Twenty-first century learning in the senior secondary school: a New Zealand teacher's innovation

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Introduction

The twenty-first century Knowledge Age is seen as a tipping point (Gladwell, 2000), equivalent in effect to the Age of Discovery, The Renaissance, the Industrial Revolution and the internal combustion engine. Educational goals for this century are identified more as the development of learning dispositions (Claxton, 2007), competencies and life-long learning than the enduring content-driven and assessment-based approach of an Industrial Age paradigm. Bolstad and Gilbert (2008) state continuation of this age-old strategy will not best serve or prepare students for living in the twenty-first century. In particular they see senior secondary school education as geared too much toward screening, sorting and disciplining students for university study.

The situation in the senior secondary school has changed significantly in the last few decades from its traditional position where specialist teachers adopt a content-centred approach in order to develop mini mes that continue their legacies. What are these changes? Bolstad and Gilbert (2008) identify a number of factors including: increased retention rates, expansion of the tertiary sector, changes to qualifications and assessment systems, emphasis on student 'pathways' and transitions from school, and the Knowledge Society and twenty-first century learning.

Passionate and professionally aware educators have begun to acknowledge the changes required and are investigating creative solutions to ensure their students are well-grounded in relevant and meaningful learning pursuits. I have identified a local teacher (John) who has this year gained school administration approval to promote an innovative course for senior students in the field of Technology. I have chosen this innovation as the theme for my doctoral study and introduce the initiative and my approach in this paper.

John's programme

Recently in New Zealand the Ministry of Education made a decision to more appropriately align the regime of achievement and unit standards for assessment of Year 11–13 students in the National Certificate of Educational Achievement (NCEA). At the same time they saw an opportunity to develop teaching and learning guides as a resource in the senior school specialist subjects. These guides identify the learning required for students at Levels 6-8 of the New Zealand Curriculum (2007) (NZC) in each of the eight learning areas. Each specialist subject was required to link itself

to one of these learning areas. This has caused issues with some subject associations who do not necessarily see themselves as coming under the auspices of a mandated curriculum learning area. This is particularly the case with some subjects on the technology fringe. For students in these subjects, Technology has been seen as 'embedded' within the teaching programmes but often not explicit enough for them to gain an understanding of the nature or practice of sound technological literacy.

John has established a programme for a class of Year 11-13 students mostly from a computer science or digital technologies background. Through an inquiry or project-based approach they will develop an understanding of the technology achievement objectives at Levels 6-8 and complete generic technology achievement standards for NCEA assessment. An emphasis within the programme will be the integration of key competencies and values from the 'front end' of the NZC and explicit teaching of the learning dispositions for twenty-first century living. They will be given opportunities to experience collaborative technological practice that will provide a range of skills and understandings to transfer to their individual projects. The significance of this initiative is threefold. Firstly, the grouping of Year 11-13 students in the same class will likely create some interesting and potentially positive dynamics. Secondly, greater understanding of the technological process and pedagogical content knowledge will likely enhance the quality of their technological practice and outcomes. Finally the integration of key competencies and values in their learning to promote positive learning dispositions will promote twenty-first century learning. These aspects will form the basis of my research which will be completed in a number of stages, developing a longitudinal type study.

The key question for this research project will be. What is the nature of teaching and learning in Technology Education using twenty-first century approaches in a multi-level classroom and how will this promote a deeper understanding?

Data gathering in the first year will be based on the students' and teacher's experiences, thoughts, and evaluations. This will provide a baseline for a two-pronged approach in the second year as students extend their first year learning and John provides interventions that will lead to the development of a longer term sustainable design. The effect of these interventions will be further studied in the third year when it is hoped that some students will progress to scholarship level in Technology having experienced three years of specialist teaching and learning programmes in this class.

