12 Technology Education in the New Zealand Curriculum: History and Rationale

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Abstract

The implementation of technology education in the New Zealand school curriculum has undergone a challenging and extensive period of research, consultation, development, program trials, and curriculum review, culminating in the publication of the 2007 curriculum. This chapter outlines a history of technology education in New Zealand from the very early days of technical education in the 1900s, through to the development of the 1995 and the 2007 technology education curriculum. A brief reflection on the origins of technology is included, followed by an overview of the philosophy of technology and how the beliefs and visions of researchers and curriculum developers have formed and shaped the 2007 New Zealand technology education curriculum. While there may have been missed opportunities along the way, there is much to celebrate. In the immediate future the successes of this forward thinking and exciting subject require further consolidation and a determined effort from the technology community to continue to develop and promote technology education through the opportunities which are presenting in New Zealand in 2016 – and whatever may follow.

Keywords

Curriculum • History • Manual • Technical • Technology • Technology education • TENZ (Technology Education New Zealand) • Techlink

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Introduction

What we now understand as the nature and practice of technology had its beginnings in the discoveries of our very earliest ancestors. Moiduser (2009) argues that technology "is a defining characteristic of humankind" (p. 392) and refers to the early work of Ortega y Gasset (1941, p. 96) stating that "Man [sic] without technology – this is, without reaction upon his medium – is not man." In the mid-1970s, the British Broadcasting Corporation published a book based on the television series entitled *The Ascent of Man*. The author, Jacob Bronowski, a British mathematician and biologist, referred to early man as "a shaper of the landscape," having "imagination, reasoning, emotional subtlety and toughness – not accepting the environment but changing it" (Bronowski 1973, p. 19). Survival of early hominid species depended on their ability to adapt to changing climatic conditions, to draw on knowledge of the environment and available resources, and be guided by the cultural practices of the time to solve problems and address needs (Moiduser 2009). It was the ability of these early species to combine the dual knowledges of "know-that," recognizing that a problem exists, and "know-how," knowing how to solve the problem, that defines what it is to be human (Hope 2009).

Together, these beliefs give credence to Moiduser's (2009) argument to teach and learn technology not only from a socio-technological perspective but also from a cognitive/epistemological perspective. As inhabitants of the twenty-first century, we live in a "technology saturated" environment and it is essential to provide students with the knowledge and skills that will equip them to participate in society as citizens who understand, and have experienced, technology as a field of human activity (Ministry of Education 2007).

In Australia and New Zealand, children enter early childhood centers at the age of three or four years, with a predisposition to include technological practice as part of their collaborative play (Mawson 2011). Specifically, and without adult supervision, these children are able to identify a need, find resources, develop a final outcome, and offer suggestions as to its fitness for purpose (Milne 2002). In effect, these very young students are already responding to their natural desires to manipulate and change their environment. It is a natural continuation, therefore, to develop programs for primary school education that acknowledge and build on these students' preschool experiences and provide them with the skills and opportunities to experience and experiment with the "made" world that they inhabit.

The Philosophy Informing Technology in the New Zealand Curriculum

The relatively "young" philosophy of technology, as described by de Vries (2005) is like "a mosaic of many different ideas and suggestions" (p. 7). Of particular significance in the practice of technology and technological development are the divisions described by Carl Mitcham (1996). He describes technology as objects or artifacts, technology as knowledge, technology as activity, and technology as volition – activity that is fundamental to being human.

These categories, illustrated in Fig. 1, are widely accepted and form the basis of a number of scholarly publications. For example, de Vries (2012) describes similar categories but includes a focus on values as a component of volition. Jones et al. (2013) further investigate this fourth category describing technology "as a characteristic of humanity." These categories provide the foundational structure of the strands and achievement objectives of the 2007 New Zealand technology curriculum, however arriving at this point took a long, and at times, tortuous route.

