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Implementing Digital Technology in *The New Zealand Curriculum*

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Abstract

This article initially reviews literature that argues for a place for digital technologies in the curriculum. Understanding of and competency in developing digital technologies is becoming an increasingly debated topic around the world. Areas of debate include where and when key components of digital literacy such as computational thinking, computer science, programming, and coding should be learned. This article argues for the inclusion of digital technologies in the curriculum and more specifically within the technology curriculum.

A case study of the decision-making process of New Zealand as it moves to include digital technologies into The New Zealand Curriculum *in subsequently presented. An account of the processes undertaken by the New Zealand Ministry of Education to include and implement digital technologies in technology education is presented. Finally, it offers a cautionary warning about two potential risks as New Zealand enters the implementation phase of its new digital technologies curriculum.*

Keywords: Digital technologies, implementation, curriculum, technology education

Introduction

As we move further into the digital age, there is recognition internationally about the need for digital technologies within the curriculum. The introduction of digital competencies as an academic subject is a recent addition to primary and junior secondary programmes in a number of countries such as Australia, England, Estonia and Cyprus (Bell & Duncan, 2015). Bell and Duncan (2015) use the term 'computing' to cover topics such as computational thinking, computer programming and related issues (algorithims, data representation and those of a social nature). Wing (2006) defines computation thinking as an approach to problem solving, designing of computer systems, and understanding related human behaviours, while drawing on fundmantal ideas of computing. This includes creating and following sets of instructions, representing instructions in a way that a computer can carry them out as a step-by-step process or algorithim (Computer Science Education Research Group, 2018). The creation of algorithms requires a range of transferrrable skills:

- *algorithmic thinking* - the process of creating algorithims to solve problems;
- *abstraction* - the process of simplifying for clarity and includes the indentification of what needs to be shown and what can be hidden such as in the creation of a map or editing a photograph on a computer;
- *decomposition* - the breaking down of a problem into small and managable parts as a recipe identifies steps to bake a cake; generalising and patterns;
- *pattern recognition and generalising* - the identification of patterns to assist with the recogition of reoccuring issues or problems and taking the solution or part thereof, then generalising it so that it can be applied to other problems;
- *evaluation* - identification of a range of possible solutions to a problem and selecting the best to use in the given situation; and
- *logical reasoning* - making sense by observing, collecting data, thinking about known facts and calculating based on the known, assisted by facilitation of existing knowledge to establish rules and check facts (Computer Science Education Research Group, 2018).

Programming refers to the implementation of an algorithm, with subsequent testing and fixing as well as the identification and selection of the learning environment and language (Bell & Duncan, 2015; Duncan & Bell, 2015). A final aspect that is considered an important part of the study of digital technologies is the social aspect, referred to as 'Humans and Computers' by Duncan and Bell (2015) and includes "digital citizenship - cyber safety, privacy, intellectual property, sustainability, ethics, equity, accessibility, legal responsibilities; careers - including diversity; project management; usability; integration into other fields; key board proficiency" (p. 3).

In July 2016, the Minister of Education announced that digital technologies needed to have greater focus and be more explicit in the New Zealand curriculum (Ministry of Education, 2017a) and would be introduced into *The New Zealand Curriculum* (NZC), coming under the umbrella of technology education (Education Gazette Editors, 2016; *Stuff*, 2016). NZC's definition is:

> 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)

The decision to situate digital technologies within the technology education curriculum was somewhat controversial. The decision was made after an 18-month consultation period with a range of interested sectors. It was welcomed by most in the technology education sector as digital technologies are fundamentally about design and development (Ministry of Education, 2017b), and therefore aligns with the philosophy of technology education. This was the outcome lobbied for by Technology Education New Zealand (TENZ), during the initial consultation phase. TENZ felt that if situated elsewhere a number of concerns could emerge. For example, if digital technologies were to become their own learning area there were fears that learning could become a series skills and knowledge based activities rather than learning built on an holistic constructivist model of learning. Another potential concern was that, in an already crowded curriculum, schools might replace technology education with digital technology (Fox-Turnbull, 2017).

However, the decision was not a popular one for the IT sector. The Institute of IT Professionals NZ (IITP), which represents thousands of IT professionals, welcomed the expansion of digital technologies in the curriculum but lobbied strongly for digital technology as a stand-alone subject

area. Chief Executive Officer of IITP, Paul Matthews stated "Digital technologies needs its own home within the curriculum. Without this, the outcome announced today simply won't get us where we need to go as a country" (*Stuff*, 2016). There were perceptions in this sector that technology education was non-academic and a 'failing' subject, and therefore joining with technology would 'dumb-down' digital technologies and give them low status in the curriculum (Matthews personal communication, July 2016, Bell, Andreae, & Bobins, 2014).

This article uses a constructionist view of making meaning to present an argument and subsequent rationale for situating digital technologies within technology education. From a constructionist stance, culture shapes world views (Crotty, 1998). Digital technologies are increasingly influencing and being influenced by human culture and society. It is, therefore, timely to discuss the role they should be playing in education and, as outlined in this paper, how they are organised within curriculum.

Implementing Digital Technologies in School Curricula

In the wider economy, businesses struggle to find people with the right skills to drive digital innovation and economic growth. They also state that this learning needs to start in the classroom (Gander et al., 2013). The theoretical perspective of Critical Inquiry seeks to understand and change the current situation and uses dialectic discussion between philosophy and science to achieve desired change (Crotty, 1998). Over the last ten years, digital technology and the role it plays in education has been a matter for global debate. Much of the debate about the inclusion of digital technologies in the curriculum has resulted in changes to national curricula. There is general agreement that digital technology belongs in the school curriculum in the twenty-first century and that curricula should reflect a change in this direction (Bell et al., 2014; Falkner, Vivian, & Falkner, 2014; Gander et al., 2013; Royal Society, 2012).