Baseline data will be gathered using questionnaire and interview to ascertain technological literacy knowledge, understandings of learning dispositions, key competencies, values and motivational factors of a range of students from each year level. Interview transcripts will then be developed and questionnaire information collated. Analysis will identify commonalities and differences in student understanding and background knowledge of the above descriptors. Analysis of this information will identify goals for subsequent teaching of the twenty-first century themes and student technological project planning. Each student will maintain their own learning journal to regularly record reflections and summaries. They will also maintain individual portfolios recording their technological process and practice. Both of these will be analysed to identify connections to the key research questions.

Research Design

Neuman (1994) defines three main theoretical groupings that will influence research design: positivist, interpretivist, or critical approaches. It is the interpretivist group of theories which best suits the investigation of the initiative in this study. Neuman describes this approach as: "the systematic analysis of socially meaningful action through the direct detailed observation of people in natural settings in order to arrive at understandings and interpretations of how people create and maintain their social worlds." (p. 68)

The emphasis on learning skills and dispositions for the twenty-first century and their inclusion in John's programme mean an interpretivist approach is the best one to take. Such an ap-

proach is more accepting of the free will of participants and data gathering will need to analyse the different meaning and understanding that these participants make of the situation they share. It involves getting inside the world of those experiencing it (Orlikowski & Baroudi, 1991). Students will take differing views and ideas of the twenty-first century skills introduced and data gathering will need to seek out the meanings they take. Their work with technology mentors and experts will also be varied and the interpretivist data gathering approaches will address the shared meaning and understandings featured.

The study will be a qualitative design, using phenomenological inquiry (Best & Kahn, 2006), constructivist, and symbolic interactionism theoretical perspectives (Cohen, Manion & Morrison, 2000). This approach, utilising a range of data sources, will also allow a degree of flexibility should new design decisions need to be reconsidered (Maxwell, 1998) as a result of findings. In referring to qualitative research Baxter and Jack (2008) state: "This ensures that the issue is not explored through one lens, but rather a variety of lenses which allow multiple facets of the phenomenon to be revealed or understood." (p. 544)

Analysis of students' learning and technological practice is well suited to the use of these designs. Observations of interactions with design process, technological experts and portfolio development, will be augmented with interviews and surveys. Data gathering will focus on the ways students use their understanding, skills and knowledge to make and justify decisions in the process and production of their technological outcomes. The study offers opportunities to inquire into the benefit of a sound technological literacy and twenty-first century learning for students developing outcomes in computer science and digital technologies. Examples of these outcomes might come from the fields of software design, gaming, and animation and film especially. Investigation into the nature and benefits of key competency and values learning for these learners is also a worthwhile contribution to the study (Bolstad & Gilbert, 2008).

Cresswell (1994) identifies qualitative studies as being useful as they tend to deeply explore topics and develop theories to explain participant behaviour. He also indicates that a qualitative study has the advantage of gathering materials of participants in their natural context and setting, helping to eliminate contrived findings. Cohen et al., (2000) review a range of researchers' opinions on naturalistic research to summarise:

- Inquiry is influenced by the values that inhere in the context
- the attribution of meaning is continuous and evolving over time
- researchers generate rather than test hypotheses
- theory generation is derivative – grounded (Glaser & Strauss, 1967)
- studies must be set in their natural settings as context is heavily implicated in meanings
- the research is holistic, that is, it seeks a description and interpretation of 'total phenomena'
- there is a move from description and data to inference, explanation, suggestion of causation, and theory generation
- hypotheses emerge *in situ* as the study develops in the observed setting.

Cohen et al., (2000) however, also identify some problems that may affect the reliability and validity of the research and will need to be considered with this approach to research.

- Participants may be unaware of the 'real' situation, distorting information or being highly selective
- Participants may wish to avoid, impress, direct, deny, or influence the researcher as his presence alters the situation
- The researcher may bring about a particular reading of a situation
- Research accepts the perspectives of the participants and corroborates the status quo, being focussed on the present and past rather than the future
- Wider social contexts and constraints may be neglected

It will be important in this study to be aware of these issues and seek some form of theoretical and methodological triangulation. Multiple data sources will be significant here.

