TECHNOLOGY TEACHER EDUCATION IN NEW ZEALAND

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ABSTRACT

Undertaken in universities and other approved private providers, technology teacher education in New Zealand involves students in theory and practice. The New Zealand Teaching Council, the teaching professional body, regulates and approves courses and programs. Based on Constructivist principles situated within Sociocultural theory, teacher education in New Zealand focuses on meeting students' individual learning needs, and is founded on the principles of equality and inclusion, guided by the Te Tiriti o Waitangi, The Treaty of Waitangi, ensuring the specific rights of Māori and the New Zealand Curriculum.

Technology, briefly defined as Intervention by Design, occurs through a range of contexts across three strands for learning: Technological Practice, the Nature of Technology, and Technological Knowledge, and within five technological areas: Designing and Developing Materials Technologies, Designing and Developing Processed Technologies and Designing and Developing Digital Technologies, Design and Visual Communication and Computational Thinking.

Technology in New Zealand, although world leading, faces a number of challenges. These include a lack of understanding of the philosophy and key ideas that underpin technology, low subject status based on its predecessor technical education, and the lack of time and facilities available in teacher education programs. Many currently practicing specialist technology teachers struggle with the philosophical changes needed to move technology from a technical, skills-based program to the needs-based student-centered program outlined in the current curriculum. Over recent years in primary education in New Zealand, the Ministry of Education's focus on literacy and numeracy has led to the marginalization of technology education in schools and teacher education programs. It is hoped that recent revisions to increase the presence of digital

technologies in the technology curriculum, and the move to teaching through inquiry, whilst acknowledging students' lived experiences, facilitates the consolidation of technology education as a learning area of status incorporating the duality of practical and academic thinking.

Keywords: New Zealand, Technology education, teacher education, curriculum pedagogy

INTRODUCTION

Aotearoa New Zealand is a democratic nation in the South West Pacific with a resident population of around 4.8 million. Nearly three quarters of the population identify as having European heritage, 15% as Māori, 12% as Asian and 7% as Pacific peoples. As the indigenous people of New Zealand, Māori have particular statutory rights under Te Tiriti o Waitangi, The Treaty of Waitangi, signed in 1840 between the British Crown and over 500 Māori rangatira (chiefs). This broader socio-political context is important because of its impact on educational policy and practice. For example, the Native Schools Act of 1867 significantly failed Māori students and communities by introducing English as the sole medium of instruction. The Waitangi Tribunal addresses violations such as these. One important change has been the recognition of te reo Māori, the Māori language, as an official language since 1987, and the emphasis in current education policy on the importance of Māori succeeding *as* Māori. In practice, this means there is an emphasis on culturally responsive pedagogies by the Ministry of Education. Teachers' practice in this context is critical since the majority of Māori tamariki and rangitahi (children and young people) attend English-medium schools, with only a very small percentage (2.5% of the total school population) taught in Māori Immersion settings.

To become a teacher of technology education, individuals must undergo formal Initial Teacher Education (ITE) programs (also known as pre-service teacher education). Teachers undertaking professional learning and development (PLD) after ITE can be referred to *as in-service* teacher education. There are 156 approved ITE programs in New Zealand, delivered as 80 qualifications by 25 providers. In New Zealand, both state and private institutions offer training programs. Seven of the nine universities have teacher education programs. These are the Universities of Auckland, Waikato, Canterbury and Otago, Victoria (in Wellington) University, Massey University, and Auckland University of Technology. Other pathways occur through private training institutions and are usually employment-based. Initial Teacher Education institutions offer programs for teaching in the sectors of early childhood education (ECE), primary, secondary, Māori and Pasifika education (New Zealand Teaching Council, 2020).

During teacher education, student teachers need to develop an holistic view of the nature of technology and how technology impacts and influences our world, people and the environment. There is also a need for student teachers to understand the role of content, pedagogical, and pedagogical content knowledge. They must also gain a thorough understanding of the values, principles and competencies that underpin and inform teaching in New Zealand. The way that teaching *looks* may differ slightly between ECE, Primary and Māori sectors, but practice is derived from a philosophy that respects and honors the Treaty of Waitangi (ToW). Signed in 1840, the ToW is an agreement between the British Crown and Māori that upholds the rights of New Zealand's Māori people, ensuring all New Zealanders have a right to fair and equitable educational opportunities to meet their future needs, thus enabling them to be confident, connected, actively involved, life-long learners (Ministry of Education, 2007).

This chapter is written from the perspective that student teachers' educational experience is closely related to their beliefs and values as professionals, which translates directly to their perceptions of the nature of technology, curriculum, pedagogy, assessment, and cultural ways of knowing. Both ITE and PLD teacher education need to focus on ways to influence teacher beliefs and values, as well as understandings of conceptual and pedagogical knowledge, with a view to enacting procedural knowledge (technological know-how) in classroom practice. The context for technology teacher education in New Zealand is described, including consideration of the influencers from the wider educational context. The profile of technology education in New Zealand is discussed, with reference to contextually relevant teaching and learning theory.

PROFILE AND STATUS OF TECHNOLOGY EDUCATION

The role and status of technology education has evolved, but its cross-disciplinary nature means that there is no single theoretical perspective to define it (Pacey, 1992). This presents a confusing professional climate for some technology teachers, who are required to navigate some uncertain challenges within their professional practice. Technology education yields unique opportunities to engage students in their learning – through both practical and innovative means. There are various types of differing and equally important understandings applied to the subject, including practical, conceptual, and tacit knowledge (Hill, 2003). For example, De Vries (2005) suggests that early philosophers about technology focused on the relationship between technology and people, or society, but more recently, conceptions of technology have focused more on what technology is. Both aspects are important and need to be understood in order to teach technology education effectively.

When asked what technology is, many people refer to technology as artefacts such as high-end electronic and digital technologies and align with a view that technology is a relatively recent phenomenon. However, an holistic view of technology education requires teachers to have a broader view of the nature of technology. Technology is an innate human endeavor. If you watch a group of pre-school children with a set of blocks and sticks – the way that they interact to build a structure illustrates this. Since the dawn of time, humans have intervened in the natural world by designing and modifying their environment, to make life easier or to increase their capability. They have identified and deployed a range of resources and materials to make tools, clothes, develop processes, and have manipulated materials to solve practical problems.

Technology education is briefly referred to as “Intervention by Design” in the New Zealand curriculum (Ministry of Education, 2007, p. 32), which involves the identification of a problem, issue, or the recognition of an opportunity to address. Technologists, or people who design and develop technologies, then undertake technological practice, with a view to developing an outcome to solve the identified problem or address an identified opportunity. This process can include the development of artefacts or products, systems, and processes.

For teachers of technology, there is a need to develop a deep understanding of technology. For example, as people become aware of a range of medical issues caused by exposure to certain materials, as global warming increases and other environmental issues arise, we begin to understand that people and technology are having a devastating impact on the planet and those who live within its bounds. The technological innovation of plastic is a case in point. Plastic was once hailed as a miracle material, known for its strength, variety, flexibility, and longevity. We are now coming to realize its long-term impact on the environment, and are becoming more aware of this pact, such as the Pacific garbage patch – a giant ocean gyre in which all dumped plastic debris has accumulated over the last 60 years. Over time, this plastic debris breaks down into small particles ~~of plastic~~ and is ingested by marine life, thus entering the food chain. Many people are now becoming more discerning about their use of plastic and some have made a decision to avoid the use of plastics in their everyday lives. In New Zealand, single-use supermarket plastic bags are prohibited and have been replaced with reusable fabric bags. Paper straws are slowly returning, sandwiches wrapped in wax-covered fabric, and many of the plastics used are recycled. These changes all involve technology in some way.