Some advocates (Armoni, 2016; Falkner et al., 2014; Gander et al., 2013; Webb et al., 2017) call for computational thinking, computer science and information systems education to be included in curricula beginning at primary school. Students before the age of 12 are forming views of their competence in the subject (Bell et al., 2014). A growing body of knowledge indicates that aspects of computational thinking and computer programming, rather like that of learning languages, is best begun at an early age, ideally around eight years of age (Bell & Duncan, 2015; Duncan, Bell, & Tanimoto, 2014; Gander et al., 2013; Webb et al., 2017). Students have a natural ability to learn foreign languages before puberty. Learning digital has the potential to empower students influence their world through involvement in digital design and development, rather than be passive participants. Bell and Duncan also suggest that being comfortable in a digital world is vital for many young people today as it prepares them for a future in computing.

Computer science (informatics, computational thinking) and information systems are considered two aspects of digital technologies that are critical components forming the foundation building blocks of the learning process (Falkner et al., 2014). Since computers have made their way into classroom, there has been a change in learning focus from using computers and more recently other digital technologies, to that of learning with them. For example, Bell et al. (2014) state that in New Zealand, after some initial teaching of computer programming in senior secondary mathematics classes in the early 1970s, teaching became dominated by a focus on how to use computers. This also occurred in the international arena (Gander et al., 2013; Royal Society, 2012) despite Papert (1980) suggesting that computers would impact on the way people think and learn and that young children should be not only taught to use computers but to programme computers. "One might say that the computer is being used to program the child. In my vision the child

programs the computer" (p. 5). Pea (1985) states that computing had the potential to change thinking and learning by reorganizing children's thinking, but acknowledges issues with transferrability to other areas of learning. Somewhat ahead of their time, Pea and Papert are right. Learning digital technologies is more than students learning to use devices, rather it is having students think critically and develop digital technologies in accurate and ethically acceptable ways, with humanity and people at the core (Bell & Duncan, 2015; Bell & Roberts, 2016; Starkey, 2016).

Bell (2016), a strong advocate for the inclusion of digital technologies into the general curriculum, states that developing a deeper understanding of aspects of computer programming is essential for students in the twenty-first century. He also states that computer programming is essentially about addressing human needs. "Understanding the nexus of human life and the discipline of programming is essential; in the 21st century, computer programs (also referred to as apps or software) permeate daily life" (Bell, 2016, p 13). Another driver of the digital technologies movement is the push for more students to become creators of software, thus assisting economic activity and independence (Bell, 2016). Rushkoff (2010) suggests that those who are not involved in programming will become programmed.

The inclusion of digital technologies has, however, highlighted a number of issues fuelling the debate, including the identification of content knowledge and how to situate this in the curriculum. A significant issue in the implementation of digital technologies is its relationship with other subjects. Traditionally, students who typically did either workshop technology/ home economics-food technology or 'typing' renamed 'computing' as computers replaced typewriters in our schools, were considered those who were unable to undertake 'more academic' subjects. Implementation of a successful digital technologies curriculum in alignment with these technical subjects, therefore, depends on a considerable shift in public perception especially by school senior management, parents, universities and employers (Bell et al., 2014).

Another issue, particularly in the primary school, is the overcrowded curriculum (Morgan & Craith, 2015; Sjøberg, 2001) and the increased teacher workload (Morgan & Craith, 2015). However, Bell (2016) suggests there was no need to remove aspects of curriculum as the learning of computer science concepts assist in the teaching of a number of mathematical concepts and increase the learning pace for students through authentic use of concepts such as sequencing also applicable to writing, mathematics and science, and rotation and angles also applicable to mathematics and science.

The final issue related to the implementation of digital technologies into the school curriculum is the need for teacher professional development. In order to implement a new curriculum, teachers need to undertake significant on-going professional development and be provided with support resources. There is also an additional danger of increased teacher workload. In their member survey report to the New Zealand Ministry of Education on the implementation of digital technologies into the New Zealand Curriculum, the then New Zealand Association of Computer, Digital and Information Technology Teachers (NZACDITT), now known as Digital Technology Teachers of Aotearoa (DTTA- Aotearoa is the Māori name for New Zealand), identified a number of concerns. One was how the curriculum implementation would be funded and resourced (McMahon, 2015). Falkner et al. (2014) identified potential difficulties in the translation of digital technology materials into an existing curriculum and the need for quality teacher professional development. With the implementation of digital technologies in Australia, teachers were

provided free professional development in the area through the provision of massively open online courses (MOOC) (Vivian, Falkner, & Falkner, 2014), addressing the issue.

Implementing Digital Technologies within Technology Education

To understand fully the place of digital technologies within technology education, we first need to have a deep and insightful understanding of the underlying philosophy of technology education (de Vries, 2005). Technology education, although a relatively late comer to the academic domain, is well established (de Vries, 2017). Essentially, technology education is about designing and developing technological outcomes, understanding how to undertake a rigorous design and development process and to situate technology within the human and physical worlds through the identification and understanding of impacts and influences technology has on planet Earth and its people. Technology education offers an holistic approach to education within which students best work immersed in authentic learning contexts to solve technological problems (Turnbull, 2002). Technology education is **not** about just making technological products or artefacts with the purpose of learning pre-determined sets of specific skills, as was common in former technical programmes. It is about students becoming skilful and knowledgeable enough to enable the development of successful, socially situated technological outcomes. Technology education is about students learning to understand how technologies and people interact and influence each other, as well as designing and developing outcomes that are fit for purpose (Compton & France, 2006).

