and man-made environment with the aim of improving quality of life.

When students undertake authentic technological practice, their learning is contextually driven. Fleer and Jane (1999) suggest that technology emerges from within a social context and does not occur in isolation from values, beliefs and social life. Technology is constructed within a particular culture taking into consideration of the social and cultural needs of the society in which it was developed (Fleer & Jane, 1999; Siraj-Blatchford, 1997). Technological solutions developed within the context of the community, in which the need arrives, using local

skills, resources and existing technologies are likely to be the most successful (Turnbull, 2002; Hennessy, 1993).

In New Zealand the aim of technology education is the development of technological literacy (Ministry of Education, 2007; Moreland & Cowie, 2007). This includes the knowledge and understandings required to skillfully and knowledgeably undertake holistic technological practice within the bounds of the context of the study and the New Zealand Curriculum. The curriculum identifies three strands, Technological Practice, the Nature of Technology, and Technological Knowledge. It develops abilities to critique technology and to understand its complexity; including how de Vries (2005) considers the knowledge of processes involved in the functioning and or making of the object an aspect of technological knowledge. Ryle's (1984) definition of knowledge includes not only 'knowing that' but also 'knowing how' is particularly applicable to technological knowledge with a clear distinction between the two. Jones and Moreland (2001) state that technological skills and knowledge come from two main categories; the first is knowledge that is context specific and related directly to the areas in which the solution is being developed and includes knowledge in a range of domains: procedural, conceptual, societal and technical. The second is generic technological knowledge, common to all technological development and applicable across the four domains of knowledge mentioned above.

Technological practice also includes developing abilities to critique technology and to understand its complexity; including how it interacts with humans and the environment (Moreland & Cowie, 2007). Typically, students are given or identify a problem for which they have to develop a technological solution. Communicated to them through a given brief from their teacher, students then develop their own initial brief outlining the direction their practice will take them. They then engage in a selection of planned activities enabling them to develop the necessary skills and knowledge to design and possibly develop appropriate technological solutions. Technology design process then is very closely aligned to the methodology of inquiry learning.

The writers believe that when taught in line with the current philosophy of technology education, students engaged in quality technological practice through the development and critique of products and systems that meet identified needs, many of the skills learned align with inquiry learning. The epistemic culture changes recommended by Claxton (2007) also align both with technological design and practice processes and those of an inquiry approach.

Guided Inquiry Learning

Inquiry learning is set within a socio-constructivist paradigm in which students are encouraged to construct their knowledge and understandings within their own cultural settings. It is a process that enables students to take greater ownership of and responsibility for their learning. It encompasses a wide range of skills and processes in active learning leading to a much broader understanding of the world the students are part of. This approach is based on the constructivist theoretical foundations of learning (Kuhlthau, et al., 2007).

One inquiry learning strategy that focuses on the facilitation of independent knowledge based learning is Guided Inquiry (Kuhlthau, et al., 2007). In order to stimulate and develop the child's curiosity and thinking adults need to interact with the child at their potential level not at their actual level (Fleer, 1995).

The Guided Inquiry approach reflects the belief that, for learners, active involvement in construction of their knowledge is essential for their effective learning (Kuhlthau, et al., 2007; Murdoch, 2004). Inquiry is guided and systematic learning that proceeds through a number of teaching/learning phases. It is very different from 'open' discovery learning in that the teachers have a major and continuing responsibility to structure a range of activities sequenced to

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 34, 2011

maximize the development of skills and thinking processes of the learners. Guided Inquiry uses a wide range of teaching approaches from teachers' exposition to independent student research (Murdoch, 2004). Inquiry methodology and integrated curriculum are also supported by Caine and Caine (1990, as cited in Murdoch, 2004). They argue that the brain seeks patterns, meaning and connectedness - methods that move from rote memorization to meaning-centred learning (Murdoch, 2004). Guided Inquiry involves students in developing deep learning through the process of self-motivated inquiry that strives towards development of 'big understandings' and 'rich concepts' (Kuhlthau, et al., 2007; Murdoch, 2004) about the world and how it functions (Blythe, 1998). Like technology education Guided Inquiry learning is centred on both process and content, with students taking considerable ownership and responsibility (Murdoch, 2004).