Figure 2 shows something of this journey stretching from the mid-1880s and the colonization of New Zealand by British settlers, through to the Education Act of 1914 which aimed to provide a more liberal syllabus for schools and better reflect the needs of a new and fast growing society (Egdell 1966). The Manual and Technical Instruction Act that was passed into law in 1900 was a significant development, offering the children of laborers and farm workers the opportunity to incorporate practical, skill-based programs into their schooling, and to prepare them for manual and trade employment once they left school. By the 1940s, subjects such as woodwork, metalwork, sewing, and cooking had been introduced for 13–15 year olds (Jones 1997). The development of technical skills was at the center of these subjects, and while a new focus on design emerged in the publication of the Workshop Craft and Home Economics syllabus in 1986, the focus on skills-based programs continued strongly and failed to significantly embrace the changing needs of a modern New Zealand society.

The publication of the first technology education curriculum in 1995 sought to bring about significant change. It aimed to implement a curriculum that had equal

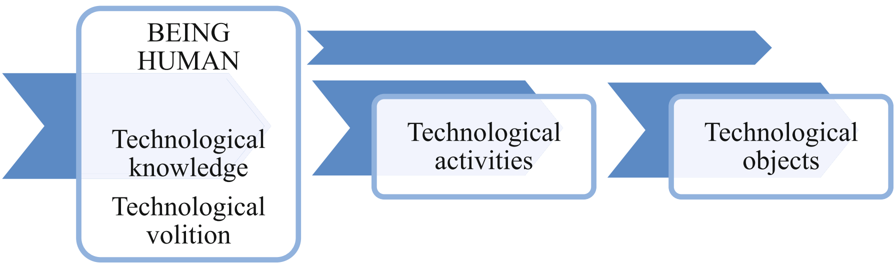

Fig. 1 Modes of manifestation of technology (Mitcham 1996, p. 160)

