

Your Mission Should You Choose to Accept It: 21st Century Learning and Technology Education

Paul Snape: University of Canterbury, College of Education

Wendy Fox-Turnbull: University of Canterbury, College of Education

Abstract:

This paper suggests that when taught in line with current philosophy of technology education, students engaged in quality technology education are more likely to be engaged with 21st century learning strategies. Technological literacy occurs through the authentic (Snape & Fox-Turnbull, 2011) development and critique of products and systems designed to meet identified technological needs. Many skills learned during this process align with skills and knowledge for success in today's world. How well prepared are our secondary schools to meet the needs of 21st century learning? New knowledges, skills and teaching methods 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 (Bolstad & Gilbert, 2008; Gilbert, 2005) and schools will need to change significantly to meet the new and emerging needs of today's students. Anecdotal evidence indicates students are becoming more disengaged with the content and assessment-driven secondary curriculum and equally with the industrial age model of schooling they are often forced to endure. Inquiry learning, and other student-centred approaches are today touted as appropriate models of learning (Kuhlthau, Maniotes, & Caspari, 2007). This paper explores both 21st Century Learning and Guided Inquiry (Kuhlthau, et al., 2007) and their connection with the technological design process, key competencies, principles, and values of the 2007 *New Zealand Curriculum* (Ministry of Education, 2007).

Key Words: Guided Inquiry Learning, Technology Education, 21st Century Learning, Curriculum

Introduction

Throughout history there have been many times where significant social change has occurred. War, plague, invention or discoveries have led to events that have resulted in tremendous paradigm shifts. These 'tipping points' (Gladwell, 2000, cited in Kay, 2010) have occurred when "a critical mass of circumstances come together and sets a new and unstoppable course." (Kay, 2010, p. xiii). The technological revolution of the last two decades particularly, has resulted in a new diverse, globalised, complex and media-saturated society. How well is our existing education system prepared for such change? Significant exponential change is occurring; the future is difficult to predict, however, one certainty that prevails is that change will continue to happen. Factory model education systems must change to prepare citizens who can not only cope but who will thrive in developing new knowledge.

Wagner (2008) in *The Global Achievement Gap*, has advocated seven survival skills for the 21st 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

These skills are at the heart of authentic learning (Newmann & Wehlage, 1993; Snape & Fox-Turnbull, 2011) where students engage in real-world problems and issues of meaning, as they investigate questions that matter. The curriculum that best supports these skills 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.

The New Zealand Curriculum (2007) was developed to set a clear direction for teaching and learning in the new millennium and along with the Framework for 21st Century Learning (Partnership for 21st Century Skills, 2009) set a direction for appropriate teaching and learning. The New Zealand Curriculum focus on principles, values and key competencies is an acknowledgement that discipline content alone will not produce the resilience necessary. Much broader 'big understandings' and 'throughlines' need to over-arch discipline learning to create the connection to the more significant themes prevalent in this current era. The curriculum also identifies a range of effective pedagogies that connect with meaningful education in this new millennium and provide teachers with a better understanding of what will best promote twenty-first century learning.

The curriculum learning area, Technology Education, best exemplifies this direction into authentic and more effective teaching and learning practices. 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 writers believe it is our technology teachers, especially in the secondary school, who are best situated to showcase the changes required. It is in this area that socio-constructivist theory links so well along with formative assessment and a much greater emphasis on self and peer evaluation and assessment.

This paper will investigate the introduced 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. 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 Vision, Principles, Values and Key Competencies in the ‘front end’ of the New Zealand Curriculum (2007). Curriculum ‘front end’ learning in New Zealand 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 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 fulfil the expectations of the

new economy (Bellanca & Brandt, 2010). In many countries the existing educational system continues to expand the gap between rich and poor, and exacerbates the divide between different ethnicities.

Technology – background and focus

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 (UNESCO, 1985).

When students undertake authentic technological practice, their learning is contextually driven. Fler 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 (Fler & 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 (Hennessy, 1993; Turnbull, 2002).