Guided Inquiry is one approach that teachers can use to enable them to plan and implement a constructivist classroom that meets the needs of and extends learning capacity for individual students. This process is outlined in Table 1, Kuhlthau's model of the Information Search Process below.

In the first phase in most cases the teacher announces a topic of study that requires thorough research, thus *initiating* the inquiry process. During this time the students are prepared for selecting a topic of research through a variety of immersion activities. A range of strategies motivate and engage students and we suggest is more likely to include learning through acquisition than later in the unit. During this phase it is not unusual for students to feel uncertain and perhaps 'bogged down'.

The second phase involves the *selection* of a topic of study and identifying significant questions within the unit they will be working on. Topics come with many parameters or points of interest for the students; assessment requirements, time available and resources or information available. During this time student may feel optimistic about the journey ahead.

Exploration, the third phase, involves sifting through in information available to find a focus. Students need to be well informed about the general topic in order to find an area to focus on. This is a most difficult phase where an abundance of open-ended questions and wonderings abound and confusion and doubt can set in. Students can become easily frustrated and discouraged. At this phase in the project many students can drop their projects when they come across inconsistencies within the information and find incompatibilities with what they might already know.

The fourth phase is *formulation* and is a time when students identify ways to focus and organise their topic which provides a degree of clarity.

The next phase, *collection*, follows naturally with an extended focus on how to present the new understandings. They now have a sense of direction and increased confidence as they take ownership.

Once they have gathered all the required information they will consider the nature of the presentation they will use to share their findings. Presentation may consider a range of styles from informal to formal outcomes. Often these may become celebrations that can be shared with peers, parents or other stakeholders in the problem or issue.

The *assessment* phase concludes the project as both teachers and students judge what has been learned about content and process. This is a time to critically reflect and evaluate on the inquiry process as a whole. It shouldn't however be confused with formative assessment of content and process which is ongoing throughout the project (Kuhlthau, et al., 2007).

Guided Inquiry offers students an opportunity to build on what they already know and gain new knowledge through active engagement in and reflecting on an experience and learning. Students are able to develop and use higher-order thinking skills with teacher guidance at critical points in the learning and development process. It allows for different modes of learning to be catered for and facilitates learning through social interaction with others. Students learn through instruction and experience that aligns with their cognitive development (Kuhlthau, et al., 2007).

Table 1. Model of the Information Search Process.

Phases	Feelings (affective)	Thoughts (cognitive)	Actions (physical
Initiative	Uncertainty	Vague	Seeking relevant information
Selection	Optimism		
Exploration	Confusion, Doubt Frustration		Exploring
Formulation	Clarity		
Collection	Sense of direction/ confidence		
Presentation	Satisfaction or disappointment	Focused	Seeking pertinent information
			Documenting
Assessment	Sense of achievement	Increased self-awareness	

(Kuthlthau, 2004, cited Kuhlthau, et al., 2007, p. 19. Reformatted by authors)

The Twenty-first Century Learning and Technology Nexus

Technology Education offers rich contexts for study, social construction of outcomes, connections, cooperation and collaboration with others, and practical engagement in worthwhile and real-world activities (Snape & Fox-Turnbull, 2011). The themes developed in this paper are an integral part of teaching and learning in this area.

Technology projects are frequently collaborative requiring cooperative work and shared processes. This introduces significantly different approaches to work than the frequently seen desk-confined, textbook and whiteboard techniques often used in our primary and post-primary classrooms. The skills required to work in cooperative and collaborative situations relate significantly to those identified in the *Framework for 21st Century Learning* (Partnership for 21st Century Skills, 2009) and 'front end' of *The New Zealand Curriculum* (Ministry of Education, 2007). The epistemic culture changes recommended by Claxton (2007) and the dispositions that capable and effective learners should be able to demonstrate, also link very closely to what happens in good technology programmes of work. The learning and innovation skills, key competencies, values and principles incorporated as approaches and elements of inquiry participation, engage and motivate students to develop new knowledge and many skills that can be transferred to understand other learning situations.