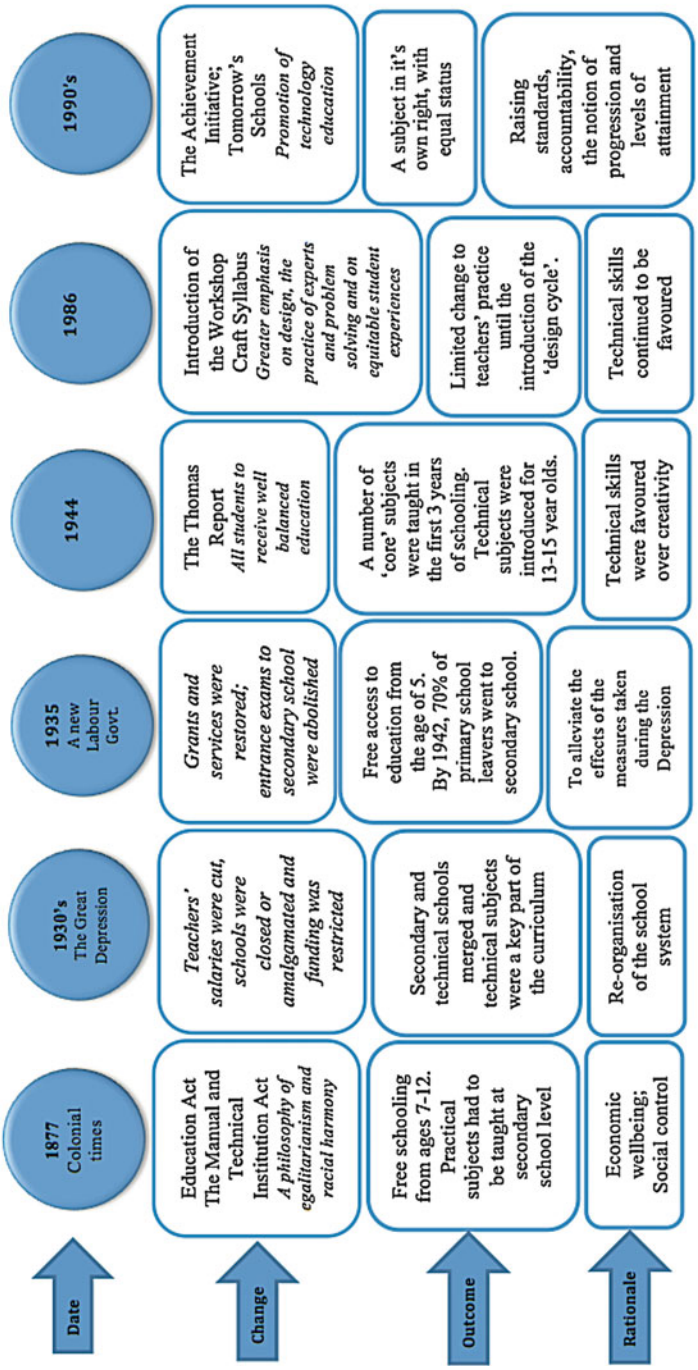

Fig. 2 The introduction of technical subjects into the New Zealand educational system

status with other learning areas, which offered a high level of intellectual rigor, and a practical capability for citizenship (V. Compton 2001).

The development of a policy framework for this new curriculum was contracted to the Centre for Science and Mathematics Education Research Centre [CSMER] at the University of Waikato by Ministry of Education. In order to fulfill the contract requirements, CSMER consulted widely and investigated best practice both nationally and internationally. The policy framework was required to be consistent with other government policies in education and to take account of the available resources in schools, current research informing teacher change and professional development, and where possible, to provide a number of implementation options that would best suit the diverse range of teachers participating in the programs (Jones 2003). A strength of this development was the extensive consultation that took place with professional technologists, teacher unions, practicing teachers, and professional organizations such as Workshop and Graphics Teachers and the New Zealand Association of Science Teachers. Jones (2003) describes this as an "eclectic mix" (p. 6) but one which attempted to gain broad ranging views to inform the development of this new curriculum.

Building on the resulting policy framework, CSMER was then contracted to develop the first draft technology curriculum. This was put out for discussion in 1993 and was trialed in schools in 1994 (Williams and Jones 2015). Again, an extensive consultation phase was undertaken and the feedback from interest groups allowed for a slightly more streamlined and focused outcome. The final curriculum which aimed to develop students' technological literacy was published in 1995 and became one of eight compulsory core subjects in 1999. Technology education was described as:

> a planned process designed to develop students' competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of a technological society (MoE 1995, p. 7).

The learning theories upon which this curriculum was based pointed to a curriculum that was to be pupil-centered, drawing on models of apprenticeship (Rogoff 1990), situated cognition (Brown et al. 1998) and learning through participation in communities of practice (Lave and Wenger 1991). Technology in the New Zealand curriculum was viewed as a human endeavor and the strengths and weaknesses of student performance were to be judged by the degree to which they could operationalize the three dimensions of the curriculum – technological knowledge and understanding, technological capability, and technology and society (Ministry of Education 1995).

This curriculum was to offer far more than the technical competency of the traditional technical subjects, it was also to develop a practical capability for citizenship (V. Compton 2001; Petrina 1992). This view linked directly with the Thomas Report of the postwar period (see Fig. 2) which advocated that patriotism and citizenship be fostered within education (Roth 1952). Education for citizenship was formally signaled in the New Zealand Curriculum Framework of 1993 when the secretary of education stated that “we need a workforce that is increasingly highly skilled and adaptable, and which has an international and multicultural perspective” (Ministry of Education 1993, p. 1). The interpretation of this through the learning areas of the curriculum presented no dominant view as such but rather common threads of creative problem solving, contributing to the future of society and the environment, and an awareness of the impact of global trends (Mutch 2005). Students were to be provided with the opportunity to study in a range of technological areas, and the focus of their work was to be positioned in a variety of relevant and authentic contexts (MoE 1995). Achievement objectives were to provide guidance for teacher planning and when considered together, were to give a structure to students’ technological practice, and provide clearly defined levels of attainment and progression (see Fig. 2); they were to be “the vehicle that would enable students to develop their technological literacy” (V. Compton and France 2007, p. 2).