Research Methodology

Two methodologies will be used in the study. In the early stages it will be more prudent to use a case study approach to identify the critical natures of the classroom environment, the teacher/student interactions, and the chosen contexts of the students. In the later stages as interventions are developed and trialled in order to determine a more sustainable model, a newer design-based implementation research model (Penuel, Fishman, Cheng & Sabelli, 2011) will be used.

A case study is an "empirical enquiry that investigates a contemporary phenomenon within its real-life context..... and relies on multiple sources of evidence" (Yin, 1994. P. 13). Orlikowski & Baroudi (1991) link case study to interpretivist researching noting that it attempts to: "understand phenomena through accessing the meanings that participants assign to them" (p. 5) but noting that researchers must acknowledge their own subjectivity in the process. In the case of this study the researcher needs to acknowledge he is implicated in the research by being involved in the class as a teacher of technology and advisor in their technological process. Multiple sources of evidence will again be important in the triangulation process. "Successful completion of case study research requires enthusiasm and intense curiosity about the phenomenon being investigated" Darke, Shanks & Broadbent (1998).

Stake (1995) and Yin (2003) base their approach to case study on a constructivist paradigm. It, "recognises the importance of the subjective human creation of meaning" (Baxter & Jack 2008). There is a close collaboration between the researcher and the participants in the study (Miller & Crabtree, 1999).

Yin (2003) identifies a variety of types of case study. The case study in this research will be a 'descriptive' type. These are used to describe an intervention or phenomenon and the real-life context in which it occurred (Yin). The study will be a multiple-case study because of its longitudinal nature. While there will be similarities in the classes over the years of the study each will contain its own individual nature and dynamics. As the study progresses findings will be related to previous years to note similarities, differences and developments. On-going students will most likely show benefits from their previous experience in this class.

Educational researchers agree that educational research is often divorced from the problems and issues of everyday practice which requires new research approaches centred on improving classroom practice (National Research Council, 2002: cited in Anonymous, 2003). Once interventions in the research study are instigated from Year Two, the programme will significantly be researched using a design-based implementation research methodology (Anonymous, 2003). This will provide for clearer evaluation of the programme's design and result in a suitable paradigm for sharing with the Technology community. Penuel et al., (2011) define this approach as including, "development and testing of innovations that foster alignment and coordination of supports for improving teaching and learning.

Penuel et al., (2011) state the approach is distinguished by four key elements:

A focus on persistent problems of practice from multiple stakeholders perspectives

A commitment to iterative, collaborative design

A concern with developing theory related to both classroom learning and implementation through systematic inquiry

A concern with developing capacity for sustaining change in systems.

Future success in improving Technology teaching and learning in the senior secondary school system will rely on people, teams, and programmes being aligned appropriately (Rowan, 2002). This will be a complex task as each institution varies in the way it is founded, the way it is resourced and how it operates. Design research involves iterative approaches to developing innovations. "Its focus on developing practical theory and tools that can be used to support local innovation and to solve problems (Reinking & Bradley, 2008), demonstrates its true potential.

In considering this model it is important to remember that the students in the study have come from a background in technology-related fields but have not been explicitly informed of the technological pedagogical content knowledge. Neither have they been given the understanding of the influences or impacts on their technological practice and outcome development. These aspects, noted in Table 1, will become important features of the study.

Table 1: The significance of Penuel et al., (2011) to the study of the initiative

Key Element	Important factors from design-based literature	Research significance
1. Problems of practice	Develop a shared understanding of the situation and nature of this research.	Build rapport with students and teacher. Interview and survey student beliefs and attitudes. Students raise issues and concerns
2. Collaborative design	Develop and test usable tools for improving teaching and learning.	Teacher and researcher work together to develop understanding. Develop student knowledge of technological practice. Explore the use of key competencies, values (NZC) Establish a guided inquiry learning model (Kuhlthau, Maniotes & Caspari, 2007). Year 11-13 students working together with experts in their field.