As students develop technological outcomes meeting the needs and opportunities of stakeholders and relating to real-world contexts, they work in authentic practices (Snape & Fox-Turnbull, 2011; Hennessy and Murphy (1999). Practices will be real to the student, their lives, and to situations they may encounter in the future workplace (Hennessy, 1993). As these are undertaken they gain an appreciation of the bigger picture (Murdoch & Hornsby, 1997; Blythe & Associates, 1998), utilise key competencies and values, create and innovate, and work with various media and educational technology. The socially embedded nature of Technology integrates a variety of skills, ethics and cross-cultural themes, offering opportunities for students to participate in, and understand many local, national or global community issues. This involvement integrates a much wider range of authentic learning experiences than is traditionally offered in post-primary education. Supportive and professionally aware technology teachers

guide and facilitate a much wider range of skills and process learning than most classroom teachers. As such their teaching can extend deeply into the realm of life-long learning for successful living in the twenty-first century.

An earlier curriculum, *Technology in the New Zealand Curriculum* (Ministry of Education, 1995), presented a list of characteristics of learning in technology. Very clear connections to the *Framework for 21st Century Learning* (Partnership for 21st Century Skills, 2009), *The New Zealand Curriculum* (Ministry of Education, 2007), and Claxton's dispositions can be seen.

Summary statements from the Technology Education Characteristics of Learning (Ministry of Education, 1995, p. 16) include:

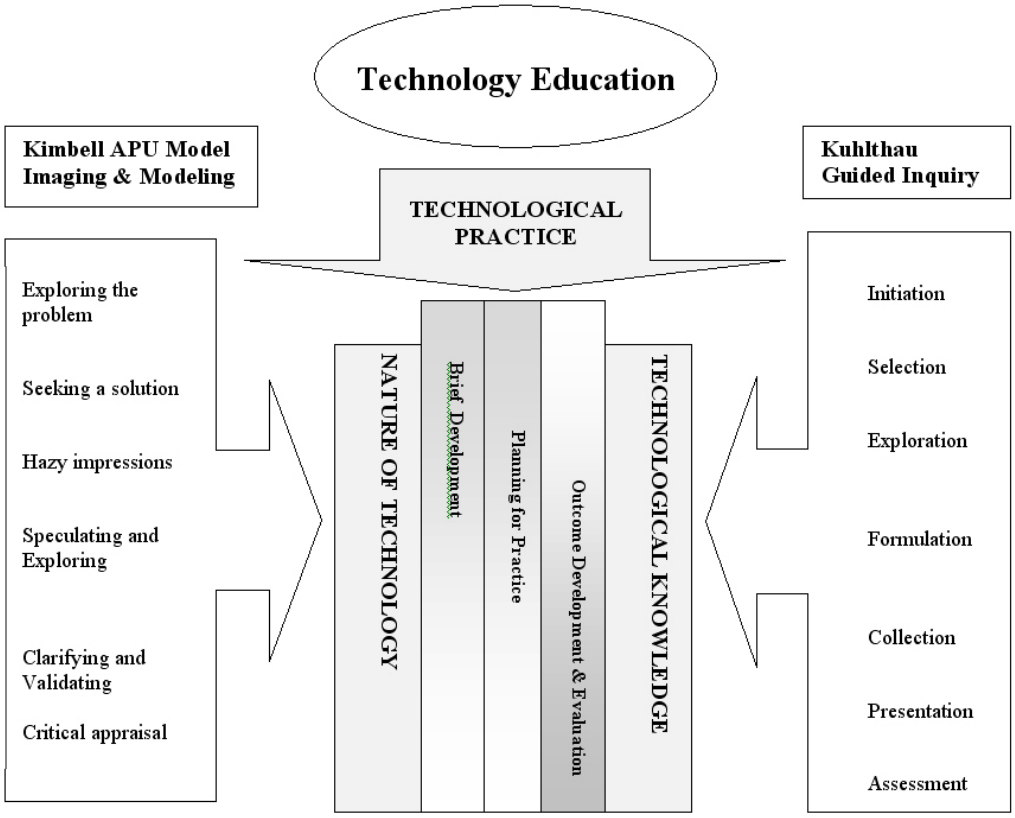
- Technology builds on students' existing knowledge and skills, values, interests, and aspirations.
- Technology develops real, identified needs or problems, and with multiple solutions. There is no single "right answer"
- Lateral thinking and willingness to test divergent options are to be encouraged
- Students should experience the satisfaction of developing a range of outcomes.
- Developments are advanced by sharing ideas, presenting concepts, and evaluating possible solutions
- Teacher's knowledge, experience, and skills provide input to assist in refining ideas, selecting resources, and achieving quality in products, as well as guiding students towards viable solutions
- Teacher supports, guides, challenges, and learns with the students, interacting with their thinking and helping to clarify ideas
- Encourages risk taking: students' ideas should be accepted and valued, and students challenged to realise their aspirations
- Technology provides opportunities for students to show initiative, make choices, and take more responsibility for their own work
- Technology requires students to work co-operatively and collaboratively &; with each other, their teachers, and other adults
- The teacher's role is to motivate, encourage, support, and provide feedback to students
- Technology offers opportunities for a wide range of people in the community to provide specialist input.