Technology is not just about designing and making "stuff" – technologists must be more deliberate in their decision-making. Technology includes understanding the impacts that decisions have on people and their environment. Technologists need to understand that they should not always design and develop anything they or others desire. A research-informed perspective is a critical part of the process. Understanding current and future societal impacts are vital factors in the nature of technology education.

The nature of technology education in New Zealand

Technology education in New Zealand emerged from technical education. The 1877 Education Act provided the framework to introduce technical studies into New Zealand classrooms. In New Zealand, technical education was introduced as a compulsory subject in the school curriculum in 1890, giving it a long history. The 1900 Manual and Technical Instruction Act introduced technical education with the sole intent of increasing students' manual skills, by focusing on woodwork and metalwork for boys, and cooking and sewing for girls. At this time in the secondary context children from working class backgrounds and those considered to be "non-academic" were encouraged to attend technical schools, which focused on the continued development of technical education (Harwood, 2003). It is from these roots that technology education emerged, and although it was one of the (then) seven learning areas in the New Zealand Curriculum Framework (Ministry of Education, 1991), many people still perceived technology as a practical subject of lower status than other subjects.

The 1980s saw a shift towards a more integrated curriculum and greater development of the "whole person." The New Zealand Curriculum Framework, published in 1993, identified technology as one of seven essential learning areas. A curriculum document, *Technology in the New Zealand Curriculum* (Ministry of Education, 1995), identified the overarching aim as being "to develop technological literacy …to enable and empower students with the know-how they will need to make informed choices about technology, and to be the technological innovators of the future" (p. 5). In other words, both vocational and general education aims were included. Three strands: technological knowledge and understanding, technological capability, and technology and society, taught across a range of technological areas are chosen by teachers and schools to "best help their students achieve the objectives of this curriculum" (p. 12). The technological areas included biotechnology, electronics and control technology, food technology, information and communication technology, materials technology, production and process technology, and structures and mechanisms. The Hangarau (Māori technology) curriculum was also published, although the identification of appropriate technical terminology was problematic. At the same time, the Workshop Craft and Home Economics syllabi were revoked, with some of these teachers unclear about their role in the face of extensive change.

At the time of implementation, the 1995 *Technology in the New Zealand Curriculum* had not previously been taught, so it made sense that a review was undertaken in a relatively short time. In 2003, this review was initiated, not just of technology but of the whole school curriculum. Targeted empirical classroom-based research informed thinking about technology education. This revision resulted in the new 2007 curriculum document *The New Zealand Curriculum* with a restructuring of the curriculum strands to technological knowledge (*know-that*), technological practice (*know-how*), and the nature of technology (*know-why*). The technological areas were modified and included structural, control, food, and information and communication technologies, and biotechnology. Both vocational and general education purposes were retained, as was the focus on technological literacy because "In technology, students learn to be innovative developers of products and systems and discerning consumers who will make a difference in the world" (Ministry of Education, 2007, p. 17). This curriculum revision attempted to draw together some of the lessons learned from the 1993 curriculum roll-out, and the need to refine teachers' understanding of the key curriculum concepts was recognized.

It was, and still is, perceived by some as a subject suitable for non-academic and/or disengaged students. Those who understand the academic and practical duality of the subject challenge this perception. The status for the subject is slowly improving. In 2017, the 2007 iteration of technology education (Ministry of Education, 2007), which is now one of eight learning areas, was revised to emphasize digital technologies. In this version there are five technological areas in the learning area of technology education. These include the designing and developing material outcomes, designing and developing processed outcomes, design and visual communication, the design and development of digital technologies, and computational thinking. Student teachers should be exposed to learning in all of these technological areas, to be well prepared for the profession. Full implementation of the revised technology curriculum was expected to occur from February 2020.

Program titles and time allocation

In New Zealand, education is compulsory for all children aged between 6 and 16, although most children enroll at school on their fifth birthday. Since 2007, government policy also provides funding for all children to attend 20 hours of free early childhood education from the age of 3. The years of schooling are variously grouped, including contributing primary school (Years 1-6; ages 5-10), full primary school (Years 1-8; ages 5-12), intermediate school (Years 7-8; ages 11-12), middle school (Years 7-9 or 10; ages 11-14), secondary school (Years 7-13 or 9-13; ages 11-18), or area school (Years 1-13; ages 5-18). In general, primary school teachers are generalists and teach across the curriculum, whereas secondary school teachers are subject specialists. Most intermediate and middle school teachers tend to be generalists. However, specialist teachers, often in a classroom dedicated to the subject, offer some subjects, like technology education. When intermediate and middle schools do not have specialist resources, partnerships may be developed with local secondary schools and students have classes there, usually for a half a day a week. Students in Years 7 & 8 in full primary schools also travel to specialist technology centers also for half a day per week or one day every two weeks in rural areas. Whilst technology education is a compulsory subject in the schooling sector (Years 1-10), the time allocated to its teaching depends on the school context, collective staff focus, or teacher's interest. For example, in a primary school, concepts for technology education can be taught through inquiry learning, meaning curriculum intentions are not always fully realized. In a secondary school context, technology education usually has the same timetabled time as other curriculum subjects from Years 9-10.

In the schooling sector, all students study programs developed from the New Zealand Curriculum (Ministry of Education, 2007), or Te Marautanga o Aotearoa (Ministry of Education, 2008). These policy documents specify a curriculum framework that outlines, in very broad terms, the knowledge and skills students are to acquire within eight essential learning areas, including technology education. Across this framework, the key competencies identify capabilities for living and lifelong learning (thinking; using language, symbols, and texts; managing self; relating to others; and participating and contributing). Values that are to be encouraged, modelled and explored include excellence; innovation, inquiry and curiosity; diversity; equity; community and participation; ecological sustainability; and integrity. Individual schools are responsible for developing their local curriculum, with each school operating autonomously under the guidance of a Board of Trustees – consisting of community representation with responsibility for setting the direction of the school, within the parameters of regulation. An independent audit agency, the Education Review Office, evaluates and reports on school performance, on average, once every three years.

Major Objectives

Technology education is positioned to assist learners' preparation for life, both in the current and future technological world. Barlex (2006) suggests that a major educational goal of technology is to teach students the capability to operate effectively and creatively in the made-world. There is also the opportunity to prepare students to participate in rapidly changing technologies, and to intervene creatively to improve their quality of life. Teachers' pedagogies need to evolve to be responsive to such requirements. For example, when designing technological outcomes, students should have ownership of their design ideas, become knowledgeable in the aspects of their technological practice, and make key decisions, from an informed perspective. Barlex (2006) stated that from a pedagogical perspective, this is fascinating, because "it is the pupil who has the knowledge and expertise in this situation, only he/she knows about his/her design" (p. 193). More recently, Barlex (2017) indicated that there are similarities between New Zealand and England, whereby the necessary change in pedagogy has been hindered by a significant and continuing need for professional development and learning, to focus on specialist knowledge and pedagogy, and with a view to modernizing the curriculum area's profile and becoming more effective teachers.

The notion of "effective pedagogy" presented in the New Zealand curriculum states, "there is no formula that will guarantee learning for every student in every context" (Ministry of Education, 2007, p. 34). It suggests students learn best when they feel supported and safe in their school or classroom. Teachers are encouraged to reflect on and consider their own actions, understand the focus of the learning, support students' collaborative practices, recognize their experiences, and offer substantive learning opportunities.