Learning in the twenty-first century presents teachers with the challenge of equipping students with skills and knowledge necessary to survive in the digital age and beyond. Many new ideas challenge current educational assumptions, and schools need to change significantly to meet the new and emerging needs of today's students (Gilbert, 2005). Many education programmes continue to be out of step with students' current lives and seem irrelevant to their future lives (Bellanca & Brandt, 2010). Skills supporting innovation, creativity, critical thinking, and problem solving are needed to fulfil the expectations of the new economy (Compton, 2010). Wagner (2008) advocates seven survival skills for the twenty-first century:

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

Bellanca and Brandt (2010) suggest a number of core twenty-first century themes, which in essence are the same as those above but also include the need for literacy in media, information and communication. In considering the requirements for twenty-first century learning, Claxton (2007) also identifies the need for a different focus of student learning, therefore an epistemic culture change is needed in schools to replace stand-alone courses with thinking skills or 'tricks of the trade' type learning.

There is a danger that implementation of digital technologies, especially computation thinking, if taught in isolation, becomes a series of skills and facts that students are expected to learn without fully understanding their contextualized role and purpose. It is acknowledged that many skills and concepts need to be taught for students to develop confidence and competence in computer science and programming during their school years (Bell et al., 2014). Digital technology learning must emerge from within a social context and must not occur in isolation from people and their values and beliefs (Ministry of Education, 2017a). It is imperative that students learn digital technologies within an authentic context and be given opportunities to explore, to collaborate, and to be creative and resilient within purposeful learning. Technological outcomes should be constructed within a particular culture, taking into consideration the needs of the society in which they are developed, and those of their developers (Bellanca & Brandt, 2010; Fleer & Jane, 1999). The need for skills and knowledge, therefore, becomes authenticated because students understand the purpose of their learning (Turnbull, 2002). This, in turn, leads to better engagement by and motivation in students (Fox-Turnbull & Snape, 2016; Snape & Fox-Turnbull, 2011). By teaching the designing and developing of digital technologies and computational thinking in an holistic fashion, using authentic contexts for learning, teachers can be assured that their students will be given the best opportunities for success.

Digital Technologies situated within Technology Education in *The New Zealand Curriculum.*

Recently, the New Zealand Minister of Education indicated the need for a greater and more explicit focus on the digital technologies curriculum (Ministry of Education, 2017a).The Ministry of Education (MOE) (2017a, p. 5) states that children and young people often arrive at school already knowing how to use digital technologies – but learners also need to be able to understand and create digital technologies to succeed in further education and the world of work (Bell et al., 2014). The definition of technology education identifies that students are taught to intervene in the man-made world by designing and developing technological outcomes (Ministry of Education, 2007), and there is a very clear directive from this Ministry of Education that digital technology is about designing and developing digital outcomes (Ministry of Education, 2017c) and belongs in technology education.

New Zealand has identified that the demand for digitally skilled people is far in excess of those who are available to work in digitally related fields. Increasing workforce capabilities in this area will, undoubtedly, better position New Zealand in the global market place. The Ministry of Education has thus recognised the need to change the curriculum to enable students to be better prepared for, and to flourish in, their digital world, within which technologies are forever changing and evolving (Ministry of Education, 2017c). They noted that in strengthening the position of digital technologies in the curriculum:

> Once this new curriculum is introduced, our kids will not just be using devices like computers and smart phones. The changed curriculum will mean that schools will be teaching our young people foundational computer science principles for all digital technologies. Students will find out about how computers work – understanding what makes 'algorithms' and 'binary code.' (Ministry of Education, 2017c)

They will be programming digital components, devices and applications, and finally, how humans and computers interact were added to these topics (Bell & Duncan, 2015).

In New Zealand technology education, students work occurs across five technological areas (Ministry of Education, 2007) ensuring they gain a range of experiences and contexts within their studies. These included biotechnology, control, food, information and communication and structural technologies. These technological areas have been reorganised and renamed to ensure digital technologies have a stronger and more explicit presence in the curriculum. The new five technological areas are:

- Computational thinking for digital technologies;

- Designing and developing digital outcomes;

- Designing and developing materials outcomes;

- Designing and developing processed outcomes; and

- Design and visual communication (DVC)(Ministry of Education, 2017b).

Table 1 identifies possible links between the 2007 and 2018 areas of technology and aims to illustrate that aspects of the previous curriculum have not been replaced by digital technologies.

Table 1: Links between the 2007 and 2018 Technological Areas.

Technological Areas	
2018	2007
Computational thinking for digital technologies	Not included
Designing & developing digital outcomes	Aspects of: • control technology, electronics • information and communication technologies
Designing & developing materials outcomes	Structural technology including: • resistant materials (wood, plastic, metal, resin) • garment and fashion design Aspects of control technology such as: • hydraulics, • pneumatics, • e-textiles
Designing & developing processed outcomes	• Food technology • Biotechnology • Textile design (new materials and fabrics)
Design & visual communication	Previously an aspect of all design and situated across all technological areas with DVC specialism at senior secondary school.

The Digital Technologies document (Ministry of Education, 2017a, 2017b) states that the existing strands of technology: Technological Practice, Technological Knowledge and Nature of

Technology are embedded within each of the technological areas. In the two new areas, progress outcomes also provide expectations of learning steps from Years 1-13.

Process undertaken by New Zealand to determine the Place of Digital Technologies

New Zealand was an early adopter of computer science in secondary schools (Bell & Roberts, 2016). In the early 2000s, national assessment for senior secondary students was available through unit standards in computer science. Unit standards were not a popular choice with 'academic' students as they were not able to gain 'merit' or 'excellence' grades as unit standards were only assessed as 'achieved' or 'not achieved' (Bell et al., 2014). Digital technologies became a technology subject in National Certificate in Educational Achievement (NCEA) qualification beginning with Year 11 in 2011, with Level 1 achievement standards (AS) rolling out to Year 13 in 2013 at Level 3. This change was a part of the NZC/NCEA alignment project which aimed to align the 2007 curriculum (Ministry of Education, 2007) with NCEA assessment standards. At this time, no change was made to NZC. The emphasis was on breadth rather than depth and aimed to assist students with informed career choices (Bell et al., 2014). This change meant considerable up-skilling for teachers to enable coverage of a range of computer science related topics including programming, algorithms, computer human interaction, encryption, artificial intelligence, formal languages, and computer graphics, among others. Prior to this, there had been some initial teaching of computer programming as a part of the mathematics curriculum from 1974 to 1985. Between 1985 and 2011, as school computers became more mainstream, the teaching and learning focus shifted to teaching students how to learn to use computers.