In New Zealand the aim of technology education is the development of technological literacy (Ministry of Education, 1995, 2007; Moreland & Cowie, 2007). This includes the knowledge and understandings required to skilfully 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.

Technology Knowledge

Artefacts have a functional and physical nature. Designers need to consider both features and how they interact with each other to improve fitness for purpose. One way to explore technological knowledge is to understand the 'dual nature' of a designed artefact (de Vries, 2005). Knowledge about the physical nature of an object; this includes knowledge of its material properties such as arithmetical, spatial kinematical, physical and biotic aspects. Knowledge of functional nature includes the following aspects: sensitive, logical, historical, lingual, social, economic, aesthetic, juridical, ethical and pistic (strong belief in the power of technology) knowledge. Technology knowledge also includes the relationship between the physical and functional features and knowing how materials contribute to the artefact's fitness for purpose (Davis, Mahar, & Noddings, 1990).

Discovery through interaction with technology artefacts, their associated features, materials, and physical and functional natures, fosters independent thinking and problem solving, skills considered vital for success in 21st century learning. Undertaking technological practice has been shown to provide students with the opportunity to collaborate with others and make a difference to their own lives and developments in their immediate community. This results in high levels of student engagement and allows students to take increasing ownership of their learning and feel empowered to make decisions regarding the nature of their outcomes (Compton, 2010, p. 1).

21st Century Learning

Learning in the 21st century needs to look significantly different to that of the past to equip students for their future lives in the Technology or Information Age. For this reason, educators face a huge challenge including the development of critical thinking and problems solving skills in our students, suggested skills vital for 21st century learning. Some critics, however, oppose the idea of developing these skills on the grounds that important 'content' will be lost (Bolstad & Gilbert, 2008).

Sfard (2008; 1998) identifies acquisition and participation as two metaphors that guide learning. The first of these, acquisition, is the more traditional model of learning in which the mind is a vessel, which needs filling with knowledge and concepts much of which is content related. She suggests in recent studies learning is dominated by the participation metaphor in which students learn through interaction with material and people. Learning through participation is more likely to facilitate critical thinking and problem solving as students work collaboratively and cooperatively to advance learning through doing.

Moreover, ongoing learning activities are never considered separated from the context within which they take place. The context, in its turn, is rich and multifarious, and its importance is pronounced by talk about situatedness, contextuality, cultural embeddedness and social mediation (2008, p.6; 1998, p. 8).

This latter model best exemplifies constructivist principles of learning and better aligns with skills needed for the 21st century. It also best explains learning in technology education. One however needs to be cognisant of concerns mentioned above about specific content. In reality learning will occur through a range of approaches and certainly through both of Sfard's (1998) complementary metaphors.

Socio-constructivist theory

Aspects of socio-cultural theory help to explain some of the fundamental principles of 21st Century learning as it puts the child's cultural community at the centre of learning. Child development in a socio-cultural paradigm does not exist within the child but rather it occurs as the child interacts with the cultural community in which he/she lives (Fleer et al., 2006). One of the fundamental claims that Vygotsky made was that human activity on both the individual and social planes is mediated by tools (Wertsch, 1981). The goal of the socio-cultural approach is to understand the relationships between human action and mental functioning, on the one hand, and the cultural, institutional, and historical context in which this action occurs, on the other (Resnick, Levine, & Teasley, 1991; Wertsch, 1998; Wertsch, Del Rio, & Alvarez, 1995). There are two fundamental and defining themes, which run through socio-cultural theory: *action* and *mediation*. Within a conceptual framework for the socio-cultural context of cognitive development, the basic unit of analysis is not the individual but activity involving active participation of people in socially constituted practices or "the appropriation of socio-cultural means and modes of activity" (Wertsch, Minick, & Arns, 1999, p. 152). A fundamental claim of socio-cultural research is that its proper focus is external or internal human action which is carried out by either groups both large and small or by individuals (Wertsch, 1998). Mediations often emerge in response to a host of varying opinions and insights into an issue thus facilitating action in unanticipated ways. Wertsch (1981) claims our mental processes are social, even in a private sphere humans retain functions of social interaction.