Teachers in New Zealand are encouraged to inquire into their practice and be adaptive in their teaching approaches (Timperley & Alton-Lee, 2008). This requires quite a different role *for* and approach *from* teachers than previously. This is particularly pertinent in technology education, where teachers and other experts must facilitate students' learning to enable progression of the intended design, to develop knowledge and understanding of the wider social, cultural, ethical and environmental considerations that impact or influence design. This includes teachers' critical reflection on their practice through a range of strategies and activities, to motivate, engage, develop, and challenge students' thinking.

Education in New Zealand has traditionally focused on the development of students' competencies, in particular their understanding of knowledge and skills. It should, however, also develop students' capability to adapt to a changing world where new knowledge is generated (Fraser, 2000). To foster a climate of innovation in technology education, teachers are likely to be required to encourage creative and critical thinking and reflection about the factors that can inform future technological developments. Such practice is significantly different to teaching students about the stages of production in a replicated product.

In technology education, students learn to be "innovative developers of products and systems and discerning consumers who will make a difference in the world" (Ministry of Education, 2007, p. 17). Technology in The New Zealand Curriculum (Ministry of Education, 2007) is defined as:

> … 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 realizing opportunities. Adaptation and innovation are at the heart of technological practice. Quality outcomes result from thinking and practices that are informed, critical, and creative. (p. 32)

In New Zealand, the aim of technology education is the development of technological literacy (Ministry of Education, 2007; Moreland & Cowie, 2007). Technological literacy is demonstrated when students have a broad understanding of the ways that made products work or are developed as a result of societal intervention, needs, or opportunities (Technology Online, 2010). Also viewed as a means to support students to function in a technological and future-focused society, technological literacy is understanding of how to undertake holistic technological practice knowledgeably and skillfully within the bounds of the learning context, and to address concepts presented in the New Zealand Curriculum (Ministry of Education, 2007, 2017).

Content organizers

New Zealand is one of a number of countries who have technology as a separate learning area in the curriculum. In other countries, there is a move towards joining or embedding it into other subjects (science, social science, environmental studies, life studies, and craft) or learning in technology has a sole focus on digital or information and communication technologies. The commonality for all nations is that technology is a relatively recent addition to the curriculum (post 1980s) and that it has experienced constant change and revision as nations come to develop their understanding and rationale for its place in the curriculum (Benson & Lunt, 2011).

In 2017, the technological areas were modified considerably in New Zealand, following a Ministry of Education directive to enhance the presence of digital technologies within the technology curriculum. The new technological areas are designing and developing materials outcomes, designing and developing processed outcomes, and design and visual communication, and two new areas specific to digital technologies: computational thinking for digital technologies, and designing and developing digital outcomes. There are generic concepts taught across all technological areas, within three strands: *Technological Practice,* the *Nature of Technology,* and *Technological Knowledge.* Together, these strands provide opportunities for learning, which develop students' abilities to critique technology, and to understand its complexity. Contextualized student learning addresses the following components.

Table 1: The eight technology curriculum components (adapted from The New Zealand Curriculum, MoE, 2007)

Technological practice	Technological knowledge	The Nature of Technology
Planning for Practice	Technological Modelling	Characteristics of Technology
Brief Development	Technological Products	Characteristics of Technological Outcomes
Outcome Development and Evaluation	Technological Systems	

Technology education in New Zealand is different to other countries because of the universal inclusion of foods, textiles and biotechnology in the curriculum. New Zealand is an agriculture-based country with its primary produce contributing significantly to the Gross Domestic Product (GDP). The recent revision to the technology aspect of the New Zealand curriculum sees textiles, woodwork, and metalwork situated within the Designing and Developing Materials Outcomes technological area. Food technology and biotechnology are currently situated within the Designing and Developing Processed Outcomes technological area. The study of food and nutrition has also remained in the Health and Physical Education learning area.

GENERAL CHARACTERISTICS OF TECHNOLOGY EDUCATION IN NEW ZEALAND

Contemporary approaches to learning in New Zealand are regularly associated with sociocultural theory (Schepens et al., 2007), which is of particular relevance to technology. Sociocultural theory considers the role of action and tools in the construction of knowledge (Wertsch, 1998) and posits that children's cognitive development is dependent upon individual responses to cultural and societal influences. The goal of the sociocultural approach to learning is to understand the relationships between human action and mental functioning, as well as the cultural, institutional, and historical context in which this action occurs (Wertsch et al., 1995). In New Zealand, technology students develop technological outcomes to meet authentic needs or realize opportunities, often situated within local communities. This involves an oscillation between critical thought and practical enactment as student work through design processes appraising practice and outcomes as they go.

According to Vygotsky (1978), human learning is an "outside-in" process described as internalization and externalization, where knowledge transforms from a social context to an inner psychological conception. Internalization is "related to reproduction of culture; externalisation, the creation of new artefacts, makes possible its transformation" (Engeström et al., 1999, p. 10). Murphy and Hall (2008) suggest that Vygotsky's account of fundamental psychological functions, such as perceptions and memory, is that they appear first as elementary functions, such as rote learning times tables, then as higher functions, such as understanding and using multiplication. These functions occur through assimilation into sociocultural practices that occur when people live, work, or study together. There are two key ideas in sociocultural research that are pertinent here, especially for technology: action and mediation. One of the fundamental claims Vygotsky made was that human activity is mediated by tools and signs (Wertsch, 1981). The underlying assumptions are that humans have access to the world only indirectly or mediately rather than directly or immediately – therefore external tools mediate action allowing the internalization of that action (Zinchenko, 1985).

Today there is a need for students to understand, appreciate and engage with the world in which they live – technology plays a major part in this learning. Students need to become familiar with the diverse range of complex communities in order to meet the requirements of sustained learning and effective participation in society. Learning to appreciate these environments and communities of practice, along with developing a mind and responsibility for the future means learners must continually be involved in meaningful and authentic learning and practice. Renzulli et al. (2004) stated, "it's the application of knowledge in authentic learning situations – not the perpetual memorisation and testing – that characterises a progressive education system" (p. 74). Education must actively engage students in the ways of life *beyond the school* (Newmann, 1996). Technology education is, by definition, future-focused.

Future-focused Approaches to Technology Education

The term future-focused is used here to recognize the evolution of technology education in New Zealand and to describe the government-advocated pedagogical practice. Teachers in New Zealand are encouraged by government to adopt a future-focused approach to education within learning communities, which are sufficiently flexible to accommodate students' learning needs, are situated within open and adaptable teaching spaces, and harness the use of digital technology (Leggat, 2015; Ministry of Education, 2016).

No generation can escape the responsibility of deciding what students should learn (Bellanca & Brandt, 2010). Learning today presents teachers with the daunting task of equipping students with the knowledge and skills necessary to survive their unknown future. Contemporary ideas about learning challenge past educational assumptions and so schools must change significantly to meet the emerging social and academic needs of today's students (Reinsfield, 2019). Reinsfield (2019) states that in the secondary school sector in New Zealand, many technology teachers still view their subject as a means to predominately develop student skills and specialist content knowledge. She asserts an urgent need to challenge teachers' views and teaching practices which negate or marginalize curriculum policy and intent, and recommends that to support the development of students' technological literacy, there needs to be an alignment of both technical and technological ways of thinking and practicing in secondary technology education.