When technology education was introduced into *The New Zealand Curriculum* in 1995, 'Information and Communication technologies' was one of the then seven technological areas. Electronics and Control technologies was another (Ministry of Education, 1995). The year 2007 saw the revised *New Zealand Curriculum* released, and the technological areas of Information and Communication Technology and Control Technology were retained (Ministry of Education, 2007). However, there were concerns that many schools did not engage with topics situated within these technological areas, despite some attempts to guide teachers into deeper and richer approaches to computing education (Bell et al., 2014).

Issues were raised by the Information Technology (IT) industry in a report released by the New Zealand Computer Society (now known as The Institute of IT Professionals - IITP) in 2008. The main concern was that the generic achievement standards of technology did not obviously relate to digital technology (Grimsey & Phillipps, 2008). This led to the society calling for a separation of Computer Science from the technology education curriculum and for it to have its own learning area within the New Zealand curriculum (Bell et al., 2014). Many in technology education disagreed with the view of the report and felt that it was based on a narrow and out-dated view of learning and technology education.

In 2015, the Education Minister undertook a systematic approach to examining the curriculum to determine the place of digital technologies within NZC, undertaking a number of steps recommended for curriculum change and enabling both scholars and practitioners to reach independent conclusions about desirability (Glatthorn, Boschee, & Whitehead, 2009). Called together to a series of three meetings held throughout 2015, were a panel of experts from a range of relevant sectors to debate the place of digital technologies in the curriculum (Starkey, 2016). At the first meeting, with this author in attendance, the Associate Deputy Secretary indicated the

Ministry was using a new approach to curriculum development. Instead of approaching and consulting with each sector individually as they had in previous consultation processes, all interested parties were invited to this series of meetings to discuss and debate the issue and develop a recommendation for the Minister of Education to consider. The sectors and organisations represented at the meetings included:

- initial and in-service teacher education providers;
- primary schools, secondary schools, early childhood centres (including Māori medium);
- computer science researchers;
- three teacher subject associations (Technology Education New Zealand, TENZ; New Zealand Graphics and Technology Teachers Association, NZGTTA; New Zealand Association of Computer and Digital and Information Technology Teachers, DTTA);
- information technologies industries;
- the New Zealand Qualifications Authority (NZQA);
- the Education Review Office (ERO);
- the primary and secondary teacher unions (NZEI and PPTA);
- the Eureka trust;
- the Royal Society;
- the Schools' Trustees Association (NZSTA);
- Kia Ata Mai Educational Trust;
- Education Council; and
- Kura Kia Kohe.

A wide range of views was held and vigorously debated in the first of the three meetings (Starkey, (2016). It became obvious that a research-informed framework would be required to further discussion. Some participants presented views from their organisations, these included Professor Tim Bell (University of Canterbury computer science department), Julie McMahon (NZACDITT), Dr Wendy Fox-Turnbull (TENZ) and Paul Matthews (IITP). The Institute for IT Professionals advocated strongly for a separate curriculum area (IITP, 2015). TENZ strongly advocated for digital technology remaining within technology. NZACDITT offered a balanced argument for staying within technology, with a number of cautions noted, and Professor Bell indicated that staying within the technology curriculum was a possibility, but not necessarily the most desirable outcome, as digital technologies needed a much stronger presence than was currently in the technology curriculum.

Ultimately, the recommendation that went forward to the Minister of Education in December 2015 suggested that digital technologies should remain situated within the technology learning area, but would receive a far greater presence than that currently occupied. On July 12 2016, the Minister announced a strengthening of digital technologies within NZC situated under the umbrella of technology education, coming into effect in 2018. Professional learning development (PLD) was to begin Term 1 2018, with full implementation of the Digital Technologies/ Hangarau Matihiko curriculum (Ministry of Education, 2017b) in Term 1 2020.

Implementing Digital Technologies into NZC-Technology

McGee (1997) suggests a five step model to curriculum development (see Figure 1). In line with this model, the New Zealand Ministry of Education planned a development process to ensure a multi-pronged approach to the development and implementation of digital technologies. Five working groups identified the nature and format of the new look technology curriculum as an

overall plan for implementation. Undertaking a similar and parallel process, Māori developed Hangarau Matihiko.

These five working groups facilitated the meeting of the five elements from McGee's model (in brackets) and were:

- Enablement & Change (Situational, Intentions);
- Implementation & Support (Learning and Teaching);
- Partnerships (Intentions, Content);
- The Learner Journey and User Voice (Intentions and Learning and Teaching); and
- National Certificate of Educational Achievement (NCEA) (Intentions, Evaluation and Teaching).
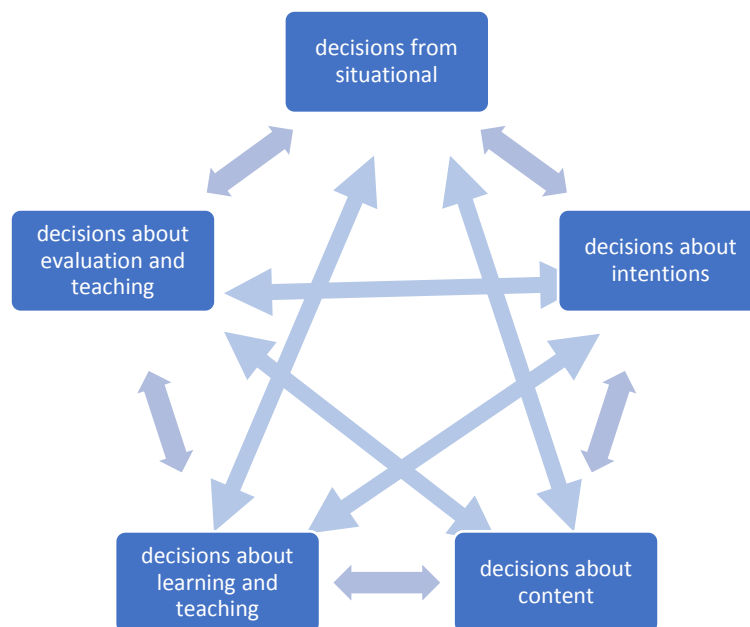

Figure 1: A Curriculum Development Model
(McGee, 1997)

This work culminated in the launch of the Digital Technologies/ Hangarau Matihiko: Draft for Consultation curriculum document (Ministry of Education, 2017a) in June 2017. New content included two new technological areas of *computational thinking* and *designing and developing digital outcomes* containing unique Māori content. At its launch, the Minister of Education with the Prime Minister, also announced that the government would spend $40 million on raising teachers' skills to deliver the new curriculum, to enable all pupils from Years 1-10 to take part in digital technologies education.

The Ministry of Education established a curriculum advisory group (CAG) as an independent panel of experts commissioned to advise the Ministry on the draft curriculum content. This advice was to include input from the working groups and provide recommendations on feedback received during consultation. This work was collated in the *Curriculum Advisory Group Report* (Curriculum Advisory Group, 2017). Significant projects undertaken by the working parties

included a drafting of the proposed new structure of technology/ hangarau, the first and final drafts (see Figures 2 & 3). The rewritten essence statement provided an overview of the curriculum area, reflecting the inclusion of digital technologies (Ministry of Education, 2017a) and learning progression for Years 1-10 students with new content. The New Zealand Qualifications Authority also modified NCEA achievement standards for senior secondary assessment.
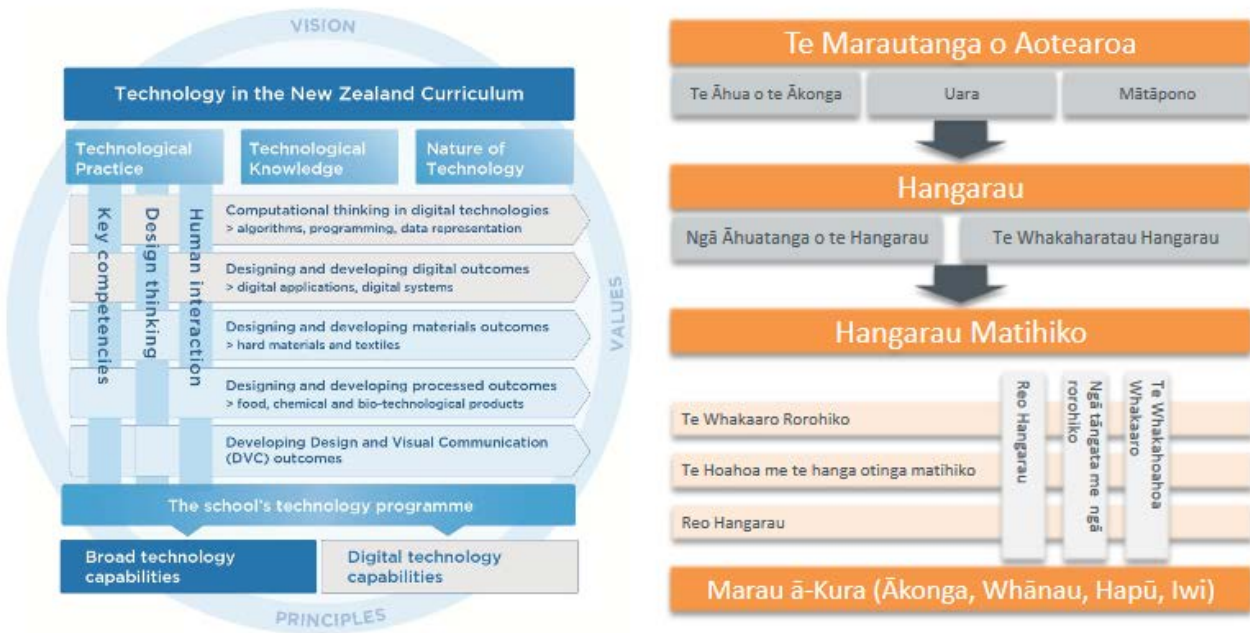

Figure 2: First draft proposed models for technology education and hangarau matihiko (Ministry of Education, 2017a)