An emphasis on real-world contexts, the practice of experts, and the planning of coherent programs in technology education were central to the professional development that followed for teachers. “Authenticity” was a frequently used term to highlight the problems, needs, and opportunities that could form the basis of classroom programs, and a wide range of technological areas which were representative of the New Zealand context pointed the way for the diversity intended by the original policy statement. In the 1995 curriculum, these included materials technology, information and communication technology, electronics and control technology, biotechnology, structures and mechanisms, process and production technology, and food technology. Design was to be an integral part of students’ technological capability and was to be integrated throughout the technology curriculum (Jones 2003).

It was recognized at this time that the professional development provided for both primary and secondary school teachers to support this new curriculum would be pivotal to the success of its implementation into New Zealand classrooms. The two programs that were developed including facilitator training and a resource package that were research informed, academic in nature, and presented over an extended time frame. These programs took into account past national and international research in teacher development, as well as technology education base line research carried out in New Zealand schools in 1995. This project referred to as the Learning in Technology Education project (LITE project) was funded by the Ministry of Education (Jones et al. 1995). Thirty facilitators were trained between 1995 and 1996, and according to the data collected over this period, “there was a high level of skill in both facilitation and programme development” (Jones 2003, p. 11) that was delivered to teachers during 1996 and 1997. Professional development programs were well funded, contracts were available in all regions in the country, and consisted in the initial phase, of up to 8 days’ classroom release for participating teachers.

It was recognized early on that sustainable and enduring teacher change could take up to 2 years of in-depth and well-supported study and practice to generate a change in teaching practice (Moreland 1997). To rely wholly on what was provided by the Ministry of Education was considered unwise, and a professional association was established in 1995 to ensure continuity in the professional development of technology teachers. This became known as TENZ – Technology Education New Zealand, and its inaugural conference was held in Auckland in 1997 and has been held biennially since then. The current goals of TENZ aim to:

- Foster the development of Technology in the New Zealand curriculum
- Develop and maintain national and international links between those working in technology education and with the wider technological community
- Support professional, curriculum, and resource development in technology education
- Encourage research in technology education
- Organize a national technology education conference every 2 years (Ministry of Education 2010)

There was a level of autonomy in the way each professional development contract was delivered, which meant that "different regions experienced quite different professional development in technology and in some cases links to the 1995 technology curriculum were not a strong feature of the programme" (Jones and Compton 2009, p. 100). However, Ministry of Education contracts delivered nationally over the next few years attempted to gain greater consistency of delivery. Two programs of greatest significance were the Technology Education Assessment National Professional Development project and the Technology National Exemplar Project. The exemplar project was run across all learning areas and was met with considerable enthusiasm by the participating teachers and the facilitators who researched and negotiated models of development. A technology exemplar matrix to guide assessment was part of this project. This became a challenging time within the technology community with very diverse views being presented, and a lack of expertise and clarity from leadership groups as to the real direction and purpose of the models that were being developed. In the end, a huge resource that had drawn together all the energies and enthusiasm of a large group of researchers was sidelined and then discarded. It was a damaging phase within the new and fragile technology community and it took time to regroup and recover. However, the strength of shared knowledge and ongoing communication within the technology community emerged from this phase and the importance of supporting and growing the fledgling professional organization of TENZ strengthened. In 2004, the Ministry of Economic Development made available funding which was accessed to support technology education. This, as reported by Jones and Compton (2009), was used to set up the Growth and Innovation Frame – Technology Initiative, which became a highly valuable source of funding in technology education through to 2013. A number of professional development projects were established over this period, including the development of Techlink, an online portal for technology teachers and educators, the Beacon Practice project for teachers of secondary technology which included materials development, curriculum leader support research, and curriculum support, and the establishment of a National

Professional Development Manager (Ministry of Education 2008). The role of the manager had significant influence in strengthening the collaboration between preservice and in-service providers of technology education and between the regions and universities. Opportunities to meet regularly, to receive updates from the Ministry of Education, to share research projects and publications, and to collaborate in the development of support for teachers came about as a result of the GIF-Technology funding.