Many education programs are out-of-step with students' current lives and seem irrelevant to their future lives (Fox-Turnbull, 2003; Reinsfield, 2018a). Skills supporting innovation, creativity, critical thinking, and problem solving need to fulfill the expectations of the future economy (Compton, 2010). Wagner (2008), in The Global Achievement Gap, advocated for the development of seven survival skills for the future, including:

- curiosity and imagination
- critical thinking and problem solving
- initiative and entrepreneurialism
- collaboration, learning by influence
- agility and adaptability
- accessing and analyzing information
- effective oral and written communication

In considering future educational approaches, Claxton (2007) identified the need for diversity when fostering students' learning capacity. He called for an epistemic culture change in schools, to replace stand-alone courses that offer a discrete focus with teachers identifying learners' needs. Aspects of such an epistemic culture might focus on the ways teachers and learners collaborate, the range of activities and methods they will engage in to support learning, the ways students can transfer their thinking, and how teachers might model learning to support successful participation in a future-focused society.

Technology education is a subject that can accommodate Claxton's aspects, whilst also including a diverse range of academic and social needs through creative, critical, and problem solving approaches (Reinsfield, 2015; 2016a; 2016b). This includes those students with a preference and abilities for practical activities who can also be creative and solve problems. Concerningly however, a sole focus on technical approaches can often equate to learning where students manufacture outcomes through a series of predetermined stages (Reinsfield & Williams, 2017). The tension for technology teachers is how they manage such traditional perceptions of the subject to interpret the curriculum and respond to the changing context of global, social, and technological need in their classrooms, from a future-focused perspective.

Taught in a variety of ways, technology education is a distinct learning area sometimes delivered within an integrated curriculum model. Teaching approaches that best support future-focused ways of learning are interdisciplinary, integrated, inquiry, problem or project-based, values and competency driven. Approaches are learner-centered and should prepare students for life in the real world, and generate curiosity, excitement and increase engagement.

Student engagement is a concept that has historically focused on teachers' need to increase achievement, encourage positive behavior and a sense of belonging within the classroom (Parsons & Taylor, 2011). Whilst important concepts, there has also been a focus in New Zealand on developing students' lifelong learning capabilities to support their ability to function in a knowledge-based society (Gilbert, 2007). Student engagement has evolved as a notion which is viewed as a means to cater to students who may be "at risk" of underachieving or disengaging from school altogether (Finn & Zimmer, 2012). In technology education, this might equate to placing students in programs that support pathways in the Trades or to learning facilitated through authentic contexts. Regardless of the program afforded to learners in technology education, it is essential that the teacher establishes and environment where, in Claxton's words, "students' questions are welcomed, discussed and refined, so the disposition to question becomes stronger – more and more robust; broader – more and more evident across different domains; and deeper – more and more flexible and sophisticated" (2007, p. 120).

Learning in technology education can take the form of problem-based learning (PBL), inquiry learning, and experiential learning, leading towards an environment where there is less intrusive teacher guidance (Kolb & Fry, 1975; Lombardi, 2007; Papert, 1980; Peacock, 1997; Snape & Fox-Turnbull, 2013). In such learning contexts, teachers provide opportunities for students to construct their own knowledge, as the result of their experiences (Kirschner, 1992). Students' own lived experiences or funds of knowledge make a valuable contribution to technology practice, as well as giving value to often-marginalized understanding and practices (Fox-Turnbull, 2015).

Funds of Knowledge

Funds of Knowledge is a theory situated with a sociocultural paradigm, which draws on the perspective that learning is a social process bound within a wider social context (González, Moll, & Amanti, 2005). Funds of Knowledge are the developed bodies of skills and knowledge accumulated by a group to ensure that they can function appropriately within their social and community contexts (Lopez, 2010). Such thinking is pertinent because if teachers know about students' home and cultural activities, and experiences, they will be better informed to maximize learning opportunities and to make the most of the knowledge and skills already established or accessible to some students (González et al., 2005).

As such, technology education provides opportunities for students to be exposed to learning about the changing nature of knowledge, technology, society, and global issues through the means of problem solving activities, which create critical and creative thinking opportunities (Education Gazette, 2017; Lai & Hong, 2015; Lewis et al., 1998; Ministry of Education, 2016b, 2017b; Wright, 2010). Students' funds of knowledge assist contributions to their own and others' technological practice, and frequently validate their cultural knowledge. Students can deploy funds of knowledge gained from passive observation and participatory enculturation. Participatory enculturation involves students being enculturated into an activity and engagement results in transferable knowledge. This engagement includes both active participation and peripheral participation, where students might be on the periphery of an activity but can still engage through the use of questioning and/or conversation. An alternative approach may be engagement through passive observation, which refers to learned knowledge obtained through passive means, when learners are non-participatory observers. For example, learning can still occur through watching movies, television or reading books - involving no direct interaction with knowledge sources. Deploying their own funds of knowledge can provide students with deeper understanding of the value of diverse cultural knowledge (Fox-Turnbull, 2015).

Experiential Learning

Experiential Learning provides opportunities for students to be exposed to phenomena through real world experiences rather than hearing about it or learning in the traditional classroom setting. Such learning is enhanced and continuous, through critical reflection of and inquiry into the experiences - leading to what Kolb (2015) describes as "spirals of learning," thereby ensuring continuing engagement and learning. Educational institutions frequently deploy this approach by engaging their students in Work Integrated Learning (WiL) and Project-based Learning (PBL). Experiential Learning has obvious links to technology education as the practical nature of technology facilitates students' engagement in solving real-world technological problems through the process of inquiry, as informed by critical reflection.

Inquiry Learning and Guided Inquiry

During Inquiry learning students are encouraged to construct their knowledge and understandings, as situated within their own cultural lens. The process enables them to take ownership of and responsibility for their learning. Inquiry learning encompasses a wide range of skills and processes in active learning, leading to a much broader understanding of the world. One Inquiry learning strategy that focuses on the facilitation of developing independent knowledge is Guided Inquiry. The guided inquiry approach reflects the belief that, for students, active involvement in construction of their knowledge is essential for effective learning (Kuhlthau et al., 2007).

Guided Inquiry is systematic learning which proceeds through a number of teaching and learning phases within a predetermined context. It involves students engaging in deep learning, through the process of self-motivated inquiry, with several distinct phases. A teacher using an Inquiry approach to learning strives towards students' development of wider or rich concepts, or learning that endures – about the world and how it functions (Blythe, 1998; Kuhlthau et al., 2007; Murdoch, 2004). Guided Inquiry is very different from an open approach to discovery learning as teachers have a continuing responsibility to structure a range of activities, which are sequenced to maximize the development of learners' thinking processes and skills.

During the first phase, the teacher usually announces a topic of study that requires thorough research, thus initiating the inquiry process. During this time, students are prepared for selecting a topic of research through a variety of immersion activities. The second phase involves the selection of a topic of study, and questioning is used to support the direction of their work. Exploration is the third and most difficult phase, and involves sifting through available information to find a specific focus. Students need to be well informed about the general topic, in order to find an appropriate area to focus on. In the fourth phase, formulation, students identify ways to focus and organize their topic, thus providing a degree of clarity. The next phase, collection, follows with an extended focus on how to present new understandings. Once students have gathered all the required information, they consider the nature of the presentation with which to share their findings. The presentation phase may consider a range of styles from informal to formal outcomes. The assessment phase concludes the project as both teachers and students judge content and skills learned throughout the process. This provides a time to critically reflect and evaluate on the inquiry process as a whole. Such reflection is not to be confused with formative assessment of content and process, which is ongoing throughout the project (Kuhlthau et al., 2007).

Guided Inquiry offers students an opportunity to build on what they already know and to gain new knowledge through active engagement in and reflection on a learning experience. Students 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, and facilitates learning through social interaction with others (Kuhlthau et al., 2007). The Guided Inquiry process reflects authentic technological practice as identified by Kimbell and colleagues (Kimbell et al., 1991). The Assessment of Performance (APU) Model (Figure 1) illustrates a technology design process, providing a succinct overview of the iterative process of thought in action, where interactions between mind (Imaging and Modeling) and hand (Confronting Reality) are formulated, tested and reformulated as design activity progresses (Stables & Kimbell, 2000). The Guided Inquiry process also reflects the Technology learning area as it is organized in The New Zealand Curriculum (Ministry of Education, 2007), as illustrated in Figure 2.