A carefully planned and delivered consultation process followed to ensure both the English medium and Māori medium sectors could respond to the proposed changes to the curriculum. The Ministry of Education commissioned the process including questionnaires, workshops, written submissions, analysis and collation of all feedback. This work culminated in the release of a report in November 2017 (Jenkins, 2017). This report indicated that the proposed changes were seen as a positive move, although questions were raised about progressions, implementation at Years 9 and 10, links to Te Whāriki (early childhood curriculum), and their application in partnership schools and other alternative schools such as Steiner schools (Jenkins, 2017).
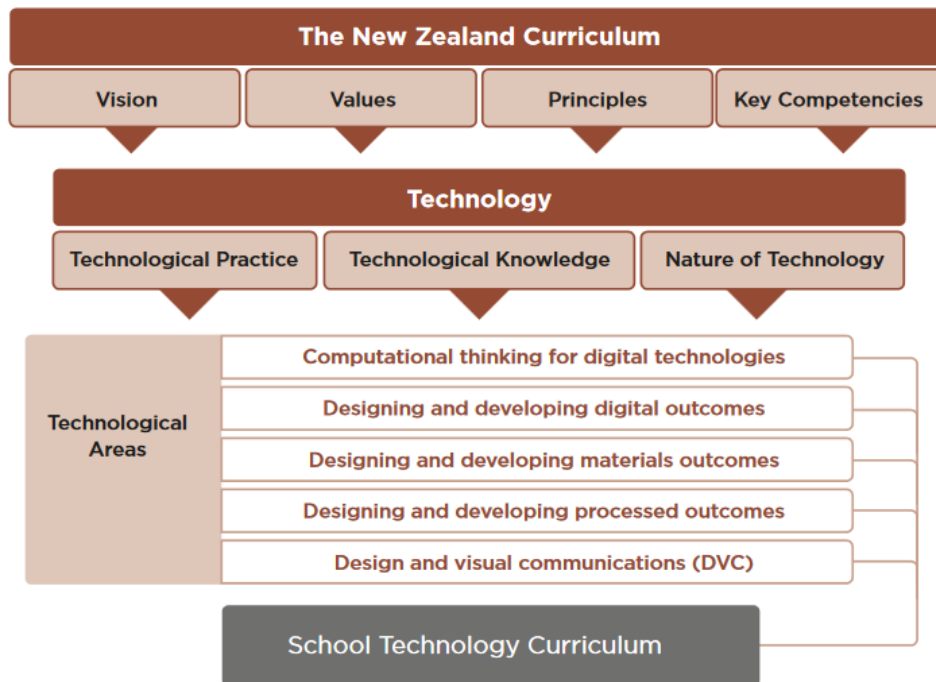
Figure 3: The released draft structure of technology
(Ministry of Education, 2017b)

Another project undertaken by the working parties was school trialling of aspects of the new strands. These trials were performed with the help of commissioned progress experts in Educational Technologies. The features of the strands that were put to the test were computational thinking for digital technologies, designing and developing digital outcomes, and subsequently writing of the draft progress outcomes of which there are eight for each strand. These proposed outcomes were also published in the draft curriculum (Ministry of Education, 2017a).

The CAG report (Curriculum Advisory Group, 2017) made 43 recommendations related to each of the working groups which offered useful comments for the Ministry of Education. A number of these recommendations are worth mentioning as they illustrate the iterative and consultative nature of the process. These were that:

- consultation needs to continue alongside research, piloting and implementation;
- there is need for greater visibility of Te Ao Māori and Te Tiriti in the Learning Area Statement and Progress Outcomes (PO) but warns against the shallow, decontextualized inclusion of Māori concepts;
- to avoid confused implementation and reporting, and unintended future consequences, the other three technological areas replace Achievement Objectives (AO) with PO OR that the language of PO/AO be clarified to reduce confusion for teachers;
- all language in the curriculum likely to date be removed (e.g. LAN, PC);
- a dedicated Professional Learning and Development (PLD) plan to bring current and new teachers (i.e. teachers in training) up to speed is developed in consultation with the Education Council of New Zealand;

- Digital Technology is part of a curriculum area in its own right with its own content, understanding and capabilities, and not just a pedagogical vehicle/tool for delivering the whole curriculum; and
- that a new name for technology that incorporates the word 'Digital' be implemented and suggests Digital and Materials Technology as one possibility.

This work ultimately led to the release of the revised technology curriculum for New Zealand (Ministry of Education, 2017b) represented in Figure 4.
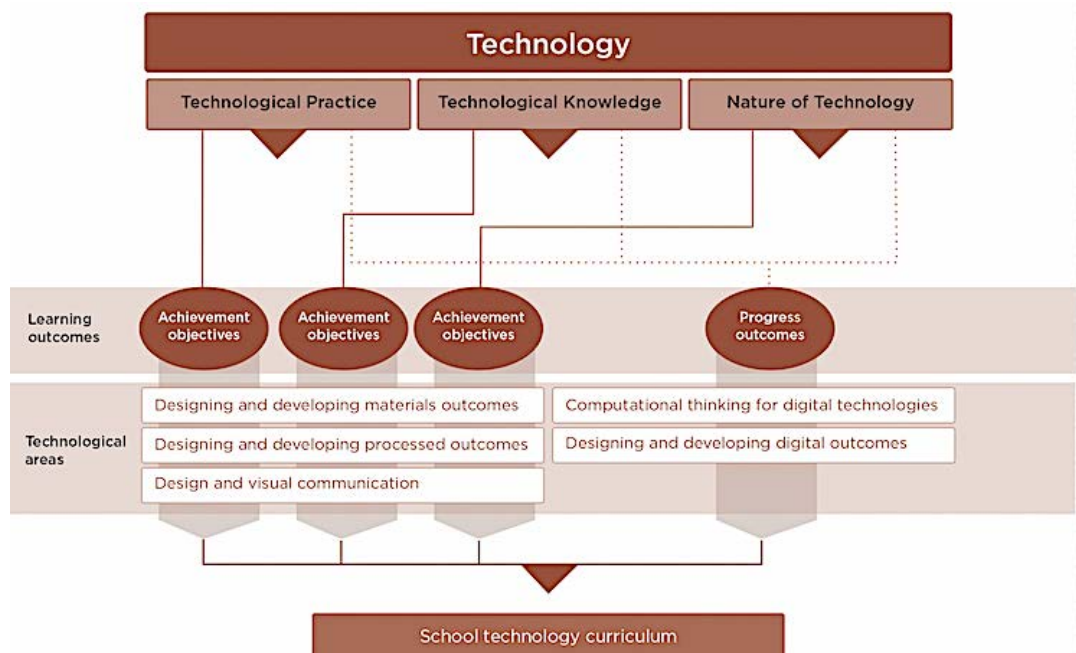

Figure 4: The final structure of technology *(Ministry of Education, 2018)*

Discussion and Conclusion

Over the last two years, the New Zealand Ministry of Education has undergone a number of very thorough consultation processes to determine firstly, the place of digital technologies in the curriculum; secondly, the structure of a proposed revised curriculum to incorporate digital technologies within technology education; and thirdly, the development of the content of the proposed digital technologies curriculum.