The 2007 New Zealand Technology Curriculum

With the introduction of the new school curriculum in 2007, there was a change of emphasis. The National Curriculum Stocktake that was carried out between 2001 and 2003 by the Wilf Malcolm Institute of Education Research at the University of Waikato reviewed all learning areas of the New Zealand curriculum. Along with other learning areas, this study invited feedback from teachers about their experiences in implementing the 1995 technology curriculum (Jones and Compton 2009). This was achieved through gathering survey data, running focus groups, and developing case studies from examples throughout the country. As a result, it became apparent that an uncertainty around what constituted “technological literacy” existed, with the technology community as a whole struggling to come to a common agreement (Ministry of Education 2002). Compton and Harwood (2004) reported that where classroom programs “focus on developing students’ understanding of and about technology almost exclusively within the context of their own technological practice” (p. 160), the level of critical analysis required for informed decision-making lacked the breadth and depth anticipated by the 1995 curriculum. This concept is exemplified in the research of Elmose and Roth (2005), in which the notion of citizens’ active participation in a society dominated by technological and scientific advances was explored. These advances were recognized as having the potential to present unforeseen and uncontrollable risks, for which populations were generally unprepared. The aim of the 2007 curriculum, therefore, was to develop programs that would foster “a broad technological literacy that would equip [students] to participate in society as informed citizens but also give them access to technology-related careers” (Ministry of Education 2007, p. 32). Furthermore, emphasis was placed on the practical nature of technology education, which aimed to include developing models, products, and systems, as well as appreciating technology as a field of human endeavor (MoE 2007). This is defined in the 2007 technology curriculum as follows:

> Technology is intervention by design: the use of practical and intellectual resources to develop products and systems (technological outcomes) that expand human possibilities by addressing needs and realising opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative. (Ministry of Education 2007, p. 32)

Technological practice remained a key part of this curriculum and is described by three subheadings or achievement objectives, namely, planning for practice, brief development, and outcome development and evaluation. It includes students studying the practice of others and gaining expert advice before planning and carrying out their own practice. There are two additional strands entitled Technological Knowledge, which includes technological modeling, technological products, and technological systems, and the Nature of Technology, which includes the characteristics of technology and the characteristics of technological outcomes. Compton et al. (2007) report that this latter strand offers an "opportunity for students to develop a philosophical understanding of technology, including how it is different from other domains of human activity" (p. 12).

These three overlapping strands work together to develop students' overall technological literacy and are described in the curriculum as the development of knowledge and skills relating to the principles and processes of technology, the ability to select appropriate materials and design solutions, and understanding technology as a human endeavor and a domain in its own right (Ministry of Education 2007).

The influence of Mitcham's philosophy of technology as artifacts, as activity, as knowledge, and as volition is clearly evident in Fig. 3, showing the technology education constructs within *The New Zealand Curriculum* (p. 25). Technology as activity is developed through the technological practice strand, technology as volition and as artifact is achieved through the nature of technology strand, and technology as knowledge, as indicated by its title, is explored through the technological knowledge strand.

The 2007 technology curriculum identifies five technological areas, including food technology, structural technology, control, biotechnology, and information and communication technology. The knowledge base, specific to each technological area within this curriculum, is recognized as vital to students' knowledge and skill development, and graphics and other forms of visual representation are acknowledged as important tools for both the exploration and communication of design ideas. The influence of culture, ethics, politics, and economics, as well as the impact of environmental issues of the day, is also acknowledged, and opportunities for these to be integrated and developed through students' technological practice are provided throughout the eight levels of attainment (Ministry of Education 2007).

A 3-year study from 2005 to 2008, known as the InSiTE project (Classroom Interaction in Science and Technology Education), was conducted at the University Waikato. This aimed to develop an understanding of the interactions between teachers, students and the ideas and tools that teachers use to support student learning (Ministry of Education 2008). Over this same period and particularly influential within the technology education community was the Ministry of Education Implementation Support Material which was delivered through the *Techlink* website. This outlined the ideas which underpinned the 2007 technology curriculum and included explanatory papers describing each of the achievement objectives, future program development, the link between technology and values, and technology and the key competencies as listed in the 2007 curriculum.