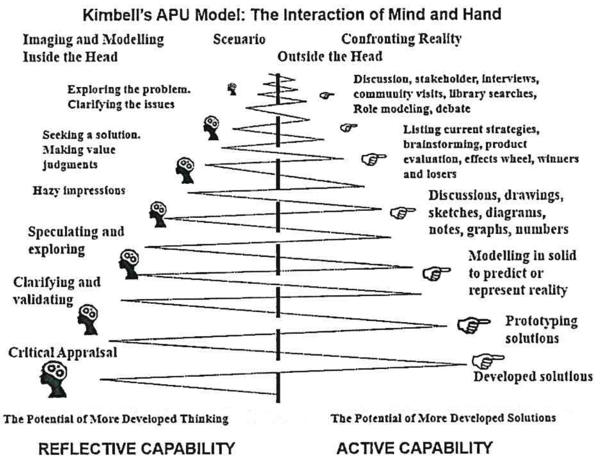

Figure 1. Kimbell and Colleagues APU Model of Technology Practice modified by W Fox Turnbull

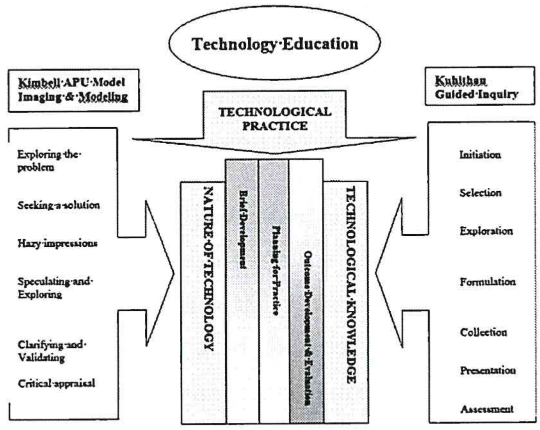

Figure 2. Technology Education and Guided Inquiry Nexus (Snape & Fox-Turnbull, 2011)

Talking for learning

The ways that teachers talk about and facilitate students' learning is key to successful outcomes in technology education. Talk plays an important role in contemporary approaches to learning and is particularly important in technology education in New Zealand because learners often work in groups to develop outcomes in response to an issue. Mercer and Dawes (2008) suggest that educational talk is either symmetrical or asymmetrical. Asymmetrical talk is the talk between teachers and students where one person takes the lead, usually the teacher. Symmetrical talk is talk between students where participants have equal status and control, which is more likely to happen when students are working in pairs or small groups. Scott (2008) uses different terms: Interactive or Non-interactive. Interactive talk includes verbal participation of all participants; non-interactive talk usually only involves one person - typically the teacher or one student who dominates the conversation and decision-making. Traditionally much educational talk in the classroom was asymmetrical; teachers acted as arbiters of knowledge and therefore acted with authority by leading conversations through the transmission of facts, demonstrating, explaining to or correcting students. Symmetrical or Interactive talk is more congruous with new ways of learning, but asymmetrical or non-interactive talk do still have a place in the classroom – at times.

Talk is given prominence in Alexander's (2008) dialogic teaching, which is a pedagogical approach where teachers need to "provide and promote the right kind of talk" (p. 10) to ensure that students learn more effectively and efficiently. Dialogic teaching demands both student engagement and teacher intervention through talk and can occur in any organizational context, whether it is whole class teaching, or during small group collaborative discussion. Argument as a tool can be effective in this space. Mercer (2006) suggests that argument is characterized by three specific types of talk: disputational (mainly Asymmetrical), cumulative, and exploratory (Symmetrical). Disputational talk is prevalent in but by no means restricted to an aggressive type argument and is characterized by participants' unwillingness to understand another person's point of view – with a constant reassertion of his or her own. Collaborative activity becomes almost impossible in such circumstances, as participants vie to have their views adopted. Defensive and uncooperative behavior typifies this type of talk where participants seek control of the discussion and aim to hold the power.

Within exploratory symmetrical talk, two subsections emerge: cumulative (Mercer & Dawes, 2008) and Intercognitive (Fox-Turnbull, 2013). Cumulative talk occurs when speakers build on each other's contributions and are supportive but uncritical; thus, shared understandings do not develop with individuals retaining ownership of their own unchanged understandings. Intercognitive talk describes talk within which participants value and build on each other's contributions and developing understandings. Participants are supportive and critical, but in a constructive manner. Used when students are working collaboratively on the development of a single outcome or project, Intercognitive talk is perfectly suited to technology education. To achieve the design and possible development of a successful technological outcome when working with others, students must find common ground when they experience differing ideas and solutions – thus demonstrating sociocultural conflict.

Sociocultural conflict theory is relevant to authentic technology practice. It is a means to acknowledge that discrepancy or conflict leads to cognitive development. A subset of sociocultural theory, with a focus on the use of language as a tool, sociocultural conflict theory identifies conflict as an essential component of any joint endeavor – to bring about cognitive change. This thinking translates to both pre- and in-service teacher education. Doise and Mugny (1984) demonstrated that when working in pairs to solve problems, learners advance to a higher level of learning than for those working by themselves. Alternative points-of-view during problem solving can force a learner to adjust his or her own viewpoint to align to that of another. The conflict can only be resolved if cognitive restructuring takes place and therefore mental change occurs because of social interaction. Language as a tool is a key component of such interactions.

Language can be a tool of intellectual adaptation within the context of teacher learning. Vygotsky (1978) described two relevant forms of language. Firstly, the nature of social speech as a means of communication with others, as described above. Secondly, as represented through private speech during teachers' engagement with professional learning – assuming that private speech connects thought with words, as internalized, self-regulating, thinking, in action. An example of language as a tool of intellectual adaptation might be that a teacher has their own belief about the way that the technology curriculum should be enacted, but they regulate their thoughts and language to communicate an alternative, more socially acceptable perspective during class, or when engaging with colleagues. Alternatively, a teacher might disagree with the social speech represented in a professional context and choose to ignore it. Teachers' actions can align with or be disparate to their espoused theories of technology education, and represent multiple perspectives, customs and motivators. This is particularly evident by the differing representations of discourse in senior secondary school contexts in New Zealand (Reinsfield, 2018a).

GENERAL PEDAGOGICAL PRINCIPLES

Technology Education offers rich contexts for study, including the social construction of outcomes, cooperation and collaboration with others, and practical engagement in worthwhile and real-world activities (Snape & Fox-Turnbull, 2011). Technology projects are frequently collaborative, requiring shared processes. This requires significantly different approaches to work than the frequently seen desk-confined, textbook and whiteboard techniques often used in traditional classrooms. The New Zealand curriculum seeks to establish the direction for student learning in schools, to provide guidance, and allow schools to shape pedagogy within their own context (Ministry of Education, 2007), with a view to "build[ing] an education system that equips New Zealanders with twenty-first century skills. It also strives to reduce underachievement in education" (Cubitt, 2006, p. 196). With the implementation of the 2007 curriculum, New Zealand education refocused efforts towards developing human capability, with a view to supporting the structure of a prosperous and inclusive society. There were more explicit connections between learning, pedagogy, and assessment. Positioned as empowered professionals and legitimate decision makers, teachers had the ability and autonomy to design appropriate learning for their students within their school context.