Rogoff (1990) outlines a socio-cultural approach involving three planes of analysis corresponding to 'personal' (intrapersonal) 'interpersonal' and community process. The developmental processes corresponding to these three planes are 'participatory appropriation' 'guided participation' and 'apprenticeship' respectively. Socio-cultural theory suggests that mental functioning involves cultural tools or mediated means. Human mental function, even when carried out by the individuals acting in isolation is inherently social in that it incorporates socially evolved organised cultural tools such as language. Notions of action and mediation are intertwined and are essential building blocks in socio-cultural theory (Daniels, 1996b).

There is a strong focus on the role adults and/or more capable peers play in learning with an emphasis on peer group interactions and collaborative learning (Daniels, 1996a; Richardson, 1998). Smith (1998, p. 21) suggests that within a socio-cultural approach children gradually come to know and understand the world through

participation in their own activities and in communication with others. Wertsch (1998) argues that virtually all action whether on an individual or social interaction plane is socio-culturally situated, even when the individual sits in solitude because of mediational means employed. To understand how individuals learn and develop through participation in the socio-cultural world, it is necessary to grant that meaning is more than a construction by individuals (Rogoff, 1998 cited in Flear, et al., 2006, p. 31).

Big Understandings and Throughlines

Effective teaching and learning programmes today will engage students in meaningful contexts where students can see a purpose for the learning. To enhance understanding, learning not only focuses on disciplinary content knowledge but needs to help students see a much bigger picture. Worthwhile, substantive or rich topics (Murdoch & Hornsby, 2003) Education Queensland (2000), allow for the integration of skills and knowledge deemed essential for life-long learning. Blythe and Associates (1998) label these 'big understandings' or 'throughlines'. They link learning to everyday life through the rich concepts, values, or competencies that enable humans to take their place in the world. A throughline might be a question, phrase or statement that helps students make connections with the world beyond school. They will incorporate aspects of principles, values, key competencies and themes identified in the Partnership Framework (Partnership for 21st Century Skills, 2009) or the New Zealand Curriculum (Ministry of Education, 2007) above and link into the list of Wagner's survival skills detailed in the introduction of this article.

Formative Assessment

Formative assessment consists of four basic components: sharing learning goals, effective questioning and conversation, self and peer evaluation, and effective feedback. Feedback or guidance in the learning process is essential where students are taking an active and increasingly independent role in the learning process. Teachers become facilitators as they co-construct, guide and support learning for students. In order for teachers to do this they must have critical content and process knowledge, an understanding of the specific needs of their students and be able to identify when to offer guidance and how much to give (Blythe, 1998; Fox-Turnbull, 2003; Kuhlthau, et al., 2007).

There is strong evidence that formative assessment can raise achievement (Clarke, 2008; Wagner., 2008). Active learning is at the heart of formative assessment and should allow teachers and students to collaborate in all stages of learning from planning, deciding contexts of study, establishing intended learning and associated success criteria, and critically engaging in analyzing learning through classroom talk (Clarke, 2008) . Clarke suggests that to ensure maximum impact on motivation and achievement schools needs to make their curriculum creative and flexible. Formative feedback is enhanced when students are:

- engaged in preplanning and planning will ensure learning is pitched at the correct level,

- motivated to achieve.
- presented with a minimum coverage, as a starting point for discussions.
- given learning objectives (intentions) that are displayed
- involved in learning that is modelled, interactive and flexible enough to change direction where required.

Assessment, evaluation and critical reflection skills are essential where individuals take greater responsibility for their own learning and are therefore an important part of twenty-first century learning. More traditional forms of teacher feedback often have a negative effect on children's learning (Clarke, 2005). Token comments in teacher's marking seldom identify the actual learning being referred to. Without reference to the specific success criteria students are unable to make the connection and determine what the teacher is in fact alluding to. Where students are actively engaged in self or peer evaluation with identified success criteria feedback is more successful. The teacher is able to model appropriate responses, correct misconceptions, and reset goals and direction.