McGee's (1997) model of curriculum development implementation recommends five aspects to the implementation process. The process undertaken by the Ministry of Education includes all five aspects of McGee's model. The process has been transparent and rigorous with a large number of interested parties having the opportunity to engage if desiring to do so. The Ministry has contracted the implementation of professional development to 44,000 teachers over the three years from February 2018.

Digital technologies, like technology education, are aimed quite purposefully at teaching students to design and develop technological outcomes within authentic contexts. This article presents the argument that digital technologies are well-situated within technology. Their incorporation into

the curriculum will place learners in a strong position to be digitally capable and literate citizens able to contribute productively to the digital economy as developers and consumers.

However, a dichotomy occurs when the state systematic curriculum, designed to ensure students meet national standards of learning such as the digital progress outcomes, are laid over constructivist-based pedagogy (Null, 2017). Student-centred, needs-based learning, as is common in New Zealand, requires inquiry-based learning, a common pedagogical approach used in a range of learning areas including technology, within which students learn skills and knowledge on a needs basis (Kuhlthau, Maniotes, & Caspari, 2007). Not all students will be learning the same skills and knowledge at the same time. This is in contrast to the teaching and learning of prescribed standards, thus the identification of a major risk of the proposed changes outlined in the article. The two new digital technological areas have progress outcomes written, trialled and published (Ministry of Education, 2017a). The risk is that teachers will teach progression outcomes in an isolated fashion. This leads to the possibility that technology programmes become skills-based as teachers and students come to terms with computer science and computation thinking skills and understanding. To counter this, it is vital that teachers ensure authentic learning contexts be used to situate students' learning and that the teaching of needs-based contextualised skills occurs. This requires deep knowledge and understanding of digital technology, technology education and related Pedagogical Content Knowledge (PCK) and careful planning of school and class programmes of work.

Teachers are increasingly pushed for teaching and learning time within a crowded curriculum. A second risk is that digital technologies, with their increased presence in the curriculum, will be perceived as more important than, and will replace, materials and process technologies. Again, well-informed programmes of work and a team-based approach within schools can ensure coverage of all aspects of the technology curriculum. Vital on-going monitoring by the Ministry of Education and the Education Review Office, and substantive professional development programmes for all teachers and student teachers offer the potential to mitigate these risks.

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References

Armoni, M. (2016). Computer science, computational thinking, programming, coding: the anomalies of transitivity in K-12 computer science education. *ACM Inroads, 7*(4), 24-27.

Bell, T. (2016). *What's all the fuss about coding?* Paper presented at the Primary and Secondary Computing Education Conference 2016.

Bell, T., Andreae, P., & Bobins, A. (2014). A case study of the introduction of computer science in NZ schools. *ACM Transactions on Computing Education, 14*(2), 10.10-10.31. doi:http://dx.doi.org/10.1145/2602485

Bell, T., & Duncan, C. (2015). *Proposed digital technologies curricula up to NZC level 5.* Retrieved from Christchurch, NZ:

Bell, T., & Roberts, J. (2016). Computational thinking is more about humans than computers. *Set, 1*(2016), 3-7. doi:10.18296/set.0030

Bellanca, J., & Brandt, R. (Eds.). (2010). *21st century skills: rethinking how students learn*. Bloomington IN: Solution Tree Press.

Claxton, G. (2007). Expanding young people's capacity to learn. *British Journal of Educational Studies, 55*(2), 115-134.

Compton, V. (2010). A new technological literacy. *Technological Literacy*, 3. Retrieved from http://www.techlink.org.nz/curriculum-support/pdfs/tech-literacy.pdf

Compton, V., & France, B. (2006). *Discussion document: background information on the new strands*. Wellington Retrieved from www.techlink.org.nz.

Computer Science Education Research Group. (2018). CS unplugged. 4.0.0. Retrieved from https://csunplugged.org/en/

Crotty, M. (1998). *The foundations of social research*. Sydney: Allen and Unwin.

Curriculum Advisory Group. (2017). *Curriculum advisory group report: digital technologies/ hangarau matihiko*. Retrieved from Ministry of Education: http://education.govt.nz/assets/Documents/dthm/Nov-17-update/Digital-Curriculum-Consultation-CAG-Report.pdf

de Vries, M. (2005). *Teaching about technology: an introduction to the philosophy of technology for non-philosophers* (Vol. 27). Dordrecht, The Netherlands: Springer.

de Vries, M. (2017). Philosophy of technology: themes and topics. In M. de Vries (Ed.), *Handbook of technology education* (pp. 7-16). Cham, Switzerland: Springer.

Duncan, C., & Bell, T. (2015). *A pilot computer science and programming course for primary school students. Paper presented at the , *. Paper presented at the Workshop in Primary and Secondary Computing Education Conference, London: England.

Duncan, C., Bell, T., & Tanimoto, S. (2014). *Should your 8-year-old learn coding?* Paper presented at the Workshop in Primary and Secondary Computing Education Conference Berlin, Germany.

Education Gazette Editors. (2016). Digital technologies to become part of the national curriculum. *Aotearoa New Zealand Education Gazette Tukutuku Kōrero, 95*. Retrieved from https://gazette.education.govt.nz/articles/digital-technologies-to-become-part-of-the-national-curriculum/

Falkner, K., Vivian, R., & Falkner, N. (2014). *The Australian digital technologies curriculum: challenge and opportunity.* Paper presented at the Australasian Computing Education Conference (ACE), Auckland, New Zealand.