Teachers in New Zealand are expected to be lifelong learners who are committed to developing their understanding of contemporary pedagogy (Ministry of Education, 2007). Enabling factors include collaborative communities, with a focus on continuous improvement, internal and external partnerships, and effective leadership. Time to reflect and critically analyze one's own practice, having a sound knowledge of pedagogical practice for application in differing learning contexts, and a safe environment to take risks are critical (Fullan, 2002; Hargreaves & Fink, 2004; Koehler & Mishra, 2009; Shulman, 1986, 1987; Timperley & Philips, 2003). Teachers of technology need to combine skilled expertise in their specialist area with strong academic understanding of underpinning technology practice and design principles. They need to be able to develop strong relationships with all students, understanding their different starting places and cultural backgrounds. Most importantly, they need to be passionate about technology and learning.

Technology emerges from within social context and does not occur in isolation from values, beliefs and social life – constructed in response to the social and cultural needs of the society in which the technological outcomes are developed (Fleer & Jane, 1999; Siraj-Blatchford, 1997). Technological solutions developed within the context of the community, within which the needs arise, and those that use local skills, resources and existing technologies, are likely to be the most successful. It is essential that pedagogical approaches in technology reflect and facilitate this thinking. Teaching today's students through yesteryear's pedagogies is no longer acceptable. The "graveyard model of teaching" (everyone in rows, passively accepting instruction) needs to be replaced with students interacting, solving problems, applying skills, and making decisions about meaningful issues (Gordon, 1998). Practices should be real to the student, and their current or possible future lives (Hennessy, 1993). As these practices are undertaken, students gain an appreciation of the bigger picture of technology (Blythe & Associates, 1998; Murdoch & Hornsby, 1997), utilize key competencies and values, create, 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. The review of the technology curriculum in 2017 (Ministry of Education, 2017) provided an opportunity to conceive pedagogy differently and re-position students' learning so that it can be inclusive of creative, innovative, and critical thinking approaches in a more purposeful manner. To develop innovative technological outcomes for example, students need to understand the nature of materials or systems and be exposed to experiences where they can manipulate and adapt resources to represent and realize their ideas. The nature of technology education in New Zealand continues to change, and teachers should be providing opportunities for students to explore conceptual, partially modelled, digitally realized or fully realized outcomes. Assessment is an important aspect of learning in any educational setting. Both assessment of and for learning impacts and influences technology education in New Zealand schools.

Assessment *of*, *for* and as Learning in Technology Education

Meyer and Land (2003) argue that teachers "perceive, apprehend, or experience particular phenomena [which] might lead to a privileged or dominant view and therefore a contestable way of understanding something" (p. 1). This perspective suggests that the core concepts presented within the technology curriculum, communicated as Achievement Objectives, and within the Indicators of Progression documentation (Ministry of Education, 2007, 2010, 2017) might be interpreted according to their dominant worldview. To make judgments about students' learning progressions, teachers need to be aware of their own bias, have sound knowledge of their students' worldviews, and be conversant with the notion of formative assessment or assessment for learning (Black & Wiliam, 1998). The principles of collaborative professional learning can support approaches, which ensure accurate and unbiased assessment. According to Earl (2011), assessment as learning provides an opportunity for students to self-regulate and challenge their own and others' ideas for application in their future learning.

Another way of assisting fair formative assessment practices is by assisting students to undertake peer and self-assessment. Clarke (2005) and Clarke et al. (2003) support the view that such approaches ensure that students take greater responsibility for their learning. To enable this process however, students must be informed of or negotiate learning intentions, which communicate very clear and specific success criteria – coupled with effective questioning from their teachers. Such practices are more likely to make students aware of the purpose, intent and scope of their learning. At this time, teachers need to be responsive in planning, teaching, and resource development to reflect curriculum concepts (Allen et al., 2013). Technology teachers must also have sound pedagogical knowledge and a commitment to a constructivist approach to teaching (Saxton et al., 2014). Brooks and Brooks' (1993) four principles of a constructivist approach to learning include

1. the seeking and valuing of the learner's point of view
2. the ability to challenge learners' suppositions by either validating or transforming their truths
3. discussing emerging issues or relevance of the learning to support the creation of personal meaning
4. contextualizing learning within the wider scope of individual understandings.

In New Zealand, curriculum documentation provides a means for teachers to plan and structure students' evolving understandings, but there are existing tensions when learners enter the latter stages of their school study. New Zealand's main secondary school qualification is the National Certificate in Educational Achievement (NCEA) (New Zealand Qualifications Authority [NZQA], 2012). Within this assessment framework, students progress from Level 1 in Year 11 to Level 3 in Year 13. Students accrue credits at each Level, to progress to the next. Students are able to choose learning programs from a range of subjects, which are assessed against either Achievement or Unit Standards. In Achievement Standards, students demonstrate understanding or mastery at Achieved, Merit, or Excellence levels – of identified knowledge and skills (e.g., Brief Development). Unit standards are competency based and students are assessed on an Achieved or Not Achieved basis. All NCEA Standards are currently under review. Some examples are outlined in Table 2 for a

Year 11 student (age 16).

Table 2: Example of Achievement and Unit Standards

Standard	Title	Assessment criteria
AS90144 NCEA Level 1 4 credits	Undertake brief development to address a need or opportunity	Undertake brief development to address a need or opportunity involves: • identifying a need or opportunity as a result of exploring the given context and issue • reflecting consideration of the social and physical environment • reflecting key stakeholder's opinion • describing the outcome to be developed • identifying the physical and functional attributes needed for the outcome • producing a final brief comprised of a conceptual statement and specifications.
US24352 NCEA Level 1 2 credits	Demonstrate knowledge of and apply safe work practices in the construction of a Building Construction Allied Trades (BCATS) project	Students need to • Demonstrate knowledge of safe working practices for the construction of a BCATS project • Select, maintain and use personal protective equipment (PPE) during the construction of a BCATS project.

The complex and sustained relationship between vocational (trades) and (general) technology education in New Zealand presents a duality between the two philosophical approaches. Unfortunately, in many schools, these programs are often taught in the same environment, by the same teachers, and to the same students (Williams, 2015). Williams states the pragmatics of such enactment means that the separation of teaching into different concepts or pathways is not always straightforward, nor possible because technology education and vocational education have differing purposes and contrasting pedagogical approaches. Thus, by blending the philosophies, a teacher is likely to be less effective or empowered to teach in a future-focused manner, to address the concepts presented within the New Zealand curriculum (Ministry of Education, 2007). Such diverse understandings about the nature of technology education have implications for student teachers' developing understandings.

TECHNOLOGY EDUCATION: A CHANGING ART

Student teachers can experience learning in technology in their undergraduate, graduate, or postgraduate study. Most undergraduate and graduate courses have 15 points associated with them. One point is the equivalent of 10 hours of study. Typically, for undergraduate and graduate primary teacher education, there will be one 15-point course with 16-36 hours of technology contact learning supplemented with additional hours allocated for thinking time, independent reading, coursework, and assignment work. The exact number of hours allocated is dependent on whether the courses are shared with other learning areas, such as science. For secondary teacher education programs in New Zealand, contact hours can range from 36-72. Even in programs with subject endorsement, which draw on learners' previous work experiences, there are time pressures, which impact the ability to address the diversity of knowledge required to adequately prepare student teachers for the profession. Developers of the pre-service technology education framework (PTTER) 2013 suggested that

> Pre-service educators can realistically only prepare teachers to recognize, understand and plan good technology teaching practice. Teacher competencies to deliver technology programs will therefore evolve through their teaching practice and involvement in continued teacher education programs. (p. 483)

The PTTER resource provides a framework for ITE programs in technology

(Forret et al., 2013), which is partially based on findings from a questionnaire investigating student teachers' beliefs and views about technology education. The authors, all ITE educators in technology, one from each of the six New Zealand universities with ITE programs, also drew on experience and recent literature to identify four cornerstones of learning. These four cornerstones: Philosophy, Rationale, Curriculum and Implementation, considered chronologically, can assist the framing of balanced programs of work in technology education. This approach is also beneficial to student teachers' wider programs of study, where they learn about and can make connections to content such as teaching and learning theory, education in the New Zealand context, or te reo and tikanga Māori (Māori language and traditions).