Technological practice	Nature of Technology	Technological Knowledge
Brief Development ***(Technology as Activity)*** (Level 1) Students will: Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available.	**Characteristics of Technology** ***(Technology as Volition)*** (Level 1) Students will: Understand that technology is purposeful intervention through design	**Technological Modelling** ***(Technology as Knowledge)*** (Level 1) Students will: Understand that functional models are used to represent reality and test design concepts and that prototypes are used
Planning for Practice ***(Technology as Activity)*** (Level 1) Students will: Outline a general plan to support the development of an outcome, identifying appropriate steps and resources.	**Characteristics of Technological Outcomes** ***(Technology as Artefact)*** (Level 1) Students will: Understand that technological outcomes are products or systems developed by people and have a physical nature and a functional nature	**Technological Products** ***(Technology as Knowledge)*** (Level 1) Students will: Understand that technological products are made from materials that have performance properties.
Outcome Development and Evaluation ***(Technology as Activity)*** (Level 1) Students will: Investigate a context to communicate potential outcomes. Evaluate these against attributes; select and develop an outcome in keeping with the identified attributes.		**Technological Systems** ***(Technology as Knowledge)*** (Level 1) Students will: Understand that technological systems have inputs, controlled transformations, and outputs.

Fig. 3 Technology curriculum constructs in the New Zealand curriculum (Compton 2009, p. 25) with examples shown from Level 1 of the curriculum

The indicators of progression which were part of this package have been organized around each of the eight achievement objectives and developed for teachers working at all levels of the technology curriculum. Figure 4 gives an example of brief development, an activity-based achievement objective which shows how students should progress from Level 1 through to Level 7.

In addition to each achievement objective descriptor, the indicators of progression offer suggestions to teachers for planning learning experiences, and progressing students as per the level indicators. For example, the Level 3 indicators, generally recommended for Year 7 and 8 students (11–13 year olds), state students will be able to "describe the physical and functional nature of the outcome they are going to produce and explain how the outcome will have the ability to address the need or opportunity." Students should also be able to "describe attributes for the outcome and identify those which are key for the development and evaluation of an outcome" (Ministry of Education 2009, p. 3). This is a significantly higher level achievement goal from that of Level 1 in which students are expected to "communicate the outcome to be produced and identify attributes for an outcome" (p. 1), and Level 2 in which they should be able to also take account of the need or opportunity being

Brief Development: Indicators of progression Levels 1 – 7			
Level 1	Level 3	Level 5	Level 7
Students will: Describe the outcome they are developing and identify the attributes it should have, taking account of the need or opportunity and the resources available.	Students will: Describe the nature of an intended outcome, explaining how it addresses the need or opportunity. Describe the key attributes that enable development and evaluation of an outcome.	Students will: Justify the nature of an intended outcome in relation to the need or opportunity. Describe specifications that reflect key stakeholder feedback and that will inform the development of an outcome and its evaluation.	Students will: Justify the nature of an intended outcome in relation to the issue to be resolved and justify specifications in terms of key stakeholder feedback and wider community considerations.

Fig. 4 Progression of achievement objective indicators of progression (Ministry of Education 2010)

addressed and the resources that are available (Ministry of Education 2009). The teacher guidance that supports each achievement objective in this document provides a number of valuable teaching suggestions. Key elements of sound pedagogy and focused technological teaching goals are carefully woven through each one. For example, teacher guidance to support the Level 3 brief development achievement objective provides the following suggestions.

Level three teachers could:

- Provide the need or opportunity and develop the conceptual statement in negotiation with the students
- Guide students to describe the physical and functional nature of an outcome (e.g., what it looks like and what it can do) taking into account the need or opportunity, conceptual statements and resources available
- Guide students to identify the key attributes an appropriate outcome should have. Key attributes reflect those that are deemed essential for the successful function of the outcome.