Successful feedback according to Clarke (2005) is likely to focus on the specific learning intention and success criteria, close gaps in learning, suggest specific improvements, happen during lesson time and lead to students becoming more familiar with this process themselves.

Higher-order Thinking Skills

Bolstad and Gilbert (2008) highlight that teaching in many secondary and tertiary institutions is very much focussed on facts and details with assessment success centred on the importance of being able to regurgitate and recall these. This style can lack an ability to motivate and engage students satisfactorily and is very much indicative of an Industrial Age model. Bolstad and Gilbert feel that with this approach, students often fail to see the bigger picture of the subject that enables them to fully appreciate it. They certainly do not develop higher-order thinking skills when the emphasis is on recall and factual understanding. "The shift from 'knowing stuff' to 'doing stuff' allows us to think about learning, and about assessment, in post-Industrial Age ways" (p. 101).

The Council for Exceptional Children (2011) state that higher-order thinking classrooms should feature these six characteristics:

- they are reflections of real-life situations and contexts
- they show collaboration among teachers, disciplines, and students
- they encourage curiosity, exploration, and investigation
- they vest responsibility for learning in the learner
- they view failure as a learning opportunity

- they acknowledge effort, not just performance

Students engaged in this type of practice will develop a much broader range of skills and dispositions. They are better motivated by the real-world contexts in their study and the problems they grapple with. Learning will better prepare them for the world they live in and will be completed in more authentic situations and contexts.

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.

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.

Inquiry learning is based on the constructivist theoretical foundations of learning (Blythe, 1998; Kuhlthau, et al., 2007). Constructivists suggests people construct their own understandings of the world in which they live (Daniels, 1996a; De Vies & Kohlberg, 1990). This is opposed to a transmission approach to learning in which learning is viewed as something the teacher does to the students. This framework is built up, tested, and altered as new learning occurs (Hennessy & Murphy, 1999; Hill & Smith, 1998). Constructivism looks at the individual's ability to make representations within their framework of knowledge, often doing so in cooperative and collaborative situations. Constructivist theorists have also long perceived that the construction of knowledge occurs through interaction with the environment (Hennessy, 1993; Maddux & Cummings, 1999; Rogoff, 1990; Vygotsky, 1978; Zuga, 1992). Hennessy states, "It is obvious that merely presenting children with new information and experiences in the classroom is insufficient to promote learning" (Hennessy, 1993, p. 11). Individuals solve problems and issues as they construct knowledge through experience and instruction. Vygotsky encouraged us to rethink social development to include the socio and cultural context in which a person lives and that to understand an individual we must understand their social relationships(Fleer, et al., 2006; Wertsch, 1998).

Guided Inquiry: an Approach

One inquiry learning strategy that focuses on the facilitation of independent knowledge based learning is Guided Inquiry (Kuhlthau, et al., 2007). The Guided Inquiry approach reflects the belief that, for learners, active involvement in construction of their knowledge is essential for their effective learning (Blythe, 1998; 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 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, 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' (Blythe, 1998; 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).

Development of higher-order thinking is a key concept to constructivism and Guided Inquiry (Kuhlthau, et al., 2007). The path to developing higher order thinking is assisted through an understanding of Vygotsky's (1978) Zone of Proximal Development (ZPD). The ZPD describes the difference between a child's actual level of cognitive function and development and their potential. Richardson (1998) defines the zone of proximal development as the "latent learning gap" between what the child can do on his or her own and what can be done with the help of a more skilful other". Vygotsky (1978) first used the term to describe the difference between the level a child can work independently and their potential. It is the child's potential rather than their actual level that is considered (Fleer, 1995; Fleer, et al., 2006). Brown & colleagues (1993) suggest that the ZPD is the region of activity that learners can navigate with help from supporting contexts.