The PTTER questionnaire recognized the importance and persistence of student teachers' values and beliefs, and shaped subsequent program development. As a result, student teachers in primary technology teacher education programs typically undertake a number of small tasks that are applicable to their future school settings, and are reflective of a range of technological areas. Links made to the technology curriculum and implications for teaching, learning and assessment are highlighted. For secondary student teachers, similar ideas are explored, but more often, in one or two technological areas. The learning at both levels prioritizes an approach to pedagogy that is learner-centered and authentic, with a view to developing student teachers' ideas about both the nature of technology and how this translates to technology education in New Zealand.

Authenticity in technology occurs through specific links to students' context and real technological practice. Learning is predominantly based on connecting students' understanding to meaningful and real-world situations, and their involvement in technological practice that is similar to practicing technologists, while using authentic tools and processes where possible. Hennessey and Murphy (1999) explained that authentic practice involves situations that are real to the student, their lives, and situations they may encounter in the future workplace. Activity embedded in authentic technological practice is more likely to produce greater understanding and provide the opportunities for students to identify, simulate, and relate to the tacit knowledge of technologists. Snape and Fox-Turnbull (2011) suggested three dimensions of authenticity to enhance learning in technology: pedagogy and instruction, teachers and learners, and activities. Learning should closely resemble everyday situations, and provide students with opportunities to make decisions about the nature, content and pace of their learning (Petraglia, 1998).

Authentic teachers take responsibility for remaining current and aware of the variety of possible opportunities that exist for student involvement and engagement (Kreber et al., 2007). As professionals, teachers must ensure that their practice pays particular attention to what is best for the students and their understanding, to help them make better sense of the world in which they live. Cranton (2001, cited in Kreber et al., 2007, p. 34) argued, "the authentic teacher cares about teaching, believes in its value, wants to work well with students, and has a professional respect for students."

Students' ownership and self-regulation is necessary if enduring learning is to take place (Murdoch & Hornsby, 2003; Reinsfield, 2018a). Riggs and Gholar (2009) focus on the role that students can play themselves to accomplish their dreams and aspirations. They describe this as the conative domain or conation, the will, drive or determination to achieve a goal – also sometimes labelled in the literature as self-actualization, self-efficacy or individuation (Kreber et al., 2007; Tessmer & Richey, 1996).

Conative learners are self-regulated, confident, diligent, and resourceful; they know what they can do and are proactive to seek support, as they require it (Zimmerman, 1990). Zimmerman argued that these learners can problem-solve, take responsibility for their learning, plan, set goals, reflect, and action the need to change their thinking. This term is also applicable to how teachers think and how their pedagogies foster students' agency in the classroom. Conation can be compared to Freire's (2005a, 2005b) construct of conscientisation in which an individual deeply understands their place in the world (Nevin & Cardelle-Elawar, 2003). For example, a teacher's concept of technology education can be determined through their espoused perception and manifesting practice, as mediated by past or present professional experiences (Harding et al., 2001).

Conative teachers and students present as motivated learners, who have high self-efficacy and intrinsic motivation and with appropriate support find a learner-centered approach to technology education an experience that affirms their confidence. This will however depend on the professional skill of the teacher to organize the learning process appropriately.

Entry requirements

In New Zealand, entry into teacher education programs is restricted. The New Zealand Teaching Council, ~~the government funded professional body,~~ mandates that all students must be interviewed and deemed "suitable for the profession of teaching." A police screen is also conducted before admission. As signaled earlier, teacher education occurs at two levels, one in pre-service or Initial Teacher Education (ITE) programs, where students are taught the fundamentals of teaching to early childhood, primary and secondary school aged children. The other type of teacher education is in-service or professional learning and development (PLD), targeted at maintaining the currency of practicing teachers.

In ITE programs, primary teacher education students experience teaching and learning in technology education, along with all other curriculum areas. Some institutions have separate courses for technology; in others, technology is clustered with other subjects such as Science. Bachelor's degree and graduate diploma are the two predominant programs where students can become primary teachers. Bachelors programs are currently three years in duration, with some institutions offering a further 4th "honors" year of study. The three-year ration of the degree is somewhat controversial, with many teacher educators espousing a need for a four year rogram. Graduate Diploma programs offer an intense year of study, undertaken over an extended university year - beginning in January and finishing in November or December, depending on the location (Note: our academic year is the same as the calendar year).

In secondary ITE programs, students cannot generally gain entry unless they have a Bachelor's degree, and some higher level papers, to support their teaching subject. For technology, this has proved problematic, as previously those with an Advanced Trades Certificate were also eligible for entry. The shift to degree level entry has contributed to a shortage of teachers who have strong practical backgrounds. The University of Waikato currently offers a 2-year pathway for those students with extensive Trades experience, which leads into a Graduate Diploma. Within the Graduate Diploma (secondary) students experience more time studying technology than their primary colleagues, however time is still of the essence so the nature of technology programs is focused on curriculum and pedagogical knowledge and skills, because students who enter the program have the expertise to ensure they have the necessary practical skills within their specialist technological areas. Within New Zealand, there is disparity in the nature and time allocated to technology teacher education across the country, as reflected in other countries.

TECHNOLOGY TEACHER EDUCATION IN NEW ZEALAND COMPARED TO OTHER COUNTRIES: CHALLENGES AND INNOVATION

These changes bring unique challenges for teacher educators in New Zealand. Current ITE courses need to be adjusted, and academic staff need to become cognizant of and respond to the changes and/or additions to the curriculum. Similar needs are represented in schools where changes to the curriculum also require considerable time and investment in teacher Professional Learning and

Development (PLD). Reinsfield's research (2018b, 2018c) has identified persisting challenges for teacher education, particularly for technology teachers in New Zealand. She indicates an urgent need for secondary school teachers to move away from traditional approaches to technology education, which emphasizes practical outcomes and safety rather than fostering students' critical and creative thinking. To enable such a change, practicing teachers need to move from a sole focus on specialist knowledge, towards the interpretation of the curriculum and/or assessment standards, and towards a student-centered approach, where teachers are positioned to guide rather than instruct their learners. Such practice reflects the authentic actions of technologists, where learning is open-ended and divergent.

There is a continued need for student teachers to reflect upon their own and others' perceptions of technology education, and it is the responsibility of ITE programs to prepare them to professionally critique (but not be explicitly critical of) the way that technology education is taught in schools. During their initial education programs, all students undertake practicum experiences in classrooms with experienced Associate Teachers, who model and guide their student teachers. This presents a number of challenges for technology teacher education in New Zealand. In the secondary sector, students undertake a practicum within technology departments, taking a range of classes with students aged from 10-18 years of age. Student teachers are taught how to foster and implement learner-centered and future-focused learning contexts so that they can remain committed to these pedagogies, particularly as what they may observe in schools may not always correlate with best practice recommendations.