The indicators of progression is an extensive document and has gone some way in bridging the gap between an absence of professional development for teachers of technology over the last 8 years, and the ongoing need to support teachers in planning programs that reflect the true essence of the technology curriculum. However, as recommended in the final report to the Ministry of Education on the 3-year technological literacy: Implications for teaching and learning research project (Compton et al. 2013), "robust facilitated professional development opportunities for teachers across all sectors" should now be offered (p. 3). The challenge for the next phase of development of this curriculum is how to build on the extensive achievements described in this chapter and effectively position technology education for its place within education in the future and ensure that it remains a key part of primary school curricular.

Conclusion and Future Directions

The evolution of the technology education curriculum in New Zealand is a tale that began in the early colonial period of New Zealand history, firstly with the introduction of the Manual and Technical Institution Act in 1900 and later on the Thomas Report of 1944 which prompted the introduction of a number of compulsory technical subjects for all 13–15 year olds (Jones 1997). The first New Zealand technology education curriculum emerged in 1995 with its emphasis on authentic design informed by the practice of experts, and finally the 2007 curriculum which, in response to a national curriculum stocktake, aimed "to develop a broad technological literacy that would better equip students to actively participate in society as informed citizens and also give them access to technology-related careers" (Ministry of Education 2007, p. 32).

The story of technology education in New Zealand concludes with the development and ongoing implementation of the new 2007 curriculum. It is a story which can rightfully celebrate many successes. It is research based, professional development provided for secondary teachers for the new curriculum has been well funded, and significant engagement by enthusiastic teachers and students in all sectors has been achieved. The community as a whole has been supported through TENZ, the professional organization for technology education, and this continues but with new challenges on the horizon. Jones et al. (2015) warn that "the subject remains susceptible to the vagaries of political whims and system disconnects" (p. 272) and this continues to be played out. Since 2008 the Ministry of Education has targeted numeracy and literacy as the major focus for professional development funding of teachers, and this has resulted in a loss of momentum in the consolidation and progress of technology education in the primary sector.

This has been complicated by an attempt to manage a congested curriculum and one that is dominated by literacy and numeracy. Learning areas other than mathematics and English are frequently taught under the heading of "topic," with several areas being combined in a way that, from anecdotal evidence observed by the author, dilutes the potential richness of areas such as technology education and results in integrated units of work that lack focus and real purpose. These units often consist of a piecing together of unrelated chunks from a number of learning areas. Compton et al. (2013) report that the components of the three strands of the technology curriculum working together have the potential to develop students' technological literacy, but this is dependent on teacher knowledge and an understanding of how each component can be developed and progressed through Levels 1–8.

A further complication has been a heightened interest in the physical learning spaces and pedagogical practices familiar to teachers in the primary sector for many years. These seem to have developed a life of their own and have driven what the author sees as a confused focus on *where* teaching and learning occurs rather than *what* is taught. For example, the reshaping of classroom architecture into "modern learning environments" and "innovative learning spaces" has occurred in many New Zealand schools, with open areas and small break-out rooms being constructed to cater for large numbers of students, but with negligible change to the way each learning area is being presented. Professional development which works alongside these changes is well overdue.

A flickering light on the horizon has been the launching of “Curious Minds” in 2014 by the Ministry of Business Innovation and Employment, the Ministry of Education, and the Office of the Prime Minister’s Chief Science Advisor (Ministry of Business Innovation and Employment 2016). This is a 10-year project designed to take a strategic approach to the government’s science investment by targeting public education. One of the goals of this project specifies the promotion of public engagement with science and technology. Two additional initiatives which will impact on the technology curriculum are the promotion of STEM education (Science, Technology, Engineering and Mathematics education) to secondary students, and the inclusion of digital technology as a new strand in the Technology curriculum (Ministry of Education 2016). A word of caution, however, from Alister Jones at the 2015 TENZ conference in which he expressed his disquiet at the way the “Curious Minds” project was playing out. He believes that, to date, there has been very little recognition of technology within this project, and the policies designed to capture public attention have not taken into account lessons learned from the past. TENZ therefore has a significant responsibility in this quickly changing environment, of asking hard questions of the Ministry of Education and continuing to promote this curriculum as the vibrant, forward thinking, and exciting subject that was anticipated 20 years ago (Jones et al. 2015).

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