From this notion comes the underlying assumption that psychological development and instruction are socially embedded (Wertsch, 1998). Theoretically classrooms should consist of zones of proximal development for all students. With support from adults, children are able to work above their actual level, however, for this to happen teachers must know their children well and purposefully plan meaningful activities (Fleer, 1995). A ZPD can include people, adults and children, with various degrees of expertise, books, videos, wall displays, scientific, technological and mathematical equipment intended to support learning (Brown, et al., 1993). To work with the ZPD in the classroom implies that the teacher is aware of the developmental stages of the children and is able to make qualitative changes in teaching towards a certain goal (Daniels, 1996b; De Vries & Kohlberg, 1990). Higher-order thinking is fostered within the ZPD (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). 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 for individual students.

In the Guided Inquiry process there are distinct phases that students go through, with some more difficult than others. Inquiry is instigated through someone's need for investigation into a pressing issue, fundamental question or troubling problem. Exploration and question formulation then facilitate significant learning.

Investigation leads to the collection of significant facts and information. Task completion and preparation for presentation complete the process (Blythe, 1998; Kuhlthau, et al., 2007). This process is outlined in Table 1, Kuhlthau's Model of the Information Search Process.

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 (Blythe, 1998; 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 (Blythe, 1998; Kuhlthau, et al., 2007).

Table 1: Model of the Information Search Process

	Initiation	Selection	Exploration	Formulation	Collection	Presentation	Assessment
Feelings (affective)	Uncertainly	Optimism	Confusion Frustration Doubt	Clarity	Sense of direction/ confidence	Satisfaction or disappointment	Sense of Achievement
Thoughts (cognitive)	Vague				Focused		
Actions (Physical)	Seeking relevant information Exploring				Seeking pertinent information Documenting		

(Kuhlthau, 2004, cited Blythe, 1998, p. 19)

Technology Education

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 above are an integral part of teaching and learning in this area.

The Assessment of Performance (APU) Model (Kimbell, Stables, Wheeler, Wozniak, & V., 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 and hand are formulated, tested and reformulated (Stables and Kimbell, 2000:195-196 cited in Stables & Kimbell, 2005).