3. Developing theory	"In design research, it is through the analysis of what happens when researchers engage in design and help support implementation that theory develops," (Edelson, 2002)	Identify new theories for teaching and learning through systematic inquiry. Theories developed must be suitable for the school's culture, resources and policies (Blumenfeld, Fishman, Krajcik, Marx & Soloway, 2000).
4. Developing sustainable change	Intentional efforts will be made to develop processes to broadcast the innovation. Design efforts should improve social capital that individuals can access to accomplish purposive action. Design-based implementation research can foster cohesion among networks of subject associations.	Theories developed will be dispersed to teachers of subjects within the senior secondary technology learning area. Continuing students will bring prior experiences and will be powerful mentors for new students. Encouraging discourse among members. Later stages of the project will focus on writing articles on the project and professional development opportunities for teachers.

A range of data gathering techniques from Mills' (2000) "Three Es" groupings (experiencing, enquiring and examining) will be utilised including observations, students' learning stories, open-ended interviews, questionnaires, journals, portfolios and technological outcome development. These methods lend themselves well to the research question and will identify the strengths of this programme to raise technological literacy and twenty-first century learning.

Twenty-first century learning and Technology Education

Transformation of the emphasis of twenty-first century learning in Technology does need a great shift from what is currently featuring (Bolstad & Gilbert, 2008). It is more about complementing the discipline knowledge with an explicit approach to developing the habits of mind and learning dispositions (Claxton, 2007) that will create the intellectual skills to enable them to, "...think analytically, to synthesise, to think creatively and practically, and apply this thinking in a range of new and different situations" (Bolstad & Gilbert, p. 99). 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).

Current content and assessment-driven approaches are frequently lacking in interest and motivation for students to truly engage and develop deeper and 'big picture' learning. This requires the explicit teaching of life-long, learning dispositions and higher order thinking skills. Rather than using an apprenticeship model of knowledge building, having students use knowledge to generate new knowledge will prepare them better. They are more likely to be the resilient and all-round learners capable to living well in the twenty-first century.

Wagner (2008), in The Global Achievement Gap, has advocated seven survival skills for the 21st century. These will become key features of John's programme. They include:

- 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

The New Zealand Curriculum (2007) was developed to set a clear direction for teaching and learning in the new millennium. Its 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' (Blythe, 1998) 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.

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.

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.

Findings of this research will most likely confirm the need to explicitly teach twenty-first century skills and dispositions and identify the impact that these have on students' motivation and engagement in Technology Education and other learning areas also. Increased engagement through better motivation and collaborative practice with peers and older students is also expected. Positive findings in the way multi-level classes might promote better learning and collaborative practice in schools may lead to some reconsideration of the way classes are organised in the senior secondary school, not only in Technology but in other learning areas too. This research may potentially identify the benefits of teaching higher curriculum levels, learning dispositions and higher-order thinking skills in the senior secondary school and help change the current emphasis on content-driven programmes.

Conclusion

The rate of change in the twenty-first century is exponential. Keeping up is a challenging process and possessing a range of skills and dispositions that will assist life-long learning to cope with this change will become an important goal in education. Technology Education provides an excellent vehicle to facilitate and promote these twenty-first century learning needs. This study will investigate the nature of inquiry in the technological design process and identify the higher-order thinking skills, and collaborative approaches to work, to enable students to, "come at life venturesome, imaginative and questioning" (Claxton, 2007).

Bolstad & Gilbert (2008) use a biological metaphor to describe the changes needed in twenty-first century curriculum. The traditional programmes in use produce conformist, and evolutionary dead end clones. What is needed are 'clades'. These are unspecialised organisms that will colonise new environments of learning. They are diverse, dynamic, innovative, and ever-evolving. Technology encourages students to see this shift from just 'knowing stuff' to 'doing stuff'. John's programme and my study will bring to light the nature of teaching and learning in Technology Education using twenty-first century approaches in a multi-level classroom and how will this promote a deeper understanding?

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