TEACHER PROFESSIONAL LEARNING AND DEVELOPMENT

Professional learning and development (PLD) structures in place (to support teachers' evolving practice) are variable in quality in New Zealand, and sometimes discount individual learning needs, especially as Ministry of Education PLD funding and provisions are targeted to the government of the times' wider educational goals rather than teachers and schools' specific needs. In a climate where teacher learning is expected to be a continuous process, an inquiry-based or collaborative approach to professional development provides a means to recognize existing experiences and understanding, and to situate the learning process as being social in nature and directly connected to practice (Webster-Wright, 2017).

In 2019, the Mātanga (Māori word for expert) project was conceptualized to offer a new approach to professional learning and development (PLD) for technology teachers in New Zealand. Its design acknowledged yet challenged traditional approaches to PLD, where teachers were positioned as the receivers of information (Granshaw, 2010). The New Zealand curriculum (2007) outlines that teachers should use an inquiry-based approach to their professional development, which is needs-based, and has the potential for a collaborative approach to learning.

Engagement with online professional learning was also a pertinent area for technology teachers because recent changes to their learning area implied that practitioners needed to be or become confident users of digital pedagogies (Ministry of Education, 2017). The principles of connectivism were used to support teachers to think differently about their learning, or to foster new understandings through the use of digital technology (Siemens, 2014). An online platform (Zoho Connect) provided discursive learning contexts, to accommodate the sharing of diverse views from colleagues outside of teachers' immediate school communities, thus extending the scope of their evolving understandings (Lai et al., 2013). This model was suited to teachers in remote areas, or for those who had limited access to curriculum support. The overarching, long-term goal of the Mātanga project is to provide self-sustaining PLD, based on community needs, and to position the agency of the learning within the community. The provision of easily accessible professional development, supported through the Technology Education New Zealand (TENZ is a professional association for technology education) network of regional meetings and conferences, has also helped to ensure its sustainability.

Teaching of Teaching and Learning

As we have identified, there is a continued need for student teachers to reflect upon their own and others' perceptions of technology education, and it is the responsibility of Initial Teacher Education programs to prepare them to professionally critique the way that technology education is taught in schools. For example, student teachers in New Zealand become conversant with formative assessment (Black & Wiliam, 1998) and the principles of active learning (Newmann et al., 1995). Clarke (2005) and Clarke et al. (2003) state that a greater role in their learning facilitates students' learning success. The same applies to student teachers who are taught about the sharing of learning intentions, questioning, self and peer assessment – all strategies of formative assessment to make learning more explicit. Student teachers are also taught to identify appropriate success criteria for the learning. When highlighted or co-constructed, learning is even greater. The identification and writing of clear, measurable learning intentions in technology clarifies aspects of technological knowledge and skills within any one lesson. Conceptual, procedural, societal knowledge and technical and information skills need to be articulated to students before the lesson commences. Teachers need to be able to identify and articulate key learning to students. Each learning intention is subsequently associated with planned learning experience/s to facilitate that learning. Student teachers are taught to purposefully plan and logically sequence these experiences. This ensures relevant information about the context of study, and relevant technological knowledge and skills are available to learners to enable the development of intended technological outcomes while being cognizant of societal, environmental and global issues influencing decision making.

When implementing technology in the classroom, each learning intention and associated experience produces some form of tangible (e.g., written, oral, visual, dramatic, graphical) evidence of learning with the potential for formative assessment opportunities. Student teachers learn how to plan, implement and assess such activity, and are encouraged to plan for the production of variety within the evidence of learning produced by their students. This evidence might take the form of things such as posters, charts, interviews, written summaries/reviews, products, systems, environment plans, discussion or oral explanations, concept maps, annotated sketches, 2D and 3D detailed drawings, functional models, prototypes and final technological outcomes. Proof of learning outcomes can be evidenced and used formatively or summatively for assessment when clear specific criteria are identified. Table 3 shows examples of muddled and context-free learning intentions in technology.

Table 3: Examples of learning objectives and contexts (adapted from Fox-Turnbull, 2012)

Context & Technology ***Component***	**Unclear learning intention** ***(to be avoided) Students are learning to...***	**Context-free learning intention** ***(desirable)*** ***Students are learning to...***
School senior ball gown/ prom dress *Technological Modelling*	Understand why making a mock-up of their ball gown is necessary to ensure quality	Understand the importance of making a mock-up has on the quality of a final outcome
Meals for the elderly living at home *Planning for Practice*	Develop a critical path to plan meal preparation for elderly living at home	Plan technological practice through the development of a critical path to ensure maximizing all team members' use of time
Wooden jigsaw puzzles for an early childhood centre *Characteristics of Technological Outcomes*	Understand how the physical and functional nature of wooden jigsaw puzzles for an early childhood centre impacts performance	Understand how the physical and functional nature of an outcome impacts on performance

Context & Technology ***Component***	**Unclear learning intention** ***(to be avoided)*** ***Students are learning to...***	**Context-free learning intention** ***(desirable) Students are learning to...***
Cell phones *Characteristics of Technological Outcomes*	Explore critical environment issues and impacts of cellphones	Explore critical environment issues and impacts of a commonly used technology
A hutch for a rabbit *Outcome Development and Evaluation*	Use a digital tool to draw 3D detailed plans of their rabbit hutch	Use a digital tool to draw 3D detailed plans of a structure
Webpage for Hamilton Hawks Running Club *Outcome Development and Evaluation*	Construct a user-friendly website for Hamilton Hawks	Construct a quality, safe, user-friendly digital outcome for a specific client

One strategy taught to student teachers is to write learning intentions that are free from the context of learning. Clarke (2008) suggests that separating the context from the learning intention can have a dramatic effect on teaching and learning. This strategy clarifies the intended learning and enables focused feedback to students. When teaching specific technological knowledge and skills, it is easy to muddle context with technological learning, so that neither become clear – developing a "mucky brown paint" rather than a clear pool of "curriculum color." There is a risk in this situation that the rich technological learning might get buried in the business of the context (Fox-Turnbull, 2012). The context or "vehicle" through which learning occurs is vitally important and must be engaging and authentic to students (Clarke, 2005, 2008). This process also facilitates opportunities for the transfer of skills and knowledge to other contexts within and across curriculum learning areas (Clarke, 2008).

CONCLUSION

Technology education in New Zealand has evolved and changed regularly since its inception into The New Zealand Curriculum Framework in 1993 (Ministry of Education, 1993). Key organizers such as curriculum strands, technological areas, and achievement objectives are currently on their third iteration. These changes have influenced the practice of teachers, students and teacher educators alike.

Initial teacher education in New Zealand currently prepares student teachers to teach in student-centered innovative learning environments. Constructivist principles situated within Sociocultural theory underpin the education system that values excellence, innovation, inquiry and curiosity, diversity, equity, community participation, ecological sustainability and integrity (Ministry of Education 2007). ITE programs prepare student teachers to teach technology through experientially-based inquiry learning approaches to design and develop technological outcomes, systems or products, to meet identified needs within social, cultural and sustainable parameters. Courses in technology education teach technological content, pedagogical, and pedagogical content knowledge, but time does not allow for the development of physical and technical skills related to individual technological areas.

Many currently practicing specialist technology teachers struggle with the philosophical changes needed to move technology from a technical, skills-based program to the needs-based student-centered program outlined in the current curriculum. In the primary sector, challenges remain but for different reasons. Over recent years in primary education in New Zealand, the Ministry of Education's focus has led to the marginalization of technology education. These challenges mean that although student teachers are learning up-to-date practice and pedagogy while at university, they rarely see quality technology education being modelled in the classroom. However, not all is lost. The recent revisions to increase the presence of digital technologies in the technology curriculum, and the move to teaching through inquiry whilst acknowledging students' lived experiences, offers exciting opportunities to consolidate the status of technology education in the future.

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