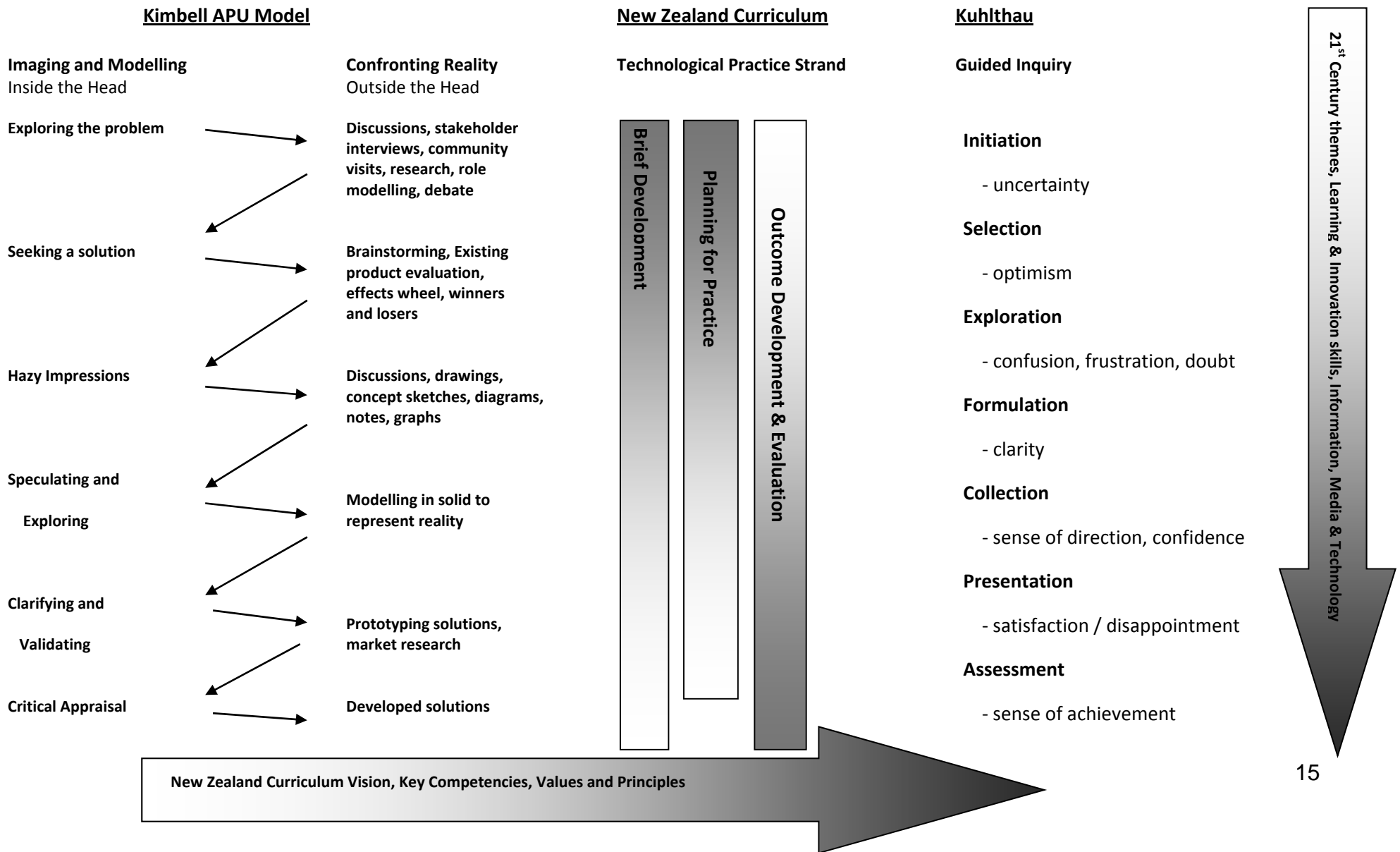
Technology projects are frequently collaborative requiring cooperative work and shared processes. This introduces significantly different approaches to work than the frequently seen desk-confined, textbook and whiteboard techniques often used in our primary and post-primary classrooms. The skills required to work in cooperative and collaborative situations relate significantly to those identified in the Partnership framework (Partnership for 21st Century Skills, 2009) and 'front end' of the New Zealand Curriculum (Ministry of Education, 2007). The learning and innovation skills, key competencies, values and principles incorporated as elements of inquiry participation, engage and motivate students to develop new knowledge and many skills that can be transferred to new learning experiences.

As students develop technological outcomes meeting the needs and opportunities of stakeholders and relating to real-world contexts, they work in authentic practices (Hennessy & Murphy, 1999; Snape & Fox-Turnbull, 2011). 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 (Blythe, 1998; Murdoch & Hornsby, 2003), 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 processes for learning than most other classroom teachers. As such, their teaching can extend deeply into the realm of life-long learning for successful living in the twenty-first century.

Figure 1 below demonstrates the connections and links between Kimbell's APU model, (Kimbell, et al., 1991), the Technological Practice strand from the New Zealand Curriculum (Ministry of Education, 2007) and Kuhlthau's Guided Inquiry procedure (Kuhlthau, et al., 2007).

Figure 1: **The Technology and Guided Learning Connection**

Kimbell's APU model (Kimbell et al., 1991) aligned with the New Zealand Curriculum (Ministry of Education, 2007), the Guided Inquiry process (Kuhlthau, C. 2004) and the Framework for 21st Century Learning developed by Paul Snape and Wendy Fox-Turnbull UC 2011



There are clear horizontal connections situated in the three different components of the model developed by the writers. 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 brainstorm, management strategies, key stages, and resources.

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 modelling.

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

Conclusion

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. Wagner's (2008) skills list introduced at the beginning of this paper does align closely with the two perspectives considered in this paper. The process of design outlined in the APU Model (Kimbell et al., 1991) involves students participating in the actions and methods of the Framework for 21st Century Learning (Partnership for 21st Century Skills, 2009) and the Principles, Values and Key Competencies of the New Zealand Curriculum. Technology teachers can successfully and seamlessly integrate all aspects within their existing programmes. Technology is in the fortunate position in that teachers can easily make a small shift to this more appropriate learning style that will engage, motivate, and satisfy their students' quest for knowledge and skills for success and life-long learning. We are hoping they will become the leaders of a change that will revitalise the education system and end the traditional content-driven, low-level learning and assessment-based regime that still frequently predominates in our schools.