The Assessment of Performance (APU) Model (Kimbell et. al., 1991) of the technology design process provides a succinct perspective of what happens in technology design. It has been described as an iterative process of 'thought in action' where interactions between mind (Imaging and Modeling) and hand (Confronting Reality) are formulated, tested and reformulated (Stables and Kimbell, 2000:195-196). The 'Imaging and Modeling' aspect of this model closely resembles the phrases of Guided Inquiry. Table 2 models the connection between the Technology learning area and the two processes that are involved as students work through their contexts of learning. There are definite horizontal connections situated in the three different components of the model developed by the writers. The ideas presented earlier detailing the dispositions required for successful inclusion in all aspects of society are features of work in this technological practice (Wagner,2008; Claxton, 2007; Partnership for 21st Century Skills, 2009 and Ministry of Education, 2007). Fox-Turnbull and Snape (2011) draw many connections to these dispositions also in their work on socio-constructivist practices in Technology Education.

In the early stages of Technological Practice using Guided Inquiry, students will explore authentic and meaningful problems either individually or in collaborative groups to develop good knowledge of the issue or situation and its effects on the various stakeholders. Practice

has been initiated with a given brief and students will research and gather important information necessary to consider what direction they will take. Their initial brief will lead into planning for practice considering a range of brainstorms, management strategies, key stages, and resources.

Table 2. Kimbell's APU (Imaging & Modeling) model (Kimbell et al. 1991) aligned with the Technology learning area (MOE, 2007) and the Guided Inquiry process (Kuhlthau, C. 2004).



In the middle stages of the process students move from hazy impressions to a formulation of a much clearer sense of direction as they progress toward their goal. These steps involve all aspects of the New Zealand Curriculum (Ministry of Education, 2007) key competencies and values. With increased clarity conceptual drawings, sketches, and discussions further their brief development and intermediate outcomes may be produced in various forms including functional modeling.

Finally brief development concludes as the final brief is prepared and the technological outcome can now be completed and evaluated for fitness for purpose. Findings can be presented using a range of information, media or technology skills and a sense of achievement is developed as students meet the needs of their stakeholders. A broad range of skills, content knowledge and processes have been integrated in students' practice through the use of an inquiry learning approach.

PROBLEMS
OF EDUCATION
IN THE 21st CENTURY
Volume 34, 2011

Conclusion

The Knowledge Age is changing the way the world works and schools have the responsibility to best prepare students to take advantage of the opportunities that will be available to them. Teaching and learning methodology and organisation in schools needs to change if students are to develop the range of skills necessary to survive life in the twenty-first century. Key to this will be the students' willingness and determination to become involved in the process and engage with topics that add meaning to their worlds. This increased focus and engagement in learning will lead to the development of a much broader range of attitudes, values, competencies and dispositions enabling them to respond positively to opportunities.

The nature of Technology Education and its alignment to the Guided Inquiry approach make this connection ideal for developing life-long learners. Many Technology teachers have successfully and seamlessly integrated these aspects into their programmes. Epistemic culture changes that further develops student's learning capacity through greater engagement, motivation, and satisfaction will propitiate their quest for knowledge, processes and skills. Technology teachers can become the leaders of change that will revitalise education systems and end the traditional content-driven, low-level learning and assessment-based regime that still frequently predominates in our schools.

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PROBLEMS
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