Fleer, M., & Jane, B. (1999). *Technology for children; developing your own approach*. Erskineville Australia: Prentice Hall

Fox-Turnbull, W. (2017). *TENZ response to digital curriculum*. Technology Education New Zealand. Christchurch, N.Z.

Fox-Turnbull, W., & Snape, P. (2016). Exemplary Teaching Practice in Technology & Engineering Education. In M. Hoepfl (Ed.), *CTETE 62nd Yearbook* (pp. 1-30). Boone, USA: Council of Technology and Engineering Teacher Education.

Gander, W., Petit, A., Berry, G., Demo, B., Vahrenhold, J., McGettrick, A., . . . Meyer, B. (2013). *Informatics education: Europe cannot afford to miss the boat. Report of the joint informatics Europe & ACM Europe working group on informatics education*. Retrieved from http://www.fit-in-it.ch/sites/default/files/small_box/Informatics%20education_final.pdf

Gilbert, J. (2005). *Catching the knowledge wave? The knowledge society and the future of education*. Wellington: NZCER Press.

Glatthorn, A., Boschee, F., & Whitehead, B. (2009). *Curriculum leadership: strategies for development and implementation*. Thousand Oaks. CA: Sage Publications.

Grimsey, G., & Phillipps, M. (2008). *Evaluation of Ttechnology achievement standards for use in New Zealand secondary school computing education: A critical report*. Retrieved from Wellington: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.208.8737&rep=rep1&type=pdf

IITP. (2015). *The digital learning area: a possible model for the future of digital technologies education in New Zealand schools*. Institute of IT Professionals. Wellington, NZ.

Jenkins, M. (2017). *Digital technologies/hangarau matihiko consultation final report*. Retrieved from http://education.govt.nz/assets/Documents/dthm/Nov-17-update/Martin-Jenkins-DT-HM-consultation-report.pdf

Kuhlthau, C., Maniotes, K., & Caspari, A. (2007). *Guided inquiry: learning in the twent first century*. Westport CT: Libraries Unlimited Inc.

McGee, C. (1997). *Teachers and curriculum decision making*. Palmerston North: The Dunmore Press.

McMahon, J. (2015). *NZACDITT summary of member responses*. NZACDITT Dunedin, NZ.

Ministry of Education. (1995). *Technology in the New Zealand curriculum*. Wellington: Learning Media.

Ministry of Education. (2007). *The New Zealand curriculum*. Wellington: Learning Media.

Ministry of Education. (2017a). *Digital technologies-Hangarau matihiki, draft for consultation*. In. Retrieved from https://education.govt.nz/assets/Documents/Ministry/consultations/DT-consultation/DTCP1701-Digital-Technologies-Hangarau-Matihiko-ENG.pdf

Ministry of Education. (2017b). Digital Technologies and the national curriculum – what's it all about? *Digital Technologies in the curriculum.* Retrieved from http://elearning.tki.org.nz/Teaching/Curriculum-areas/Digital-Technologies-in-the-curriculum

Ministry of Education. (2017c). Strengthening digital technologies hangarau matihiko in the curriculum. Retrieved from https://www.education.govt.nz/ministry-of-education/consultations-and-reviews/digital-technology-consultation/

Ministry of Education. (2018). The New Zealand Curriculum Online: Technology. Retrieved from http://nzcurriculum.tki.org.nz/The-New-Zealand-Curriculum/Technology

Morgan, M., & Craith, D. N. (2015). Workload, stress and resilience of primary teachers: Report of a survey of INTO members. *Irish Teachers' Journal, 3*(1), 9-19.

Null, W. (2017). *Curriculum: From Theory to Practice.* . Lanham, Maryland, USA: Rowman & Littlefield.

Papert, S. (1980). *Mindstorms: children, computers and powerful ideas*. New York: Basic Books Inc.

Pea, R. D. (1985). Beyond amplification: Using the computer to reorganize mental functioning *Educational Psychologist, 20*(4), 167-182.

Royal Society. (2012). *Shut down or restart? The way forward for computing in UK schools*. Retrieved from London: https://royalsociety.org/~/media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf

Rushkoff, D. (2010). *Program or be programmed: ten commands for a digital age*. New York Or Books.

Sjøberg, S. (2001). *Science and technology in education –current challenges and possible solutions*. Invited contribution to meeting of European Ministers of Education and Research. Uppsala

Snape, P., & Fox-Turnbull, W. (2011). Perspectives of authenticity: Implementation in technology education. *International Journal of Technology and Design Education* (early access online).

Starkey, L. (2016). An equitable curriculum for a digital age. *Curriculum Matters, 12*, 29-45.

Stuff. (2016). Digital Technologies coming to NZ curriulum(7 July 2016). Retrieved from http://www.stuff.co.nz/national/education/81763452/Digital-technology-coming-to-the-NZ-Curriculum

Turnbull, W. (2002). The place of authenticity in technology in the New Zealand curriculum. *International Journal of Technology and Design Education, 12*, 23-40.

Vivian, R., Falkner, K., & Falkner, N. (2014). Addressing the challenges of a new digital technologies curriculum: MOOCs as a scalable solution for teacher professional development. *Research in Learning Technology, 22*(0), 1-19.

Wagner, T. (2008). *The global achievement gap: why even our best schools don't teach the new survival skills our children need‐ and what we can do about it.* New York: Basic Books.

Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Syslo, M. M. (2017). Computer science in K-12 school curriculua of 21 century: why, what and when? *Educational Information Technology, 22*, 445-468. doi:10.1007/s10639-016-9493-x

Wing, J. M. (2006). Computational thinking. *Commun. ACM, 49*, 33-35.