References

- Bellanca, J., & Brandt, R. (2010). *Rethinking how students learn*.
- Best, J., & Kahn, J. (1998). *Research in education*. Needham Heights MA: Allyn and Bacon.
- Blythe, T. (1998). *The teaching for understanding guide*. San Francisco: Jossey-Bass.
- Bolstad, R., & Gilbert, J. (2008). *Disciplining and drafting Or 21st century learning?: rethinking the New Zealand senior secondary curriculum for the future*. Wellington: New Zealand Council for Educational Research.
- Brown, A., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J. (1993). Distributed expertise in the classroom. In G. Salomon (Ed.), *Distributed cognitions; psychological and educational considerations*. Melbourne: Cambridge University Press.
- Clarke, S. (2005). *Formative assessment in action: weaving the elements together*. Oxon: Hodder Murray.
- Clarke, S. (2008). *Active learning through formative assessment*. London: Hodder Education.
- Compton, V. (2010). A new technological literacy. *Technological Literacy 3* Retrieved 20 July 2011, from <http://www.techlink.org.nz/curriculum-support/pdfs/tech-literacy.pdf>
- Council for Exceptional Children. (2011). Teaching high order thinking skills using real world problem solving. Retrieved from <http://www.cec.sped.org>

- Daniels, H. (1996a). *An introduction to Vygotsky*. London: : Routledge.
- Daniels, H. (Ed.). (1996b). *The genesis of higher mental functions*. London: Routledge.
- Davis, R., Mahar, C., & Noddings, N. (Eds.). (1990). *Constructivist views on the teaching and learning of mathematics*. Reston Va: National Council for Teachers of Mathematics.
- De Vries, R., & Kohlberg, L. (1990). Constructivist early education: overview and comparison with other programmes. *National Association for the Education of Young Children*.
- de Vries, M. (2005). *Teaching about technology: an introduction to the philosophy of technology for non-philosophers* (Vol. 27). Dordrecht: Springer.
- Education Queensland. (2000). New basics technical paper. Retrieved from <http://education.qid.gov.au>. doi:10.1007/510798-011-9168-2
- Fleer, M. (1995). Staff-child interactions- a Vygotskian perspective. *Canberra: Australian Early Childhood Association Inc., 1*.
- Fleer, M., Edwards, S., Hammer, M., Kennedy, A., Ridgway, A., & Robbins, J. (2006). *Early childhood learning communities - sociocultural research in practice*. Frenchs Forest NSW: Pearson Education
- Fleer, M., & Jane, B. (1999). *Technology for children; developing your own approach*. Erskineville Australia: Prentice Hall
- Fox-Turnbull, W. (2003). *The place of authentic technological practice and assessment in technology education* Unpublished Thesis for Master of Teaching and Learning, Christchurch College of Education, Christchurch.
- Gilbert, J. (2005). *Catching the knowledge wave? The knowledge society and the future of education*. Wellington: NZCER Press.
- Hennessy, S. (1993). Situated cognition and cognition apprenticeship: implications for classroom learning. *Studies in Science Education, 22*, 1-41.
- Hennessy, S., & Murphy, P. (1999). The potential for collaborative problem solving in design and technology. *International Journal of Technology and Design Education, 9*(1), 1-36.
- Hill, A. M., & Smith, H. A. (1998). Practice meets theory in technology education: A case of authentic learning in a high school setting. *Journal of Technology, 9*(2).
- Jones, A., & Moreland, J. (2001). *Frameworks and cognitive tools for enhancing practicing teachers' pedagogical content knowledge*. Paper presented at the ASERA.
- Kay, K. (2010). 21st century skills: why they matter, what they are and how we get there. In J. Bellance & R. Brandt (Eds.), *21st century skills: rethinking how students learn*. Bloomington IN: Solution Tree Press.
- Kimbell, R., Stables, K., Wheeler, A., Wozniak, A., & V., K. A. (1991). *The assessment of performance in design and technology*. London, UK: Schools Examinations and Assessment Council.
- Kuhlthau, C., Maniotes, K., & Caspari, A. (2007). *Guided inquiry: learning in the 21st century*. Westport CT:: Libraries Unlimited Inc.
- Maddux, C. D., & Cummings, R. (1999). Constructivism: has the term outlived its usefulness? *Computers in Schools, 15*(3/4), 5-20.
- Ministry of Education. (1995). *Technology in the New Zealand curriculum*. Wellington: Learning Media.
- Ministry of Education. (2007). *The New Zealand curriculum*. Wellington: Learning Media.
- Moreland, J., & Cowie, B. (2007). Teaching approaches. In M. de Vries, R. Custer, J. Dakers & G. Martin (Eds.), *Analyzing best practices in technology education*. Rotterdam: Sense Publishers.
- Murdoch, K. (2004). *Classroom connections- strategies for integrated learning*. . South Yarra: Eleanor Curtain Publishing.
- Murdoch, K., & Hornsby, D. (2003). *Planning curriculum connections whole school planning for integrated curriculum*. . South Yarra Eleanor Curtain Publishing.
- Newmann, F., & Wehlage, G. (1993). Educational leadership: five standards of authentic instruction. *Educational Leadership, 50*(7), 8-12.
- Partnership for 21st Century Skills. (2009). Retrieved 20 July, 2011, from www.p21.org
- Resnick, L. B., Levine, J. M., & Teasley, S. D. (Eds.). (1991). *Perspectives on social shared cognition* (first ed.). Washington: American Psychological Association.

- Richardson, K. (1998). *Models of Cognitive Development*. Hove, U.K.: Psychology Press Ltd.
- Rogoff, B. (1990). *Apprenticeship in thinking: cognitive development in social context*. New York: Oxford University Press.
- Ryle, G. (1984). *The concept of mind*. Chicago: University of Chicago Press.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing one. *Educational Researcher*, 27(2), 4-13.
- Siraj-Blatchford, J. (1997). *Learning technology, science and social justice: an integrated approach for 3-13 year olds*. Nottingham: Education Now Publishing Cooperative.
- Smith, A. B. (1998). *Understanding children's development* (4 ed.). Wellington: Bridget Williams Books Ltd.
- Snape, P., & Fox-Turnbull, W. (2011). Perspectives of authenticity: implementation in technology education. *International Journal of Technology and Design Education*, early access online.
- Stables, K., & Kimbell, R. (2005, April 18-22, 2005). *Unorthodox methodologies: approaches to understanding design and technology*. Paper presented at the PATT15, Van der Valk Motel Haarlem-Zuid.
- Turnbull, W. (2002). The place of authenticity in technology in the New Zealand curriculum. *International Journal of Technology and Design Education*, 12, 23-40.
- UNESCO. (1985). *International Symposium on the Teaching of Technology in the Context of General Education*, Jerusalem.
- Vygotsky, L. S. (1978). Mind in society: the development of higher psychological processes. In M. Cole, V. John-Steiner & E. Souberman (Eds.). London: Harvard University Press.
- Wagner, T. (2008). *The global achievement gap: why even our best schools don't teach the new survival skills our children need- and what we can do about it*. New York: Basic Books.
- Wertsch, J. (1998). *Mind as action: the task of sociocultural analysis*. New York: Oxford University Press.
- Wertsch, J. (Ed.). (1981). *General genetic law of cultural development*. Armonk NY: Sharp.
- Wertsch, J., Del Rio, P., & Alvarez, A. (Eds.). (1995). *Sociocultural Studies of the Mind*. Cambridge: Cambridge University Press.
- Wertsch, J., Minick, N., & Arns, F. (Eds.). (1999). *The creation of context in joint problem-solving*. Cambridge, MA: Harvard University Press.
- Zuga, K. (1992). Social reconstruction: curriculum and technology education. *Journal of Technology Education*, 3(2).